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Electrical Experimenter

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Vol. VII. Whole No. 77 **Contents for SEPTEMBER, 1919** **No. 5**

EDITORIAL

HAIL

EVERY year millions of dollars' worth of crops and property are destroyed by hailstorms. Not infrequently human beings and cattle are killed, due to their inability to reach shelter in time. Of course such occurrences are not very frequent, which is explained by the fact that the average size of a hailstone is not much larger than a small hazelnut. But hailstones the size of a man's fist are by no means uncommon. Stones weighing two pounds have been observed, but these are very rare. But whatever their size or weight, hailstones are exceedingly destructive. Hurled from a great height, with a powerful wind accelerating their own speed, these frozen ice-pellets destroy vegetation at an appalling rate annually. Fruit on trees, crops and all vegetables are mowed down over great areas several times each year.

In the United States there is an average of over three hailstorms a year—Ohio leading with over ten such storms annually. Now the curious and outstanding fact about hailstorms is that nearly all of them occur during the summer, and practically none occur without thunder and lightning. There is nothing new contained in this statement—every child knows it. But here the writer would like to inject a new thought: namely, that the formation of hailstones is directly due to certain and as yet not clearly understood electrical processes. In other words, the formation of these round ice stones is the product of the electric current or static electricity.

This theory can be upheld by a few very simple arguments. In the first place, the height at which hail-clouds move is very low—never high enough to permit water to freeze. Proof: During all hailstorms rain always falls amid the hailstones, *and this rain is quite warm.* If the hail were formed by a sudden cold air wave, as our text-books want us to believe, where do the warm raindrops come from—or why does it not snow at least? However, it never does, particularly during the summer season.

But this is not all of the story. According to Jaentr, who investigated the subject thoroly, each hailstone is, as a rule, composed of a mass of mixed snow and ice in whose interstices there is held a gas—probably air or oxygen—powerfully comprest within the central cavity. If the hailstone is opened under water, the enclosed gas is seen to expand. According to Jaentr this gas is held under a pressure of as high as *fifty atmospheres!* We know that cold alone cannot produce such a result, but we do know that the electrical current under certain favorable circumstances can and does produce cold. However, we admit that our present knowledge is not sufficient to permit of a clear understanding of the complicated processes that take place in the formation of a hailstone. It should be a fruitful field for the investigator.

This brings us to a remedy for hailstorms. Many methods have been tried in the past to prevent these destructive storms—notably cannonading the clouds in France, Austria and Italy. No relief whatsoever was had.

But if we once admit the electrical nature of hailstorms and fully prove it, the remedy should be simple. Huge kites, larger than those built up to now and capable of carrying a thick, stranded copper cable, should be sent aloft immediately when storm clouds gather. At a ridiculously low cost a dozen such kites, spaced a mile apart, could draw the electrical charge to earth, thus emptying the clouds of their danger. It is worth a trial at least.

H. GERNSBACK.

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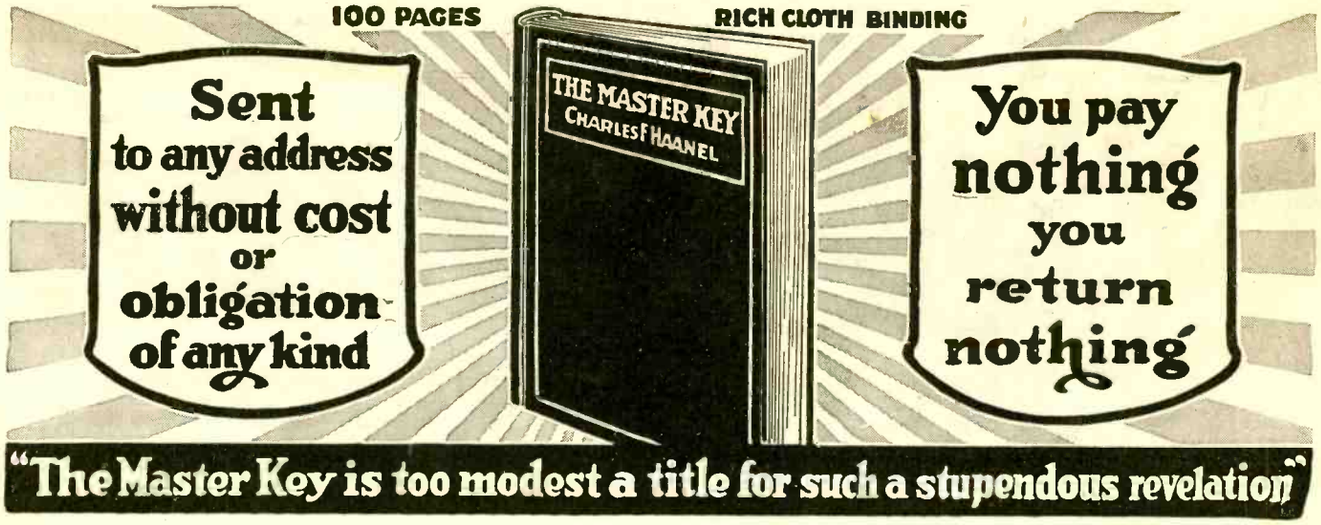

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Each issue of the RADIO AMATEUR NEWS now contains 48 pages (or more) and an artistic cover in two colors. The illustrations average 125 every month and there are from 40 to 50 up-to-date articles, some by our biggest radio scientists, in every issue.

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Junior Radio Course

By E. T. JONES
Associate Editor

A distinctly new feature begins with the September issue in our new **Junior Radio Course.** In this issue Lesson No. 1 will appear complete. This course is intended for the beginner and everything presented will be in plain English, even the merest tyro in radio will find no trouble in understanding and assimilating the knowledge. The series is a very important one and nothing like it has ever appeared in print before. Everyone owes it to himself in this new age to know something about wireless and this course will enlighten all laymen. Profusely illustrated with pictures that anyone can understand.

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Miss Evelyn Gosnell
in "Up in Mabel's Room"

Are You a Blond?

The Secret of Making People Like You

Wallace Reid
Star in "The Valley of the Giants"
A Paramount-Artcraft Picture

THE greatest asset any man can possibly have is the faculty for making people like him. It is even more important than ability.

The secret of making people like you lies in your ability to understand the emotional and mental characteristics of the people you meet.

Did you know that a blonde has an entirely different temperament than a brunet?—that to get along with a blond type you must act entirely different than you would to get along with a brunet?

When you really know the difference between blonds and brunets, the difference in their characters, temperaments, abilities and peculiar traits you will save yourself many a mistake—and you will incidently learn much you never knew before about yourself.

* * * * * * *

PAUL GRAHAM was a blond, and not until he learned that there was all the difference in the world between the characteristics of a blond and those of a brunet did he discover the secret of making people like him.

Paul had been keeping books for years for a large corporation which had branches all over the country. It was generally thought by his associates that he would never rise above that job. He had a tremendous ability with figures—could wind them around his little finger—but he did *not* have the ability to mix with big men; did *not* know how to make people like him.

Then one day the impossible happened. Paul Graham became popular.

Business men of importance who had formerly given him only a passing nod of acquaintance suddenly showed a desire for his friendship. People—even strangers—actually went out of their way to do things for him. Even *he* was astounded at his new power over men and women. Not only could he get them to do what he wanted them to do, but they actually anticipated his wishes and seemed eager to please him.

From the day the change took place he began to go up in business. Now he is the Head Auditor for his corporation at an immense increase in salary. And all this came to him simply because he learned the secret of making people like him.

You, too, can have the power of making people like you. For by the same method used by Paul Graham, you can, at a glance, tell the characteristics of any man, woman or child—tell instantly their likes and dislikes, and YOU CAN MAKE PEOPLE LIKE YOU: Here is how it is done.

Everyone you know can be placed in one of two general types—blond or brunet. There is as big a difference between the mental and emotional characteristics of a blond and those of a brunet as there is between night and day. You persuade a blond in one way—a brunet in another. Blonds enjoy one phase of life—brunets another. Blonds make good in one kind of a job—brunets in one entirely different.

To know these differences scientifically is the first step in judging men and women; in getting on well with them; in mastering their minds; in making them like you; in winning their respect, admiration, love and friendship.

And when you have learned these differences—when you can tell at a glance just what to do and say to make any man or woman like you, your success in life is assured.

For example, there's the case of a large manufacturing concern. Trouble sprang up at one of the factories. The men talked strike. Things looked ugly. Harry Winslow was sent to straighten it out. On the eve of a general walkout he pacified the men and headed off the strike. And not only this, but ever since then, that factory has led all the others for production. He was able to do this, because he knew how to make these men like him and do what he wanted them to do.

Another case, entirely different, is that of Henry Peters. Because of his ability to make people like him—his faculty for "getting under the skin" and making people think his way, he was given the position of Assistant to the President of a large firm. Two other men, both well-liked by their fellow employees, had each expected to get the job. So when the outside man, Peters, came in, he was looked upon by everyone as an interloper and was openly disliked by every other person in the office.

Peters was handicapped in every way. But in spite of that, in three weeks he had made fast friends of everyone in the house and had even won over the two men who had been most bitter against him. The whole secret is that he could tell in an instant how to appeal to any man and make him well-liked.

A certain woman who had this ability moved with her family to another town. As is often the case, it is a very difficult thing for any woman to break into the chill circle of society in this town, if she was not known. But her ability to make people like her soon won for her the close friendship of many of the "best families" in the town. Some people wonder how she did it. It was simply the secret at work—the secret of judging people's character and making them like you.

* * * * * * *

YOU realize, of course, that just knowing the difference between a blond and a brunet could not accomplish all these wonderful things. There are other things to be taken into account. But here is the whole secret.

You know that everyone does not think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant "hit" with anyone, if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you and believe in you and will go miles out of their way to PLEASE YOU.

You can do this easily by knowing certain simple signs. In addition to the difference in complexion, every man, woman and child has written on them signs as distinct as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

Knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advantage. Every great leader uses this method. That is why he IS a leader. Use it yourself and you will quickly become a leader—nothing can stop you.

You have heard of Dr. Blackford, the Master Character Analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker, Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

So great was the demand for these services that Dr. Blackford could not even begin to fill all the engagements. So Dr. Blackford has explained the method in a simple, seven-lesson course, entitled, "Reading Character at Sight." Even a half hour's reading of this wonderful course will give you an insight into human nature and a power over people which will surprise you.

Such confidence have the publishers in Dr. Blackford's course, "Reading Character at Sight," that they will gladly send it to you on approval, all charges prepaid. Look it over thoroughly. See if it lives up to all the claims made for it. If you do not want to keep it, then return it and the transaction is closed. And if you decide to keep it—as you surely will—then merely remit five dollars in full payment.

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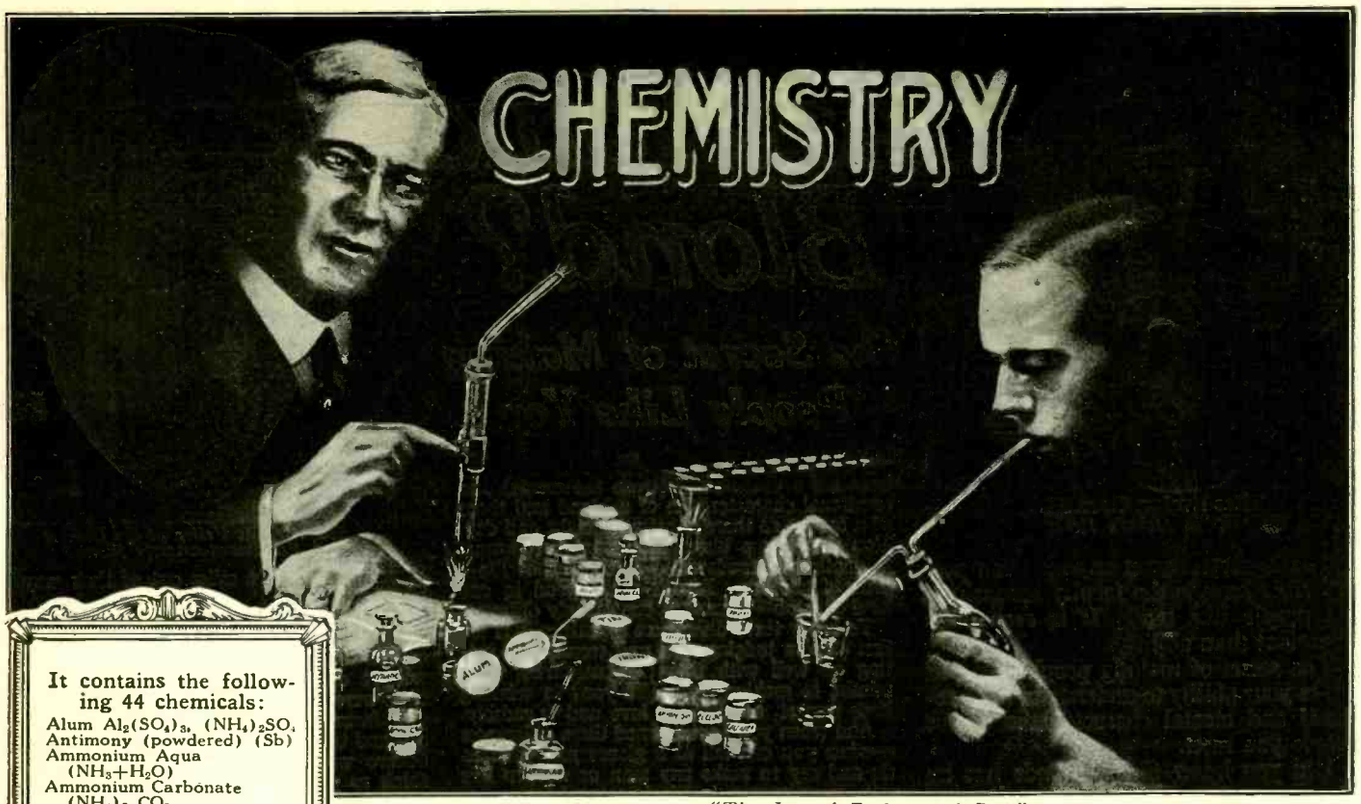

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The Instruction book is a real Chemistry Course for the Beginner. Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature:** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

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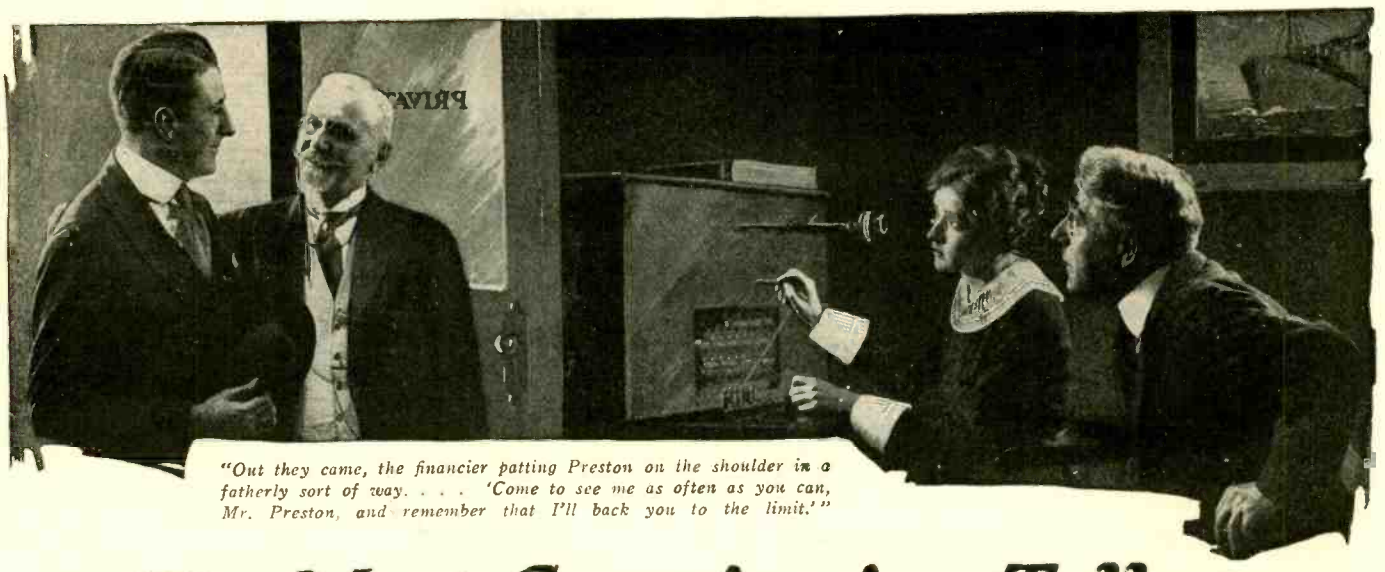

"Out they came, the financier patting Preston on the shoulder in a fatherly sort of way. . . . 'Come to see me as often as you can, Mr. Preston, and remember that I'll back you to the limit.'"

The Most Convincing Talker I Ever Met

Everywhere this man goes, people shower him with favors and seek his friendship. Things which other people ask for and are refused, he gets instantly. How he does it is told in this amazing story.

LET me ask you this: There is a big business deal to be put through. It involves millions of dollars. Putting it through depends wholly on one thing—getting the backing of a great financier.

But this man is bitterly opposed to your idea and to your associates. Seven of the most able men and women in all America have tried to win over this financier. They failed dismally and completely.

Now, could you, a total stranger to this man, walk in on him unannounced, talk for less than an hour, and then have him take your arm as a token of friendship, and give you a signed letter agreeing to back you to the limit?

Could you?

ASTOUNDING? Yes! But it *WAS* done. And I'll tell you how. Here is the way it all came about. For a long time the directors of our company had felt the handicap of limited capital. We had business in sight running into a million dollars a month. But we couldn't finance this volume of sales. We simply had to get big backing, and that was all there was to it.

Because of trade affiliations, one man—a great financier in New York—controlled the situation. Win him over and the rest was easy. But how to win him?—that was the question. No less than five men and two women—all people of influence and reputation—had tried. They were all repulsed—turned down cold and flat.

You know how a thing of this sort grows on you and how bitter utter defeat is. Well, we were talking it over at a board meeting when one of our directors announced that he knew of only one man who could possibly put through the deal—a man by the name of Preston.

So it was agreed that Preston was to be sounded out at luncheon the following day. He proved to be a fine type of American. At 34 years of age he had become president and majority stockholder of a thriving manufacturing business rated at three-quarters of a million dollars.

Preston was deeply interested, as anyone would be over the prospect of closing such a big deal. The director in question said casually, "Why don't you run down to New York and take a shot at it, Preston?" Preston looked out of the window for a moment, and then quietly answered, "You're on."

I WENT along with Preston simply as a matter of form to represent our interests. Aboard the 10:25 train out of Chicago we headed for the smoker and got to talking with the crowd there.

Then I noticed something. Preston had dominated them all. Everyone was eagerly hanging on his words, and looking at him with open admiration. No sooner would he stop talking than one of the men would start him up again. And as the men dropped off at stations along the way they gave Preston their cards, with pressing invitations to look them up. No doubt about it, Preston was *THE* man aboard that car.

The colored porter, too, came under his sway. For that night, when the berths were being made up, the porter came unasked to Preston, told him that his berth was right over the car trucks, and insisted upon changing it to a more comfortable one.

And so it went all the way to New York. Everyone who met Preston took a great liking to him the instant he spoke. They seemed to be eager for his companionship—wanted to be with him every minute, openly admired him, and loaded him with favors.

Even the usual haughty room clerk at the hotel showed a great interest in Preston's welfare. He showered us with attention while a long line of people waited to register.

The next morning we called on the great financier—the man who was so bitterly against us and had flatly turned down seven of our shrewd influential representatives.

I waited in the reception room—nervous, restless, with pins and needles running up and down my spine. Surely Preston would meet the same humiliating fate?

But no! In less than an hour out they came, arm in arm, the financier patting Preston on the shoulder in a fatherly sort of way. And then I heard the surprising words, "Come to see me as often as you can, Mr. Preston, *and remember that I'll back you to the limit!*"

AT the hotel that night sleep wouldn't come. I couldn't get the amazing Preston out of my thoughts. What an irresistible power over men's minds he had. Didn't even have to ask for what he wanted! People actually competed for his attention, anticipated his wishes and eagerly met them. What a man! What power! . . . Then the tremendous possibilities of it all—think what could be done with such power!

What was the secret? For secret there must be. So the first thing next morning I hurried to Preston's room, told him my thoughts, and asked him the secret of his power.

Preston laughed good-naturedly. "Nothing to it—I—well—that—is—" he stalled. "I don't like to talk about myself, but I've simply mastered the knack of talking convincingly, that's all."

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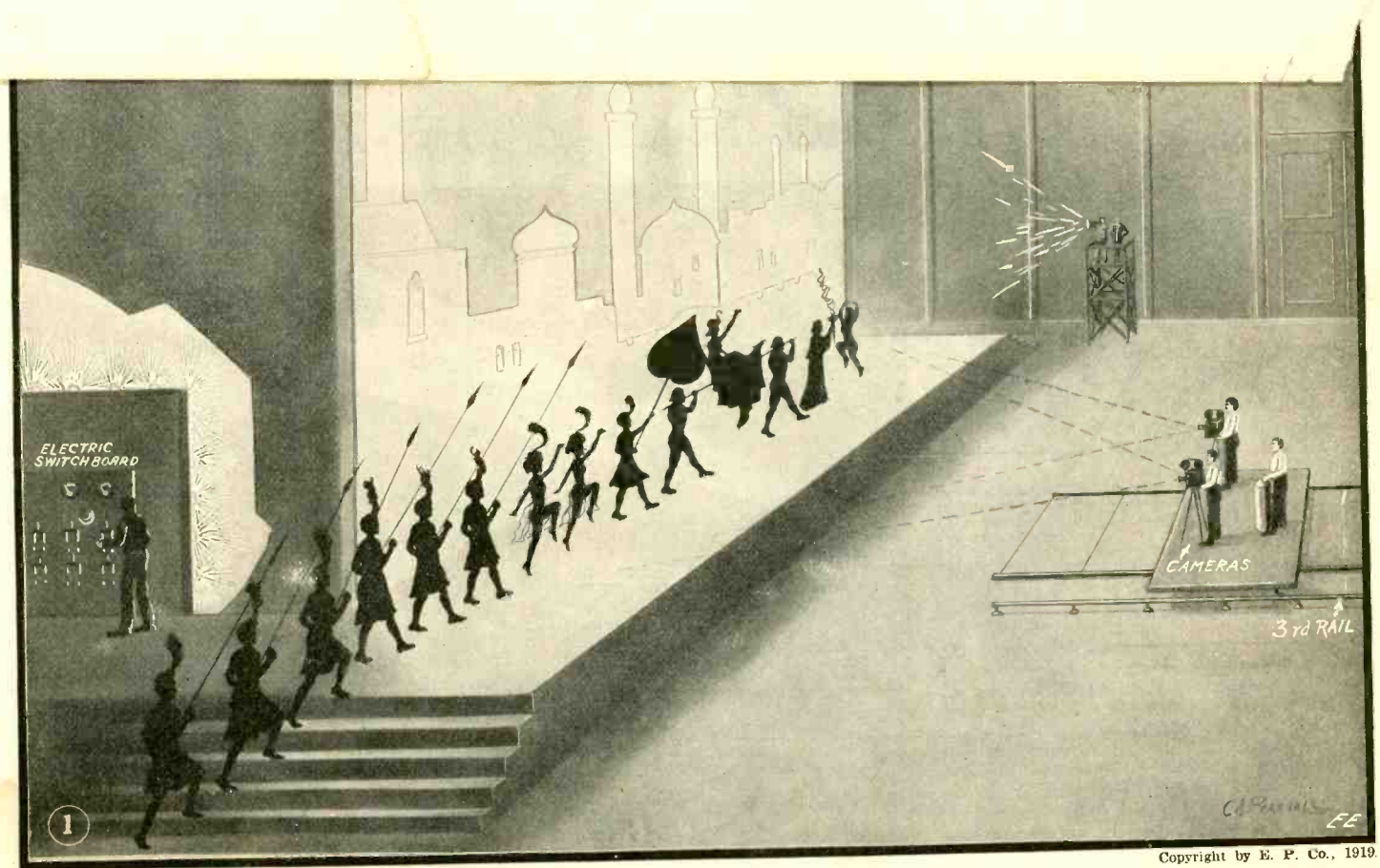

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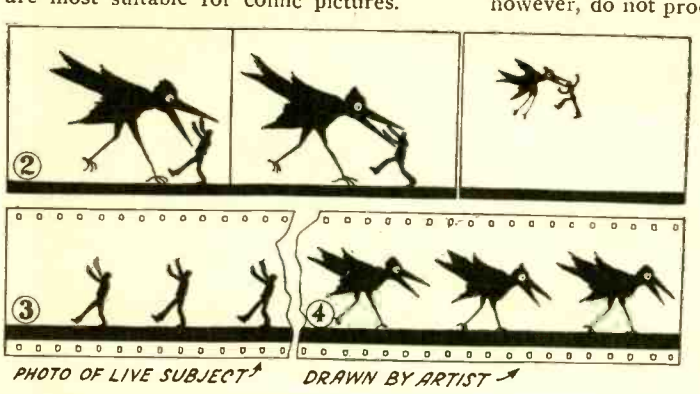

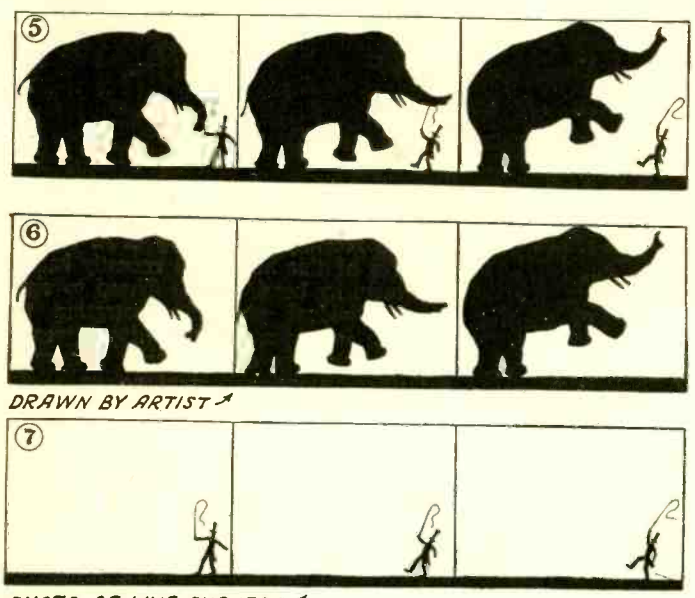

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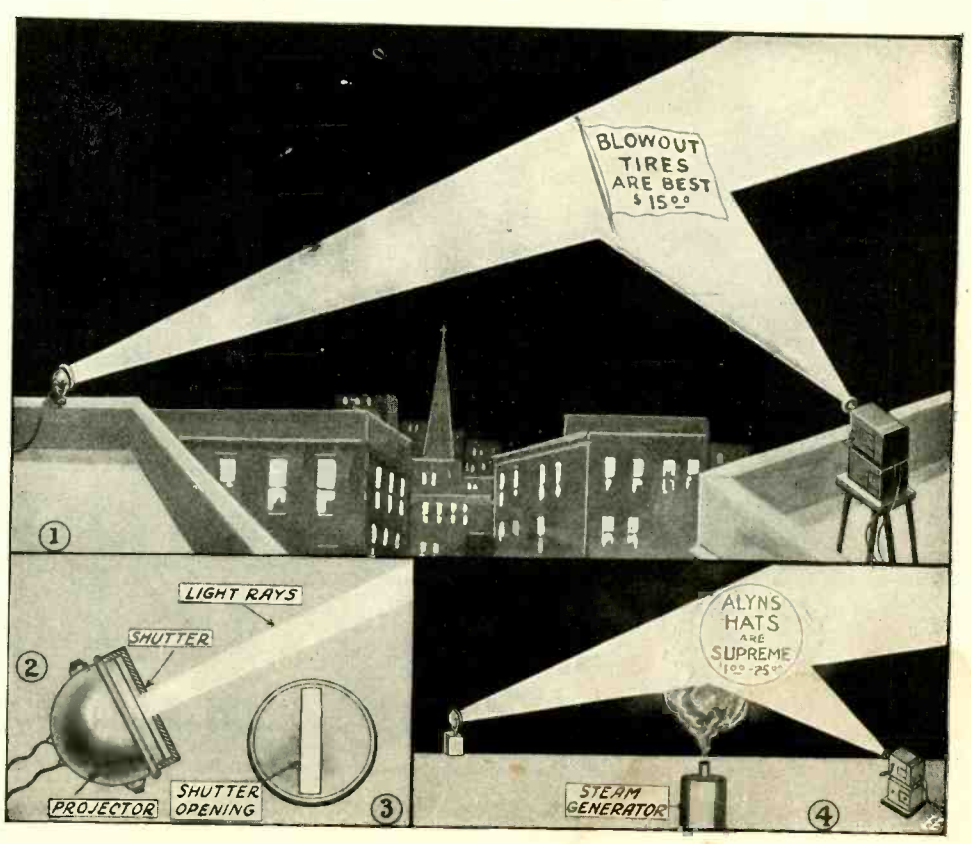

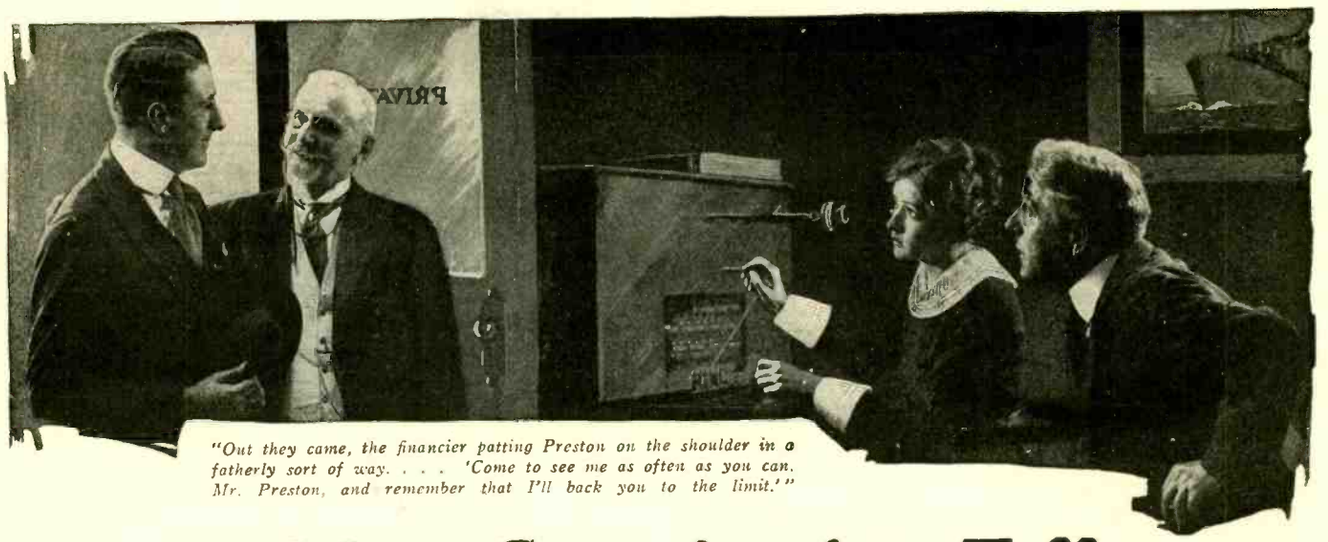

"Out they came, the financier patting Preston on the shoulder in a fatherly sort of way. . . . 'Come to see me as often as you can, Mr. Preston, and remember that I'll back you to the limit.'"

The Most Convincing Talker I Ever Met

Everywhere this man goes, people shower him with favors and seek his friendship. Things which other people ask for and are refused, he gets instantly. How he does it is told in this amazing story.

LET me ask you this: There is a big business deal to be put through. It involves millions of dollars. Putting it through depends wholly on one thing—getting the backing of a great financier.

But this man is bitterly opposed to your idea and to your associates. Seven of the most able men and women in all America have tried to win over this financier. They failed dismally and completely.

Now, could you, a total stranger to this man, walk in on him unannounced, talk for less than an hour, and then have him take your arm as a token of friendship, and give you a signed letter agreeing to back you to the limit?

Could you?

ASTOUNDING? Yes! But it *WAS* done. And I'll tell you how. Here is the way it all came about. For a long time the directors of our company had felt the handicap of limited capital. We had business in sight running into a million dollars a month. But we couldn't finance this volume of sales. We simply had to get big backing, and that was all there was to it.

Because of trade affiliations, one man—a great financier in New York—controlled the situation. Win him over and the rest was easy. But how to win him?—that was the question. No less than five men and two women—all people of influence and reputation—had tried. They were all repulsed—turned down cold and flat.

You know how a thing of this sort grows on you and how bitter utter defeat is. Well, we were talking it over at a board meeting when one of our directors announced that he knew of only one man who could possibly put through the deal—a man by the name of Preston.

So it was agreed that Preston was to be sounded out at luncheon the following day. He proved to be a fine type of American. At 34 years of age he had become president and majority stockholder of a thriving manufacturing business rated at three-quarters of a million dollars.

Preston was deeply interested, as anyone would be over the prospect of closing such a big deal. The director in question said casually, "Why don't you run down to New York and take a shot at it, Preston?" Preston looked out of the window for a moment, and then quietly answered, "You're on."

I WENT along with Preston simply as a matter of form to represent our interests. Aboard the 10:25 train out of Chicago we headed for the smoker and got to talking with the crowd there.

Then I noticed something. Preston had dominated them all. Everyone was eagerly hanging on his words, and looking at him with open admiration. No sooner would he stop talking than one of the men would start him up again. And as the men dropped off at stations along the way they gave Preston their cards, with pressing invitations to look them up. No doubt about it, Preston was *THE* man aboard that car.

The colored porter, too, came under his sway. For that night, when the berths were being made up, the porter came unasked to Preston, told him that his berth was right over the car trucks, and insisted upon changing it to a more comfortable one.

And so it went all the way to New York. Everyone who met Preston took a great liking to him the instant he spoke. They seemed to be eager for his companionship—wanted to be with him every minute, openly admired him, and loaded him with favors.

Even the usual haughty room clerk at the hotel showed a great interest in Preston's welfare. He showered us with attention while a long line of people waited to register.

The next morning we called on the great financier—the man who was so bitterly against us and had flatly turned down seven of our shrewd influential representatives.

I waited in the reception room—nervous, restless, with pins and needles running up and down my spine. Surely Preston would meet the same humiliating fate?

But no! In less than an hour out they came, arm in arm, the financier patting Preston on the shoulder in a fatherly sort of way. And then I heard the surprising words, "Come to see me as often as you can, Mr. Preston, *and remember that I'll back you to the limit!*"

AT the hotel that night sleep wouldn't come. I couldn't get the amazing Preston out of my thoughts. What an irresistible power over men's minds he had. Didn't even have to ask for what he wanted! People actually competed for his attention, anticipated his wishes and eagerly met them. What a man! What power! . . . Then the tremendous possibilities of it all—think what could be done with such power!

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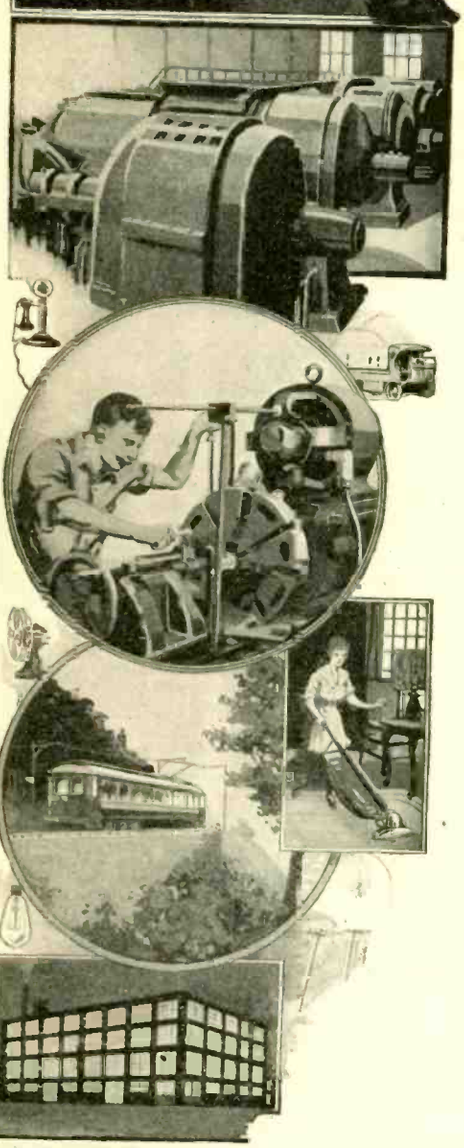

Master Electricity By Actual Practice

The only way you can become an expert is by doing the very work under competent instructors, which you will be called upon to do later on. In other words, *learn by doing.* That is the method of the New York Electrical School.

Five minutes of actual practice properly directed is worth more to a man than years and years of book study. Indeed, Actual Practice is the only training of value, and graduates of New York Electrical School have proved themselves to be the only men that are fully qualified to satisfy EVERY demand of the Electrical Profession.

The Only Institution of the Kind in America

At this "Learn by Doing" School a man acquires the art of Electrical Drafting; the best business method and experience in Electrical Contracting, together with the skill to install, operate and maintain all systems for producing, transmitting and using electricity. A school for Old and Young. Individual instruction.

Over 5,500 Graduates are Successful Men in the Electrical World

No previous knowledge of electricity, mechanics or mathematics is necessary to take this electrical course. You can begin the course now and by steady application prepare yourself in a short time. You will be taught by practical electrical experts with actual apparatus, under actual conditions.

Special Automobile Ignition Course

We have just installed a special automobile ignition course for auto mechanics, garage men and owners. The course covers completely ignition, starting, lighting and other electrical equipment in connection with automobiles, motor boats, etc.

Let us explain our complete courses to you in person. If you can't call, send now for 64-page book—it's FREE to you.

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29 W. 17th St., New York, N. Y.

Please send FREE and without obligation to me your 64-page book.

.....(NAME)

.....(ADDRESS)

New York Electrical School

29 West 17th Street, New York

ELECTRICAL EXPERIMENTER

H. GERNSBACK – EDITOR
H. W. SECOR – ASSOCIATE EDITOR

Vol. VII. Whole No. 77 SEPTEMBER, 1919 No. 5

Silhouette Movies

By H. GUMPEL

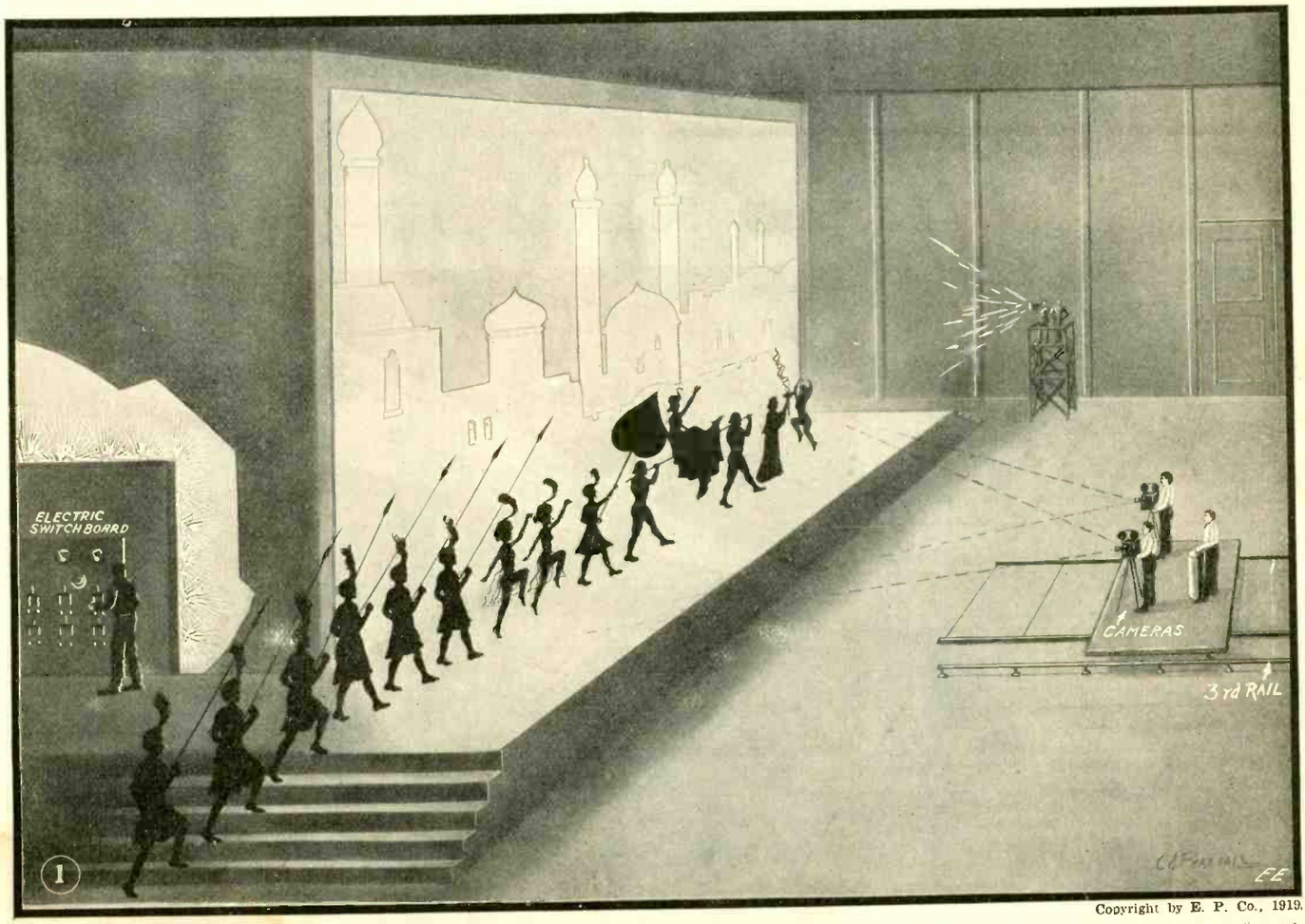
PROGRESSIVENESS, combined with resourcefulness and inventive ingenuity, are counting for much to-day in the production of live motion-picture films. The public wants to be entertained during their leisure hours. Something radically new has to take the place of the old, constantly, to suit the "movie" fans and keep the theaters filled. The greatest attractions of to-day will lose their interest and novelty to-morrow. It

Mechanical Production of Moving Picture Films in "Silhouette"

is therefore self-evident that in this atmosphere of changeability there is a great field open for wide-awake inventors.

The latest novelty in the film world is the photographic production of *silhouette pictures* recently patented by C. A. Gilbert. Pictures of this kind until recently had to be drawn by hand. From fifteen to eighteen individual pictures illustrating the progress in action are needed per second. The individually drawn comic picture is therefore expensive in manufacture.

Gilbert is using silhouettes. Since these



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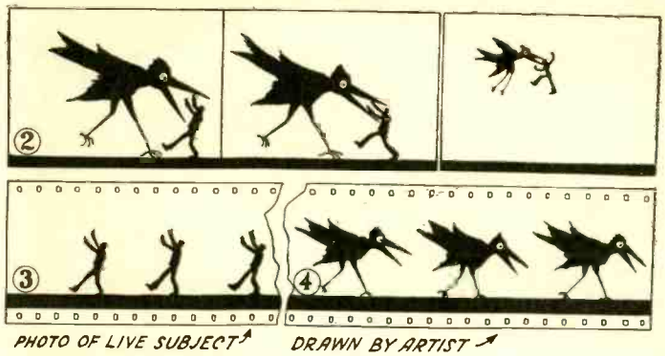

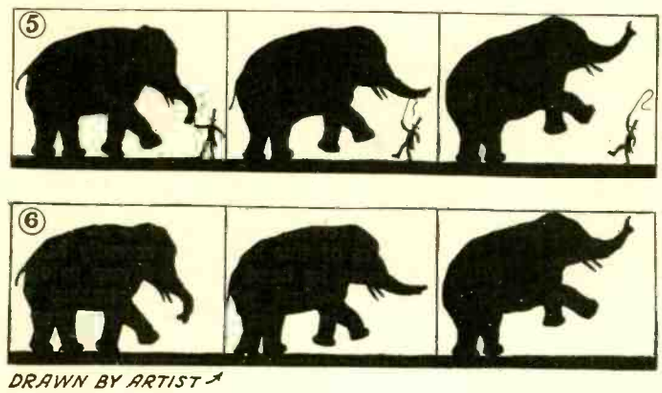

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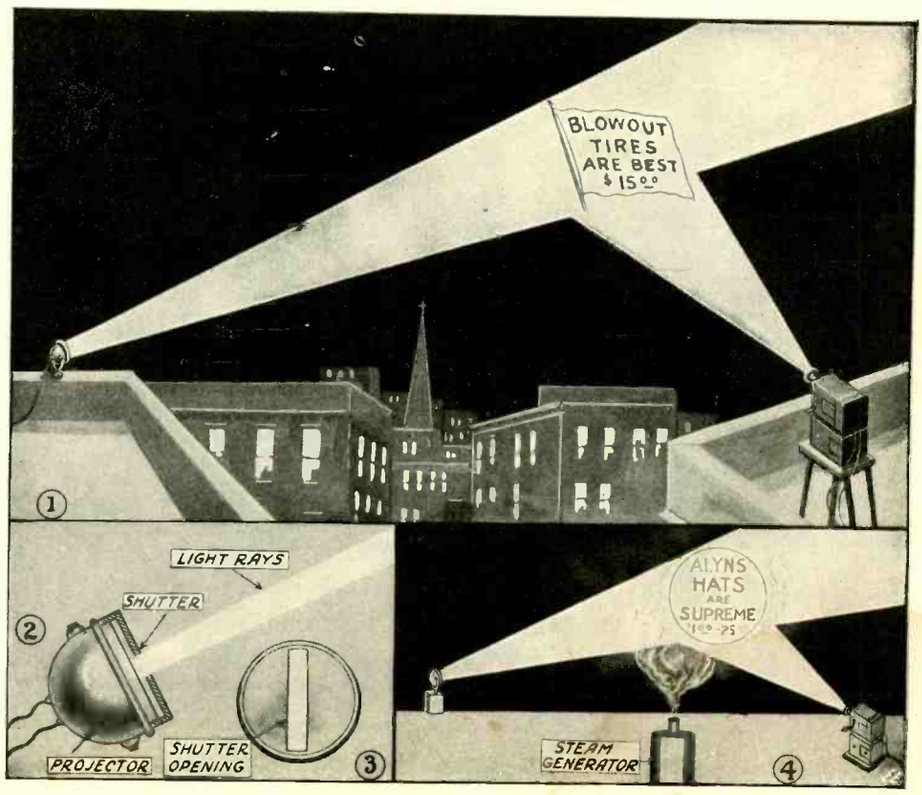
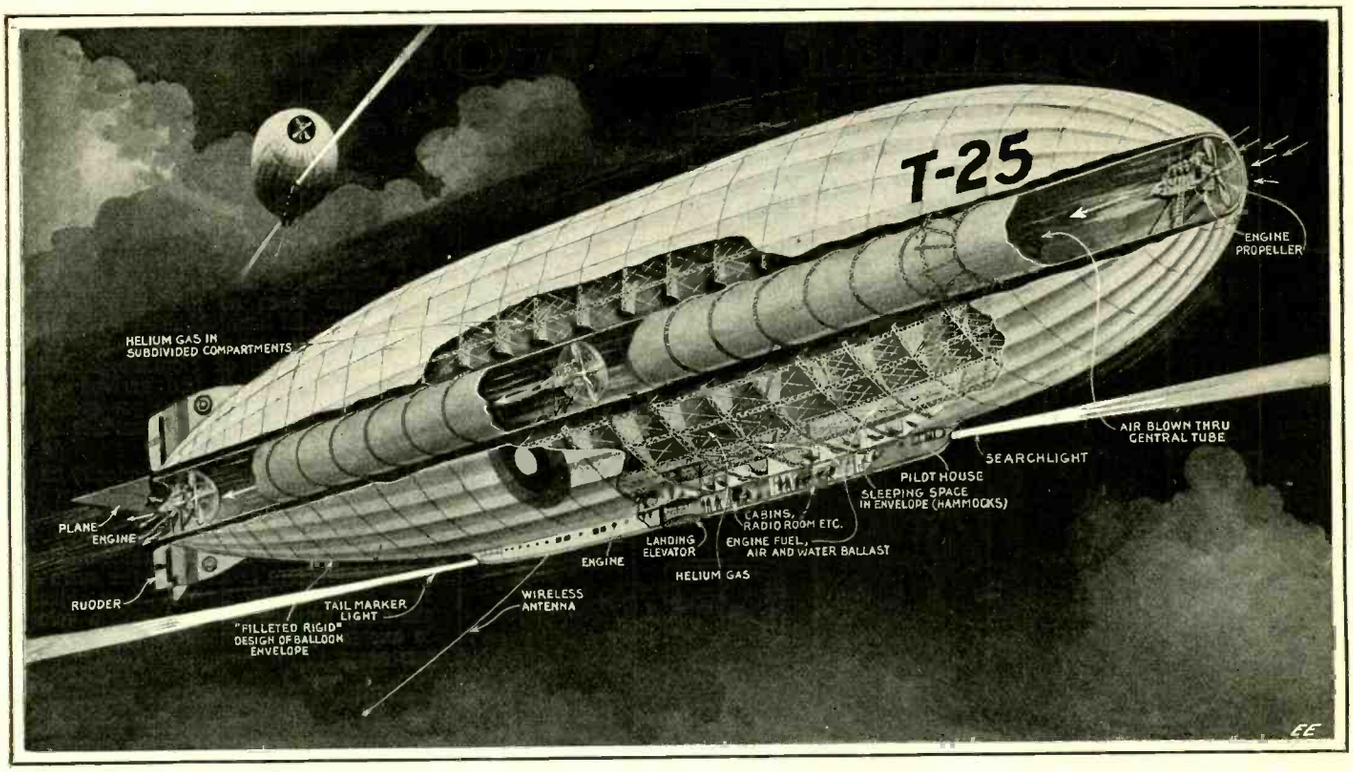




This Illustration Shows a Recent Development In Simplifying the Airship and at the Same Time Making for More Efficiency all Around. The Idea Is To Do Away Entirely With the Underslung Power Gondolas, Such as are Used on the English and German Airships of the Zeppelin Type. The Engines are Housed in a Wind Tunnel Running Thru the Center of the Airship as Shown. Propellers Which are from Fifteen to Twenty Feet in Diameter Create a Sort of Vacuum Within the Tube, and the Airship Therefore will Virtually Suck Its Way Thru the Air at an Increased Speed.

Speeding Up the Airship

By H. GERNSBACK

ON its historic cruise to the United States the R-34, while making a splendid achievement, disappointed many for the reason that it had been hoped that the dirigible would make a westerly passage much quicker than it actually did. Of course, the airship had to battle against head-winds nearly all the way over, which is best proven by the fact that on its return trip it accomplisht the eastward passage in 75 hours.

One reason, and the entire reason, that Brown and Alcock flew across the ocean in sixteen hours with an airplane, while the quickest trip of the airship took over four times as long, is explained in one word—friction. The airplane offers but little surface to the wind, due to the fact that its surfaces not only are comparatively small, but cutting like a knife, they do not offer much resistance to the air. The airship on the other hand, due to its large and cumbersome bulk, gives rise to enormous friction not only head on, but along its sides as well. In this capacity it stands on a par with the big ocean liner that sinks deep into the water, and consequently needs an enormous power to move it, whereas the little motorboat-hydroplane, when provided with suitable vanes, will actually skim above the water, hardly touching the latter, at a speed many times that of the ocean liner. Here we have the same comparison. It is simply a matter of reduced friction of the mechanical birds and their natural element, the air. We therefore find that if we can do away with all unnecessary friction on the huge airship, we will be able to propel it much faster. Take the case of the R-34 with its four gondolas; these take up quite a good deal of room and make for air resistance when the airship is in flight. While to the layman this appears trifling, it tends to retard the total speed of the airship very considerably, and if we can do away with these gondolas and their engines, we will increase the speed of the airship by just so much.

Also, if we can diminish the resistance created by the nose of the airship as it plows its way thru the air, we will again increase its speed. This, of course, is apparent, and the following experiment, which anyone may try himself, ought to prove it abundantly. Take a pail of water and try to drag it with the open side thru a stream of water. You will meet with an enormous resistance. Take the same pail and make a hole of about half the diameter in the bottom of the pail. You will now find that you can drag the pail with considerable ease, for the reason that the water flows right thru it. In the former experiment it was necessary to first fill the pail with water, and after this move (displace) a column of water represented by the diameter of the pail.

With these things in view, the writer offers a novel idea in which it is proposed to speed up dirigibles considerably. The idea is made clear in the accompanying illustration. It will be seen that this airship has no gondolas whatsoever, and the power plant is not hung underneath the airship, as is common in all Zeppelin types. Instead, the center of the airship is hollow, forming a wind tunnel extending clear thru the entire length of the airship. This air tube, of course, is not a small affair, but is anywhere from 15 to 25 feet in diameter, as will be noted. The three engines are stationed, the first at the nose, the second at the tail end, and the third in the center of the wind tunnel. The propellers must be of the same diameter as that of the tunnel, and the object is to have all three of them working at the same time in order to suck in the air at the nose of the ship and form a sort of vacuum. The air will then flow thru the tunnel, the same as the water flows thru the pail after we made a central opening in its bottom. From this it will be seen that the airship will *virtually suck its way thru the air*, and it should be possible for such a craft to make much greater speed than with the former methods. Moreover, as the engines are not exposed to the elements, it would also seem that not so much engine trouble should develop, as is the case with the under-slung type. Another very important consideration is that inasmuch as the air is rushing right back of the engines, the cooling of the latter is infinitely better than at present. And as every engine man knows, the better an engine is cooled the less likelihood there is of trouble developing.

In the aërial liner of the future, in order to do away with all unnecessary head resistance, the crew's quarters, etc., will probably be located at the bottom of the airship, and as will be noted in the illustration, the entire living quarters are fashioned with stream lines, to minimize all unnecessary air resistance.

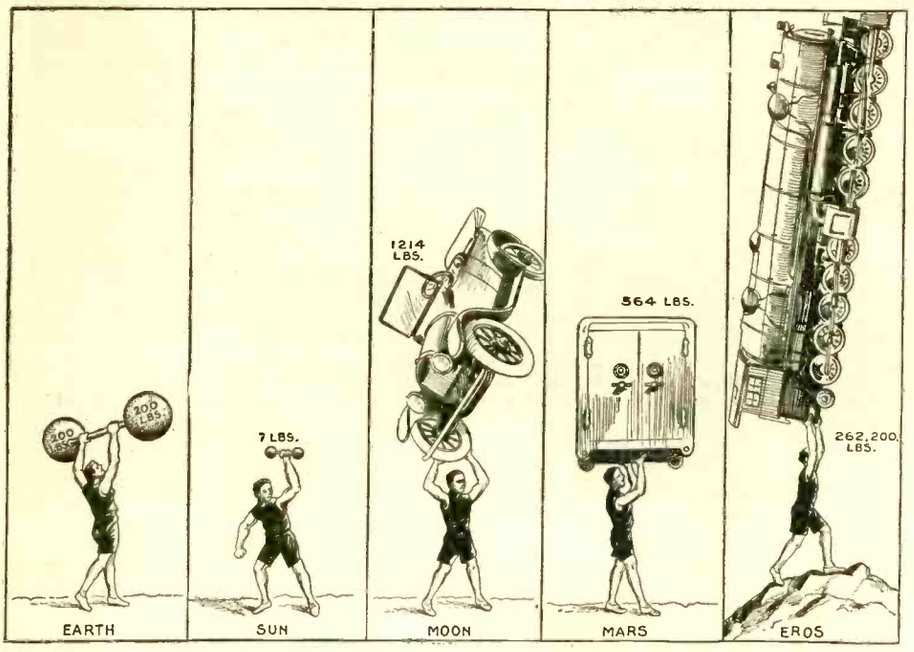
Hydrogen gas will probably not be used much longer, as already Zeppelin types in Germany demonstrated that these huge bags are not safe with the enormous quantities of inflammable gas stored within their metallic girders. Electric sparks set up by the electrical machinery of wireless apparatus are a constant danger to the explosive gas, and the same is true should lightning hit the dirigible. The airship of the future for this reason will use Helium gas in its subdivided compartments, or some other

(*Continued on page* 446)

Popular Astronomy

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

Interesting Phenomena of Gravitation



This Shows Graphically How Much a Human Being Would Be Able to Lift on the Various Heavenly Bodies. This Illustrates That a Pound Does Not Weigh a Pound Everywhere in the Universe, But Changes According to the Mass and Density of the Heavenly Body upon Which It Is Placed.

THE earth is revolving around the sun in an orbit that is almost a perfect circle with a velocity of *eighteen and one-half miles per second.* If for any reason this orbital velocity should suddenly cease or be brought to *zero,* the earth would fall into the sun and the time of falling would be sixty-four and one-half days. If its orbital velocity should be brought *almost* to zero, that is if the earth still possest a slight motion at right angles to the line connecting it with the sun, it would describe an extremely narrow ellipse with the sun at the further focus (see diagram 1), and would return to the point where its velocity had changed after one hundred and twenty-nine days.

If the orbital velocity should be increased more and more, the ellipse would become wider and wider, and the period of the earth's revolution longer and longer. When the orbital velocity reached eighteen and one-half miles per second the earth would be revolving around the sun in a circular orbit in a period of 365¼ days (as it does now). If the orbital velocity should increase still more the earth's orbit would become elliptical again with the sun now at the nearer focus and the width of the ellipse would increase as the velocity increased.

THE EARTH COULD LEAVE SOLAR SYSTEM.

When the orbital velocity reached 26.2 miles per second (the velocity from infinity or parabolic velocity for the earth), the earth would escape the control of the sun and leave the solar system on the curve of a parabola never to return. If the orbital velocity should exceed 26.2 miles per second the earth would also escape from the solar system, but the curve would be hyperbolic instead of parabolic in form.

Now each planet in the solar system has its parabolic velocity or, as we might call it, velocity of escape from the solar system, and as this varies inversely as the square root of the planet's distance from the sun, it becomes less and less as the planet's distance from the sun increases.

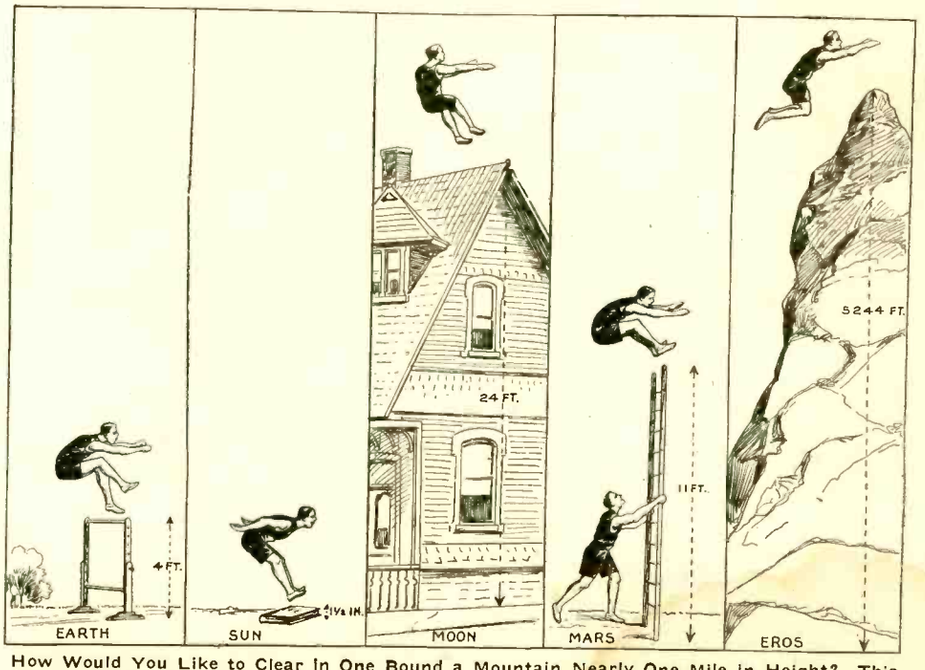
For Neptune the parabolic velocity is only 4.7 miles per second. If its orbital velocity of three and one-third miles per second should be increased to this parabolic velocity Neptune would escape from the solar system.

If a body should fall from infinity or the distance of the stars toward the sun under the force of the sun's attraction *alone,* it would have acquired a velocity of 4.7 miles per second by the time it had reached the orbit of Neptune, 26.2 miles per second when it had arrived at the earth's orbit and 383 miles per second by the time it had reached the surface of the sun.

Let us consider now what velocity an object at the surface of the sun must possess in order to escape the sun's attraction and pass off into space. Evidently this would be the same as the parabolic velocity or velocity from infinity for the sun's surface, 383 *miles per second.* Any object at the solar surface endowed with a velocity in excess of this amount would leave the sun never to return.

THROWING A STONE INTO INFINITY.

Since it can be shown that this velocity of escape varies directly as the square root of the mass of the attracting body, it is possible to compute the velocity of escape for objects on all of the planets in the solar system as well as for objects on the sun. These values are given in Table I. Objects on any of the planets possessing these velocities or greater velocities escape from the control of their respective planets and either become satellites of the sun or leave the solar system entirely, depending on the excess of their velocities over the critical value. It will be noted from a glance at these critical velocities given in Table I that it would be easily possible to fire a cannon ball from Ceres, the largest asteroid, that would pass off into space, never touching the surface of the asteroid, while on Eros a stone could be thrown from the hand with sufficient velocity to enable it to escape the control of the asteroid.



How Would You Like to Clear In One Bound a Mountain Nearly One Mile In Height? This Is Exactly What You Could Do If You Were on Eros, the Small Asteroid. If You Could Jump Four Feet High on Earth, You Could Jump Over One Mile on Eros. Even on the Moon You Could Jump Over a House Without Much Trouble, with One Bound.

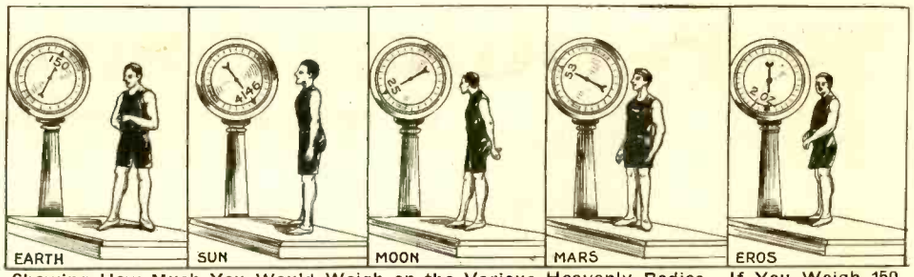
SHOOT A CANNON BALL FIVE MILES A SECOND AND YOU HAVE A NEW MOON.

In the last column in Table I is given the velocities for satellites grazing the surfaces of the various planets, the sun or moon, in circular orbits. It can be shown that these values are equal to the critical velocities or velocities of escape multiplied by the square root of one-half. It will be noted that for the sun this value is 271 *miles per second,* that is, an object hurled from the sun with a velocity of 271 miles per second would become a satellite of the sun, moving close to its surface in a circular orbit. An object hurled from the earth's surface with a velocity of 5 miles per second would likewise become a satellite of the earth, revolving around it in a circular orbit close to the surface.

It is interesting to consider in this connection what would be the course of projectiles hurled from the earth or other planets with varying velocities.

If an object should be thrown from a mountain or some other elevated position on the earth's surface *horizontally* (neglecting resistance of air) with a very slight initial velocity, it would fall almost straight downward, and if the earth were concentrated at a point at its center the object would move in a very narrow ellipse around the earth's center, returning to the point of departure again after 30 minutes. If the velocity is increased more and more the object falls further and further to one side, and if the earth were concentrated at its surface so the object would not encounter the surface; it would move in an elliptical path, always returning to the original point. The widths of the ellipse would increase with the velocity (see diagram II). Finally when the velocity with which the object is hurled reaches 5 miles per second it leaves the earth entirely and becomes a satellite of the earth, moving in a circular orbit with a period of 1 hour 25 minutes. If the velocity is increased beyond 5 miles per second the object continues to revolve around the earth in an elliptical orbit whose width increases with the velocity until a velocity of 7 miles per second is reached, when the object flies off on a parabolic curve, escaping the earth's attraction entirely and becoming a satellite of the sun. The same principle holds for all the other members of the solar system as well as for the earth, and a reference to table I will show the velocity of escape for each member of the solar system as well as the velocity with which an object must be thrown from the surface in order to make it a satellite of the planet in question.

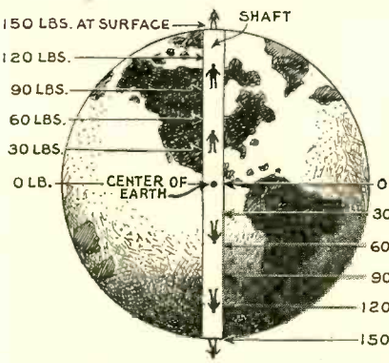
It is interesting to consider in this connection what would happen if the earth should suddenly explode. All particles that received an initial velocity *under seven miles per second,* the velocity of escape, would come back to the scene of the catastrophe *repeatedly* in elliptical orbits, and those that were ejected with *equal velocities* would come back *at the same time,* however different the directions of their ejection or the width of their orbits. If the velocity of ejection equaled or exceeded seven miles per second, they would not return.



Showing How Much You Would Weigh on the Various Heavenly Bodies. If You Weigh 150 Pounds on Earth, Your Weight Would Shrink to 2 Ounces on Eros. While on the Sun You Would Weigh over 2 Tons and You Would Not Have Sufficient Strength to Lift Your Own Body.

WEIGHT ON OTHER PLANETS.

Let us consider now some of the interesting phenomena arising from the fact that the surface gravity of a planet, or its attraction for objects at its surface, is proportional to its mass or the quantity of matter that it contains. This affects directly the weight of objects at the surfaces of the planets and the amount of work that can be performed against the attraction of gravity on the various planets.



Do You Know That if There Were a Shaft Drilled Right thru the Earth, and if You Were to Descend into Same, You Would Weigh Nothing When You Arrived at the Center? Our Illustration Shows How Much You Would Weigh at the Different Levels in the Shaft.

Taking the earth's attraction for objects at its surface as the unit, the relative surface gravity for all other planets, the sun, and the moon, has been computed (see Table I) by multiplying the density by the radius, both quantities relative to the corresponding values for the earth.

We then find what a man weighing 150 lbs. on the earth would weigh if it were possible for him to exist on the sun, moon or other planets, to what height he could jump against the attraction of gravity and what weights he could lift; also with what velocity an object must be endowed to enable it to escape from the planet and under what condition it would become a satellite of the planet revolving close to its surface in a circular orbit.

We note (Table I) that a man who weighs 150 lbs. on the earth would weigh 4,146 lbs., or over *two tons,* on the sun. If he could jump to a height of four feet on the earth he would find himself unable to raise his body even two inches by his own energy, against the sun's surface gravity. He would be, indeed, crushed by his own weight, lifting his arms and feet and moving about only with the greatest effort. He would have as much difficulty in lifting a weight of seven pounds on the sun as in lifting a weight of two hundred pounds on the earth.

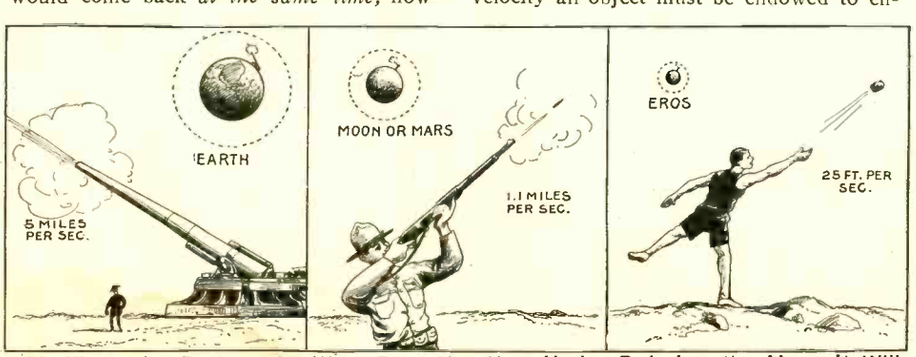
On the asteroid Eros on the contrary his weight would be but *two ounces.* He could jump to the height of a mile as easily as he could jump to a height of four feet on the earth, and he could lift *one hundred and thirty tons* as easily as he would lift two hundred pounds on the earth.

It will be noted that the weight of the large engine on the cover drawing is given as 684,000 pounds. This corresponds to a weight of 500 lbs. on Earth. This is probably the limit a professional strong man could lift on earth.

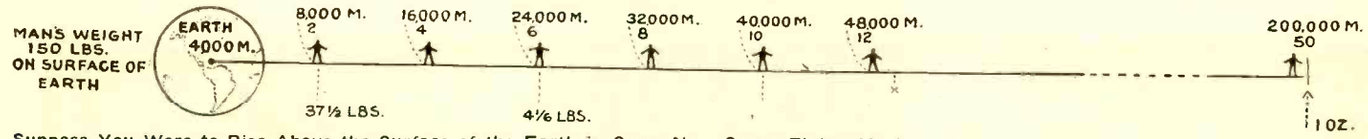
LIVING IN A VACUUM.

This brings us to the interesting subject as to what would happen if we were to visit one of our small planetary bodies on which there is no atmosphere, such as for instance our moon and any of the Asteroids. Being that the gravitational pull is so small on these bodies, the atmosphere—if they had any—probably escaped aeons ago. Consequently, if we were to visit any of these heavenly bodies, we would be placed in an absolute vacuum much greater than we can procure with our best vacuum pumps on earth. How, then, could we walk on such a body and exist? We must always remember that every square inch of our body on earth is weighed down with an atmospheric pressure of 14.7 pounds. The total pressure upon the human body is therefore enormous, amounting to 47,040 lbs. Remove this pressure and our blood vessels would burst like an automobile tire.

The thing to do then, if we are ever enabled to visit the moon or one of the Asteroids, would be to encase ourselves in a strong rubber fabric by having strips of thick rubber sheeting wrapt all around our body, as suggested in our cover drawing. These rubber strips would be wrapt around the body and limbs similar to what our soldiers do with their puttees. It would, of course, also be necessary that we should bring along our own air, and this, too, is suggested in our cover drawing, where a compress air tank is strapt to the back of the man, an automatic air valve regulating the air supply as it is consumed. By means of suitable chemicals the air could be renewed automatically for an indefinite time. In order that we can see about us, it would also be necessary for us to provide a sort of helmet fitted with a thick glass plate adjusted air-tight to the helmet. The whole contrivance would then be strapt to the body.



This Illustration Depicts with What Force You Must Hurl a Body Into the Air so It Will Never Return,—in Other Words, Becoming a New Satellite. If You Could Build a Cannon to Shoot a Projectile into the Air Going at the Rate of Five Miles per Second, It Would Become a New Moon Gravitating Around the Earth In an Orbit of Its Own. On Mars the Velocity Need Only Be 1.1 Miles per Second, While on Eros You Could Throw a Stone into the Air So That It Would Never Return.



Suppose You Were to Rise Above the Surface of the Earth in Some New Space-Flying Machine. This chart Shows How Much Weight You Would Lose as You Get Away from the Gravitational Attraction of the Earth.

The feet as well as the hands would also have to be encased in very snug-fitting rubber, as no part of the human body should be exposed to the vacuum which would draw out the blood immediately. It is well known that when aviators ascend to a great height blood begins to flow out from underneath the finger nails, due to the reduced pressure. It can be easily imagined what will happen if all the pressure was removed and the hand was exposed to the vacuum.

His greatest difficulty, granted he were able to withstand the lack of air and atmospheric pressure, would be experienced in retaining a foothold upon this insecure mass of rock spinning thru space, for so slight is the attractive force that holds him to the surface that *it would be possible for him to jump with sufficient initial velocity to escape from the asteroid,* the velocity of escape being only thirty-six feet per second, and the height to which he is able to jump against the force of gravity being 1 mile.

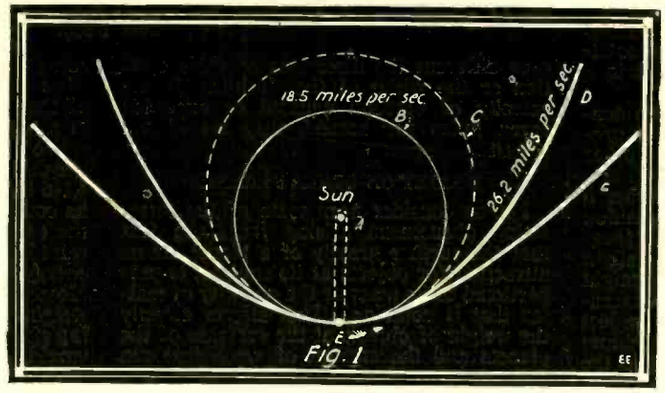
Referring to Table I, we note that the surface gravity of Uranus is nearest to that of the earth and that a man who weighs 150 lbs. on the earth would weigh 149 lbs. on Uranus and would be able to do practically the same amount of work. This arises from the fact that the greatly *increased radius* of Uranus, three and eight-tenths that of the earth, is offset by its greatly *decreased density,* which is only one-quarter that of the earth, the product of the two giving the surface quantity of Uranus. This is also true in a less degree with Saturn and Neptune. The huge bulk of Jupiter, however, considerably overbalances its low density, and a man who weighs 150 lbs. on the earth would find his weight of 378 lbs. a burden to him on Jupiter.

MAN WEIGHS 53 POUNDS ON MARS.

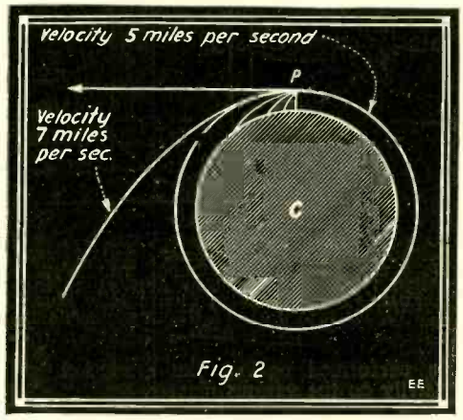
On Mars, on the other hand, he would find he weighed only 53 lbs. and that he could jump nearly three times as high as he could on the earth and lift loads nearly three times as heavy. On the moon he would weigh only one-sixth as much as on the earth and could throw a ball six times as far and jump six times as high. He would lift six hundred pounds as readily as he would lift one hundred pounds on the earth.

Venus most closely resembles the earth among the terrestrial planets and a man would find, if he were suddenly transferred to Venus, that he would only lose twenty-two pounds in weight by the change. He could lift weights fifteen per cent heavier and jump fifteen per cent. higher than on the earth.

Let us note in passing the low velocity of escape for the moon, Mercury and Mars. This is believed to have an important bearing upon the possibility of these bodies possessing and holding atmospheres. The molecules of gases in the atmosphere are moving in all directions at high velocities. It has been computed that the molecular velocity of oxygen is 1.8 miles per second at zero centigrade, of nitrogen 2.0 miles per second, of water vapor 2.5 miles per second, of helium 5.2 miles per second and of hydrogen 7.4 miles per second. Evidently then the earth could not *permanently* hold free hydrogen in its atmosphere or the moon and Mars any of these gases. Even if Mars were originally clothed with an extensive atmosphere it is, according to the kinetic theory of gases, losing it molecule by molecule. Moreover, in inter-planetary space there must be wandering molecules of gases that have deserted the bodies in the solar system that have low velocities of escape. Of course upon even the largest asteroids there could not be any of the atmospheric gases of the earth, as the velocity of escape is so excessively low for all of these bodies.



This Illustrates What Would Happen If the Earth's Orbital Velocity, 18.5 Miles per Second, Were to Change Suddenly. A, If the Velocity Would Almost Cease. B, Present Velocity of Earth. C, Velocity Greater Than 18.5 Miles per Second. D, Velocity 26.2 Miles per Second. E, Velocity Greater Than 26.2 Miles per Second. At This Speed the Earth Leaves the Solar System Never to Return.



To Illustrate Course of Projectiles Hurled Horizontally from P, a Point on the Earth's Surface (Neglecting Friction of Air) at Different Velocities in Direction of Arrow. If Velocity Is Less Than 7 Miles per Second, Projectile Moves in Elliptical Curve Whose Width Depends Directly on Initial Velocity with Which Projectile Is Hurled. If Velocity Equals T Miles per Second, Projectile Becomes a Satellite of the Planet, and if Velocity is 7 Miles per Second or Greater, the Projectile Escapes Earth's Attraction and Goes Off Into Space.

WEIGHT INSIDE OF EARTH.

Let us consider now, in concluding, what would be the effect upon a man's weight if he should fall toward the earth's center thru a circular shaft (see diagram III), assuming that the earth's density is uniform thruout. Since surface gravity is equal to the density times the radius, his weight at the surface will be decreased as he falls toward the center proportionally directly to his *distance below the surface.* At a distance below the surface equal to one-fifth of the radius his weight will be decreased one-fifth of the value for the surface, that is a man who weighs 150 lbs. on the surface would weigh 120 lbs. one-fifth of the distance to the center or eight hundred miles below the surface. Two thousand miles below the surface or one-half the distance to the center his weight would be one-half the surface value or seventy-five pounds and *at the earth's center*

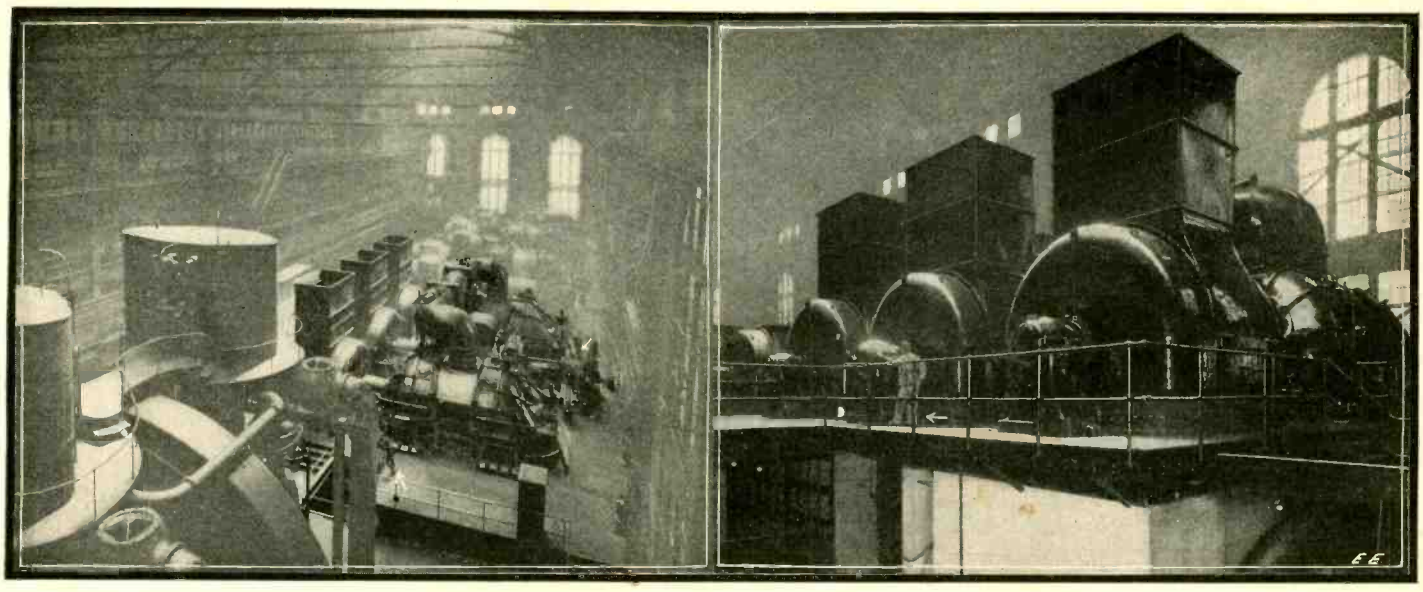
(*Continued on page* 449)

TABLE I.

	Diameter (In Miles)	Density (Relative to Earth's)	Radius (Relative to Earth's)	Surface Gravity (Relative to Earth's)	Man's Weight in Pounds	Height Man can Jump	Weight Man can Lift	Velocity of Escape	Velocity with which object must be projected to become a satellite moving close to surface in perfect circle
Earth	7,918	1.00	1.00	1.00	150 lbs.	4 feet	200 lbs.	7 mi. per sec.	5 mi. per sec.
Sun	864,392	.25	109.17	27.64	4,146 "	1.7 in.	7 "	383 "	271 "
Moon	2,160	.60	.27	.16	25 "	24 feet	1,214 "	1.5 "	1.1 "
Mercury	3,009	.81	.38	.31	46 "	13 "	650 "	2.2 "	1.6 "
Venus	7,701	.88	.97	.85	128 "	5 "	234 "	6.6 "	4.7 "
Mars	4,339	.65	.55	.35	53 "	11 "	564 "	1.5 "	1.1 "
Jupiter	88,392	.23	11.16	2.52	378 "	1.6 "	79 "	37 "	26 "
Saturn	74,163	.11	9.37	1.07	160 "	3.75 "	187 "	22 "	16 "
Uranus	30,193	.26	3.81	.99	149 "	4.0 "	201 "	13 "	9 "
Neptune	34,823	.20	4.40	.87	130 "	4.6 "	231 "	14 "	10 "
Ceres (largest asteroid)	485	.60	.0606	.036	6 "	108 "	5,406 "	1736 ft. per sec.	1228 ft. per sec.
Eros (small asteroid)	10	.60	.00126	.00076	2 oz.	5,244 feet (almost 1 mile)	262,200 " (130 tons)	36 " (*See Note*)	25 "

Note:—Objects leaving surface with velocity greater than values given here would not return.

Note:—The surface gravity is the product of the planet's density by its radius (relative to corresponding values for the earth's), that is, Col. 4 is the product of Col. 2 and Col. 3.



New York City Can Now Boast of the Largest Steam Turbine-Dynamo Generating Unit in the World—100,000 Throbbing Horse-Power. It Comprises a Triplex Turbo-Alternator, Occupying About One-Fourth the Space of the Old-Type Reciprocating Engine Shown at the Extreme Left of the Photo Herewith. The Comparative Size of the 100,000 H.P. Turbine Unit May Be Judged by the Man Standing Beside It—See Arrows. The Old Reciprocating Steam Engine Towered 75 feet into the Air; the New Turbine-Dynamo Stands But 20 Feet in Height. The Current Delivered Is Three Phase, 25 Cycle Frequency, at a Potential of 11,000 Volts.

World's Biggest Turbine-Dynamo--100,000 H. P.

By WILLIAM H. EASTON

TO her already long list of "greatest things in the world," New York City can now add another item, for the Interborough Rapid Transit Company has recently placed in operation at its 74th Street power house a triplex turbine-generator that is as superior to its rivals in power as the Woolworth Building is in height or the arch of the Hell Gate Bridge in length of span.

One hundred thousand horsepower is the amount of power this great engine can develop when pushed to its maximum. It is difficult to find an example that will convey an adequate impression of this figure, but the following may be of some assistance. Suppose our army now abroad, which consists of about a million men, has been landed over night and is marching up Fifth Avenue. Visualize the parades you have seen and then realize that it will take over three days and nights for this particular one, moving steadily forward in regular formation, to pass thru the Arch of Victory. Now, in a contest of strength between the turbine and all of these men taken together, the turbine would probably win.

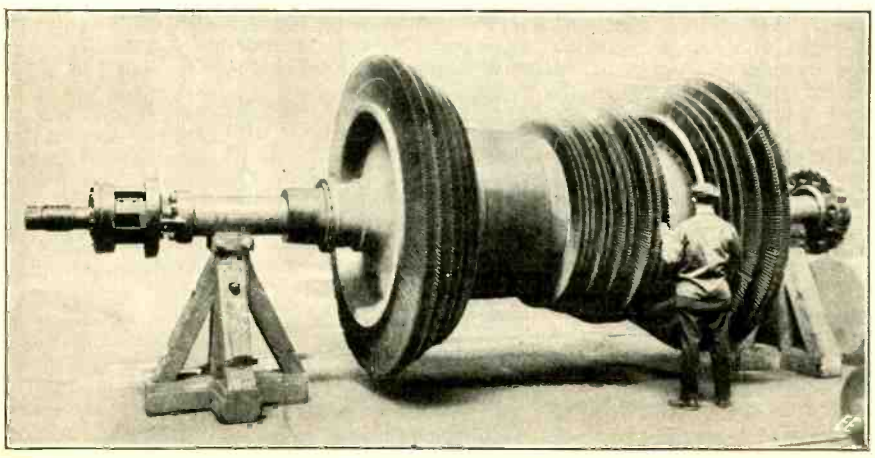
How the Turbine Operates.

The visitor, journeying to 74th Street to see this great turbine, will probably be disappointed in its appearance. It has, indeed, a massiveness that speaks of immense power within, but in size it is dwarft by the old vertical reciprocating engine, of one-twelfth its capacity, beside which it stands; and in addition, since all its working parts are enclosed, it is entirely lacking in the fascination that visual movement imparts. But its deficiencies as a spectacle are real virtues in the eyes of the engineer, for they mean lower first cost, smaller space occupied, reduced installation and operating charges, and a high degree of reliability.

The very conspicuous difference in size between the turbine and the reciprocating engine is due to their different operating principles. The reciprocating engine consists essentially of a cylinder in which a piston is pushed up and down by the steam. The main parts of the turbine, however, are a spindle, carrying hundreds of small vanes, and a casing which encloses the spindle. The steam acting upon the vanes of the spindle revolves it as the wind turns a windmill. The motion of the turbine is, therefore, rotary and as there are no heavy parts to be stopt and started at the end of every stroke, as there are in a reciprocating engine, very high speeds are permissible, thus making it possible to develop great power from a comparatively small machine. The speed of this particular turbine is 1,500 revolutions a minute.

As has been said, the turbine is triplex; that is, it consists of one *high pressure* element and two *low pressure* elements, each connected to a separate electric generator. This gives it the appearance of three distinct machines, but it is actually a *single unit* and all three elements are started and controlled as one. The triplex arrangement is employed because it is mechanically greatly superior to the single element design for a machine of such great power. There is also the very decided additional advantage that, in an emergency, any one or two of the elements can be shut down without stopping the others. All the power eggs are, therefore, not in one basket, and the high efficiency of a single large ma-

(*Continued on page* 453)



A Close View of the Rotating Blades or "Rotor" of One of the Steam Turbines Comprising the Triplex 100,000 Horse-Power Generating Unit Recently Installed for the Interborough Rapid Transit Company, New York City, at Its 74th Street Power House. Almost Beyond Conception Is the Delicacy and Accuracy of Balance of This Wonderful Blading. It requires the Highest Degree of Workmanship to Build Such a Rotating Mass, Which Shall Be Perfectly Balanced When Revolving at 1,500 Revolutions per Minute.

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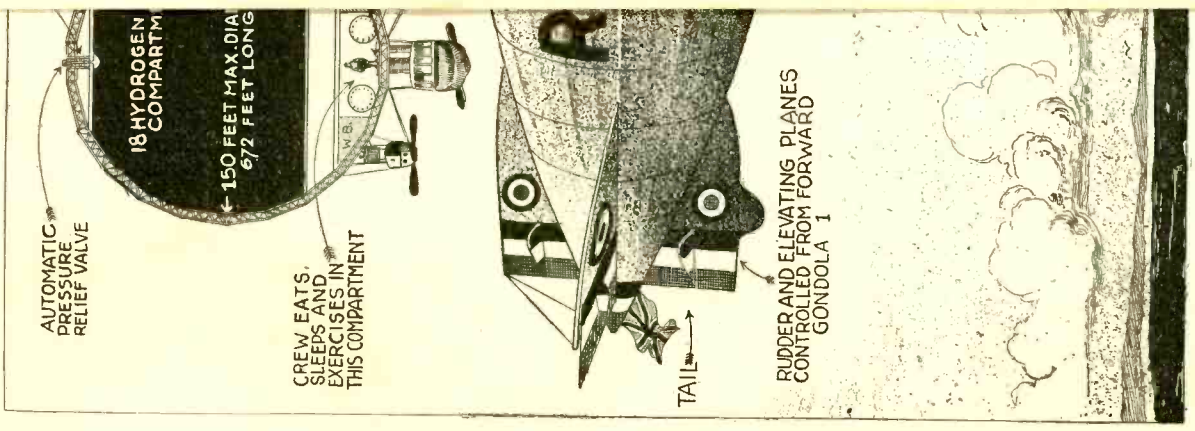

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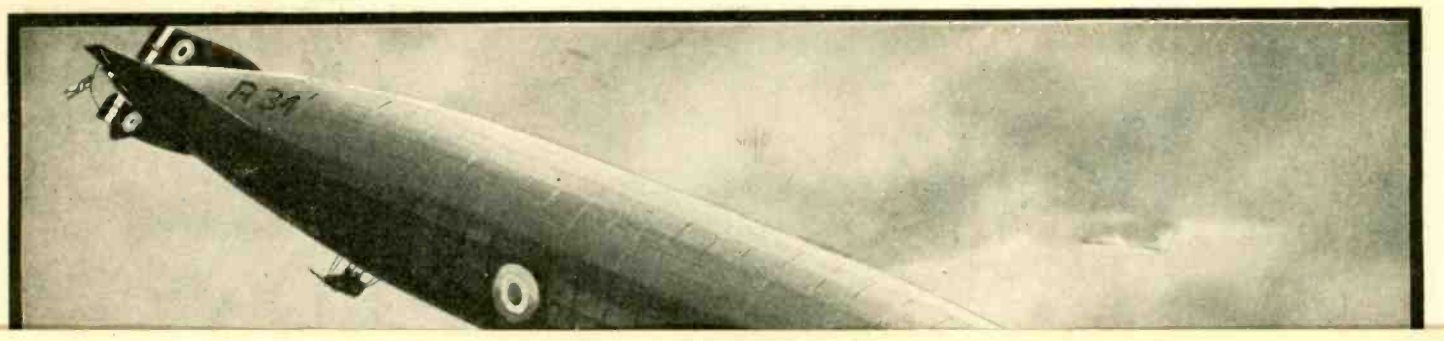

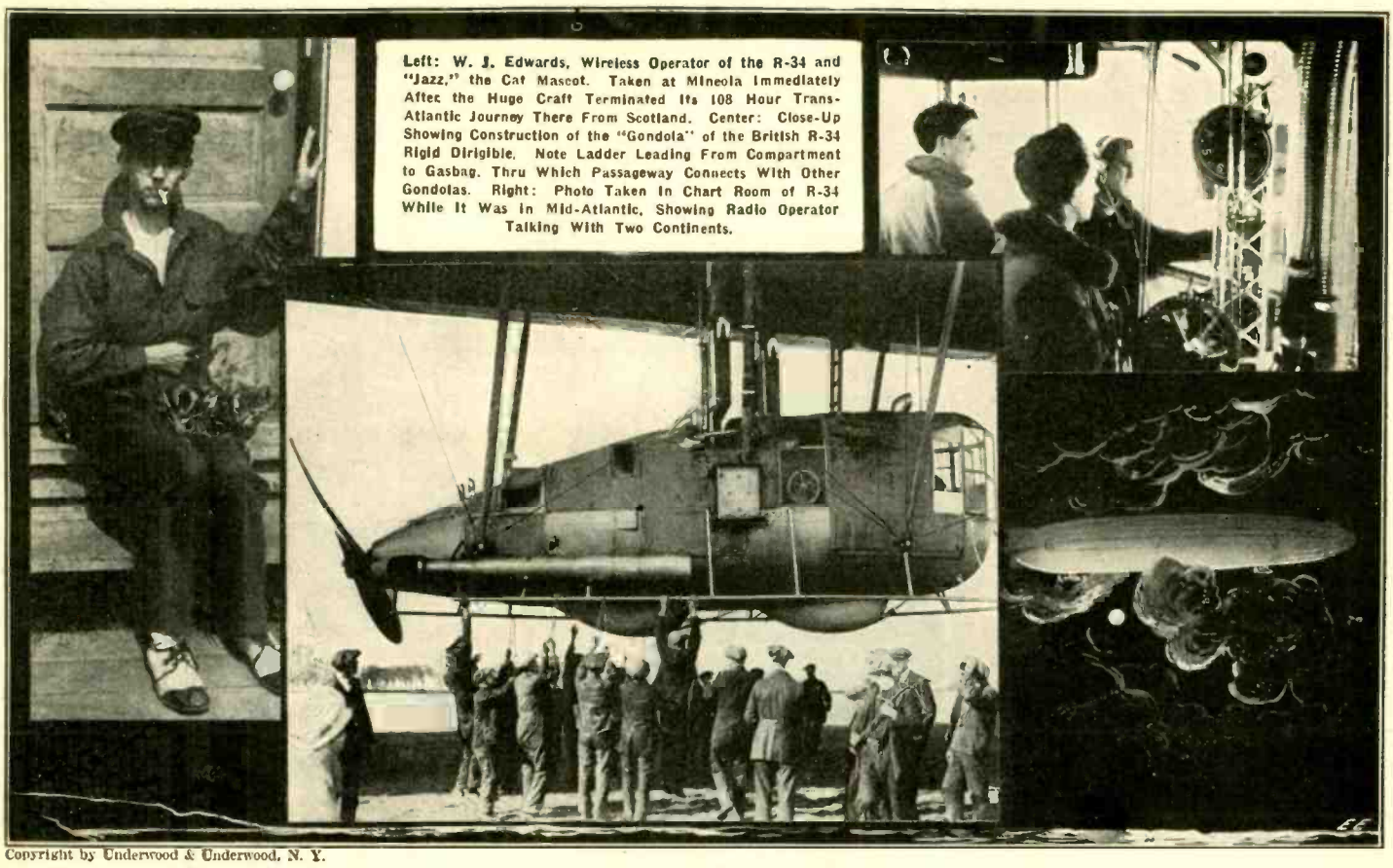

Left: W. J. Edwards, Wireless Operator of the R-34 and "Jazz," the Cat Mascot. Taken at Mineola Immediately After the Huge Craft Terminated Its 108 Hour Trans-Atlantic Journey There From Scotland. Center: Close-Up Showing Construction of the "Gondola" of the British R-34 Rigid Dirigible. Note Ladder Leading From Compartment to Gasbag. Thru Which Passageway Connects With Other Gondolas. Right: Photo Taken In Chart Room of R-34 While It Was In Mid-Atlantic, Showing Radio Operator Talking With Two Continents.

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When the machine starts to rise and the guy ropes are thrown off, she rises until she finds her equilibrium. It may be 500 and then it may be 3,000 feet. When she finds her equilibrium, the motors start. Meanwhile the wind carries her wherever it pleases. That is the reason why in most cases a start is made between midnight and dawn.

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The sleeping quarters are not very comfortable. The men sleep in light hammocks suspended from the framework. There are about ten hammocks, which are woven from Italian hemp. There is not much feeling of stability. If a man fell out of one, he would fall thru the fabric and out into the clouds. One cannot get a good, deep, untroubled slumber.

At the extreme end of the envelope there are no gas compartments—that is, for about twenty-five feet from the bow and from the tail there is vacant space. There are only two stationary electric lights inside the envelope, making it necessary for the men to carry electric flashlights.

The cockpits fore and aft are equipt with heliographs. The observer is not comfortable. He is compelled to stand upon an aluminum ladder with his head above the ship. The extra clothes carried by the crew are strapt to the side of the envelope. The crew of the R-34 brought only their dress uniforms with them on their voyage as extra clothing.

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Running along the deck inside the envelope are the parachutes and life-belts. These appliances are kept in canvas containers. The life-belts are inflated with air. They go around the chest, and when wrapt up look like a bundle of clothes. Both the parachutes and life-belts are always available. If overland the men were forced to leave the ship, the parachutes might save them, while if over the sea the parachutes and life-belts would both be used and might possibly save them.

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Lieut. R. F. Durrant of the *Royal Air Force* claims the following ranges for his Radio apparata: With a three-step ampli-

(*Continued on page* 438)

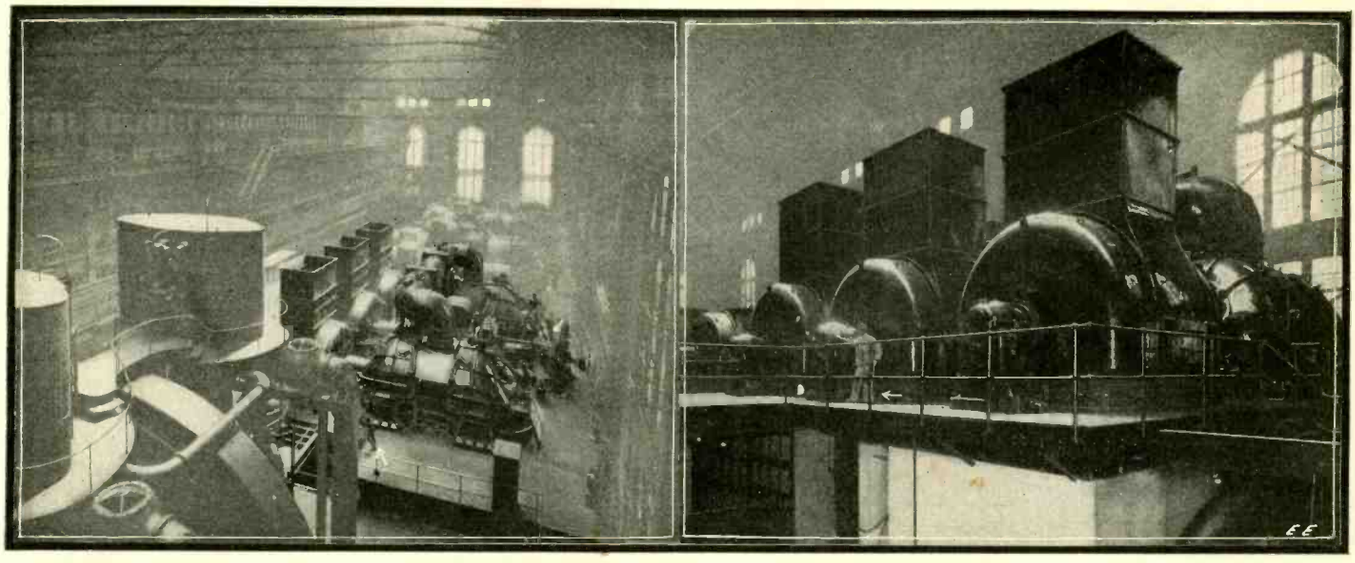
To the Editor of the Electrical Experimenter:

I regret that owing to circumstances beyond my control it was deemed advisable to postpone the publication of the article which I had intended for your August number. But the objections to its appearance will be shortly removed and I shall be pleased to forward it in due course for embodiment in your October issue.

Irrespective of this, I think it well on this occasion to notify your readers, as a precaution, that I am not one of those who display the sign "Do it now" on their desks and office doors. My motto is "Do not do it now. Think it over".

Very truly yours,

N. TESLA.



New York City Can Now Boast of the Largest Steam Turbine-Dynamo Generating Unit in the World—100,000 Throbbing Horse-Power. It Comprises a Triplex Turbo-Alternator, Occupying About One-Fourth the Space of the Old-Type Reciprocating Engine Shown at the Extreme Left of the Photo Herewith. The Comparative Size of the 100,000 H.P. Turbine Unit May Be Judged by the Man Standing Beside It—See Arrows. The Old Reciprocating Steam Engine Towered 75 feet into the Air; the New Turbine-Dynamo Stands But 20 Feet in Height. The Current Delivered Is Three Phase, 25 Cycle Frequency, at a Potential of 11,000 Volts.

World's Biggest Turbine-Dynamo--100,000 H. P.

By WILLIAM H. EASTON

TO her already long list of "greatest things in the world," New York City can now add another item, for the Interborough Rapid Transit Company has recently placed in operation at its 74th Street power house a triplex turbine-generator that is as superior to its rivals in power as the Woolworth Building is in height or the arch of the Hell Gate Bridge in length of span.

One hundred thousand horsepower is the amount of power this great engine can develop when pushed to its maximum. It is difficult to find an example that will convey an adequate impression of this figure, but the following may be of some assistance. Suppose our army now abroad, which consists of about a million men, has been landed over night and is marching up Fifth Avenue. Visualize the parades you have seen and then realize that it will take over three days and nights for this particular one, moving steadily forward in regular formation, to pass thru the Arch of Victory. Now, in a contest of strength between the turbine and all of these men taken together, the turbine would probably win.

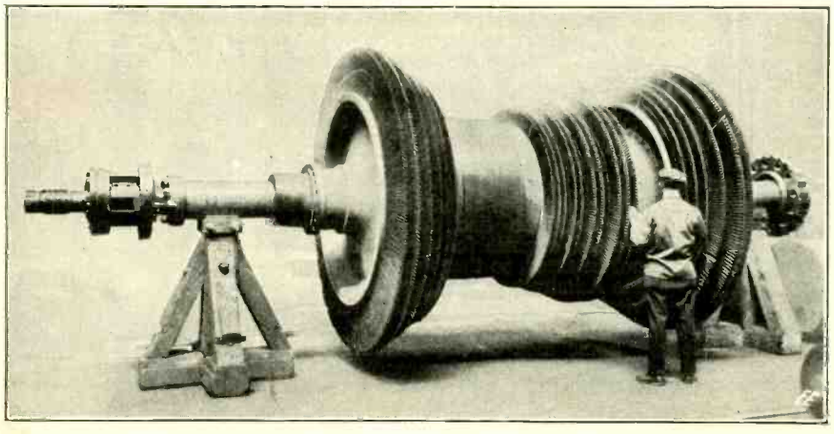
How the Turbine Operates.

The visitor, journeying to 74th Street to see this great turbine, will probably be disappointed in its appearance. It has, indeed, a massiveness that speaks of immense power within, but in size it is dwarft by the old vertical reciprocating engine, of one-twelfth its capacity, beside which it stands; and in addition, since all its working parts are enclosed, it is entirely lacking in the fascination that visual movement imparts. But its deficiencies as a spectacle are real virtues in the eyes of the engineer, for they mean lower first cost, smaller space occupied, reduced installation and operating charges, and a high degree of reliability.

The very conspicuous difference in size between the turbine and the reciprocating engine is due to their different operating principles. The reciprocating engine consists essentially of a cylinder in which a piston is pushed up and down by the steam. The main parts of the turbine, however, are a spindle, carrying hundreds of small vanes, and a casing which encloses the spindle. The steam acting upon the vanes of the spindle revolves it as the wind turns a windmill. The motion of the turbine is, therefore, rotary and as there are no heavy parts to be stopt and started at the end of every stroke, as there are in a reciprocating engine, very high speeds are permissible, thus making it possible to develop great power from a comparatively small machine. The speed of this particular turbine is 1,500 revolutions a minute.

As has been said, the turbine is triplex; that is, it consists of one *high pressure* element and two *low pressure* elements, each connected to a separate electric generator. This gives it the appearance of three distinct machines, but it is actually a *single unit* and all three elements are started and controlled as one. The triplex arrangement is employed because it is mechanically greatly superior to the single element design for a machine of such great power. There is also the very decided additional advantage that, in an emergency, any one or two of the elements can be shut down without stopping the others. All the power eggs are, therefore, not in one basket, and the high efficiency of a single large ma-

(*Continued on page* 453)



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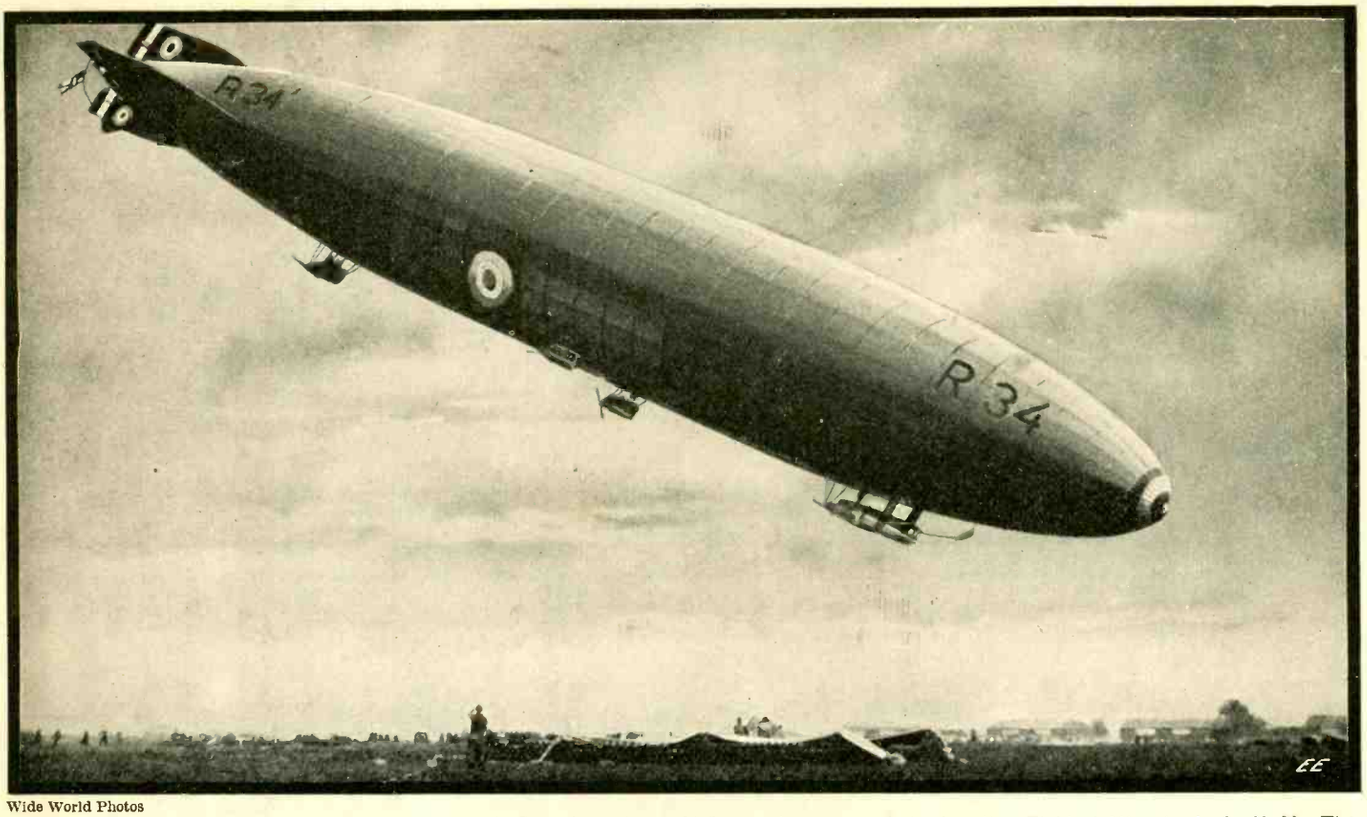

Wide World Photos

An Exceptionally Fine Picture of the Giant British Dirigible—the R-34 Descending Toward the Landing Field at Mineola, L. I., N. Y. The Engines Are Kept Running While Descending, and the Rudders Altered to Steer the Ship Up or Down.

How the R-34 Crost the Atlantic

Details of the Giant 2,000,000 Cu. Ft. Trans-Atlantic Blimp

THE plucky English fliers succeeded in flying across the Atlantic Ocean, a course extending over 3,000 miles, in a gas bag known variously as a dirigible and blimp, and finally as her commander termed her, a "filleted rigid," meaning a rigid or framed gas filled balloon, having filleted or flat segmented sides. After making a successful landing at Mineola, L. I., N. Y., she sailed away on her return to England and landed there after a record-breaking voyage of 75 hours.

At Mineola the R-34 was hauled down and held by powerful cables, a large force of several hundred enlisted men being required to watch her day and night, in the event of wind gusts, storms, change of buoyancy due to the heat of the sun expanding the gas with which she was filled, and a hundred and one other expected but uncertain capers which the gigantic 670-foot "blimp" might cut up.

Some idea of her great bulk can be ascertained from the accompanying semi-sectional view of her, which shows the steering, eating and sleeping quarters, as well as many other interesting features.

LANDING TOWERS FOR DIRIGIBLES.

On her successful return to England the great airship was "anchored" to a new device designated by British Air Force engineers a "landing tower." Several of these towers are now in use in England for "anchoring" these giant lighter-than-air machines. They are provided with elevators to bring the crew and passengers to earth. The airship is held by the "nose" in such a manner as to ride a storm much more safely than if held to the ground. Such a device was described and illustrated in the July issue of this magazine.

Automatic landing and mooring are essential before airships can be put up as a commercial proposition.

Three points are being studied by the British technical departments now. One is moving the airship in the open, the second is the economy of man power required in landing, and the third the necessity for a good reserve of speed. This last is not a question of petrol supply, but of horsepower and the size of the ship.

A recent trial trip of the R-32 gave from 67 to 70 miles an hour, and she has 1,550,000 cubic feet capacity.

The R-34 has 2,000,000, and on her Atlantic trip reached approximately 60 miles an hour, but this is not going to be the speed of the future airship.

Major Scott, before he sailed, said he had no doubt that 100 miles an hour with proportionate "dispersal" lift, which is 50 per cent of the actual lift, would be obtained from airships that would be built with a capacity of 5,000,000 cubic feet.

Unless the size of the airship is increased, engines for this higher speed cannot be fitted, so that the experiments which the Admiralty is going to carry out will be vital to the commercial interests of the future.

Some idea of the wonderful aerial engineering features incorporated in the R-34, the first blimp to cross the Atlantic Ocean, can be gained from the following excellent description by Capt. Samuel T. Moore, commander of the balloon troop helping care for the transatlantic airship.

The forward gondola is the navigator's office and it is from this that the ship is controlled thru speaking tubes, electric bells and signals. The steering gear is also controlled from this gondola, as well as the rudder. On the side of this cabin are "elevator wheels" which control the elevators for changing the altitude when necessary. There is a table in the navigator's office on which charts are made while a flight is in progress. Many scientific instruments are on it, as well as the controller for the radio station. There is an engine in it, and immediately behind it are two more engines on either side. One or two of these engines work while the other sleeps. All the engines on the ship could be kept working if it were necessary, but as a general rule one of them is stopt and cleaned while the dirigible is in operation.

In the aft gondola are two more engines, making five in all—one in bow, two amidship and two at the stern. There are, however, only four propellers, the two engines at the stern having only one propeller. Two men are at work at the engines during the flight, one man operating and the other oiling.

DECK WALK 600 FEET LONG.

Inside the huge envelope there is a deck just 600 feet long and very narrow, covered with linoleum. It is not difficult for a man to balance himself as he walks along this deck, but it would be difficult for two men to walk it.

There are eighteen hydrogen gas compartments inside the shell, as shown in the semi-sectional view herewith. Nine of them have automatic valves, while the other nine are equipt with hand valves. The pressure of the hydrogen is not constant, but varies according to atmospheric conditions, with heat causing an expansion and cold contraction. This is regulated by the valves. If

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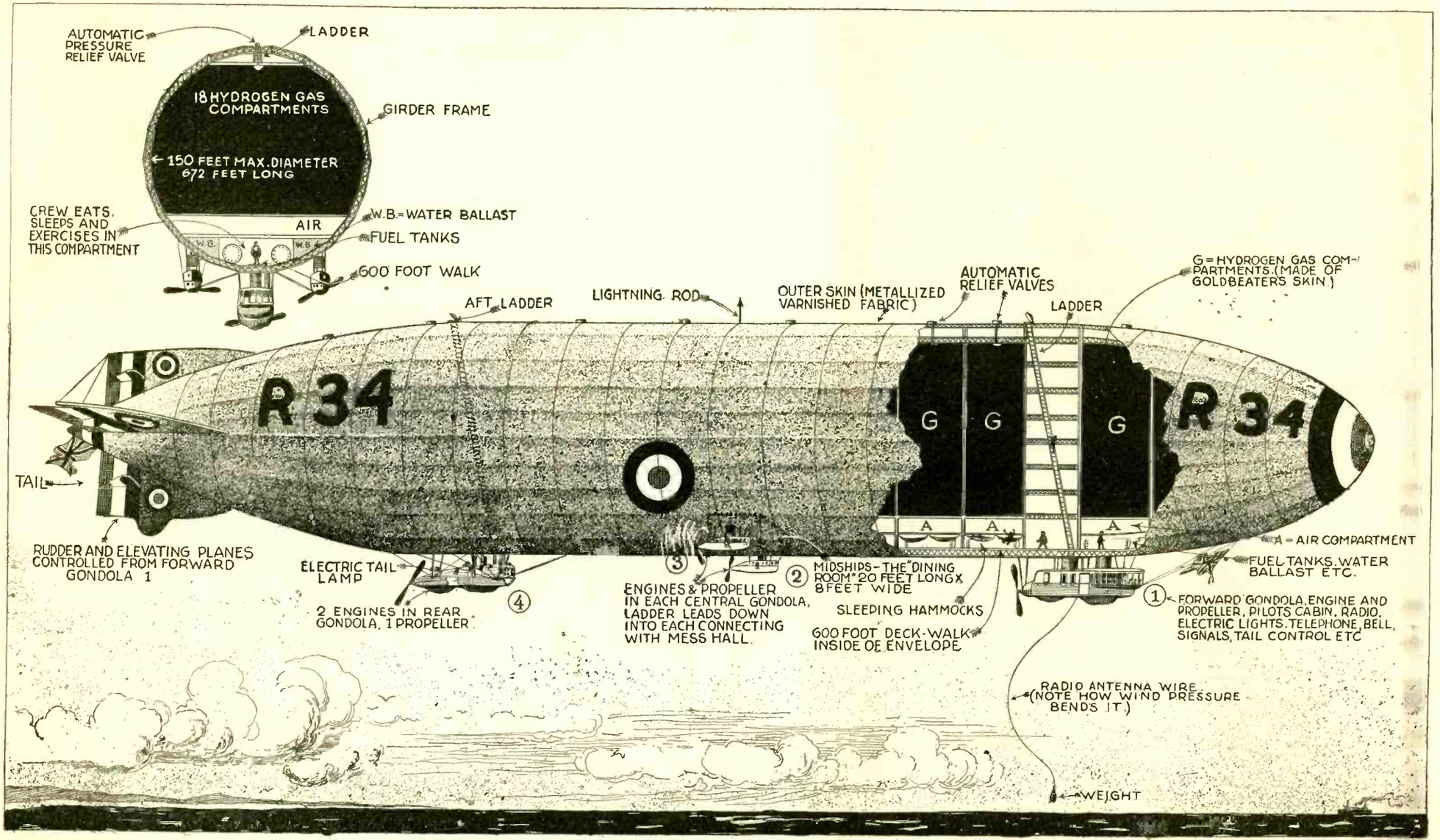
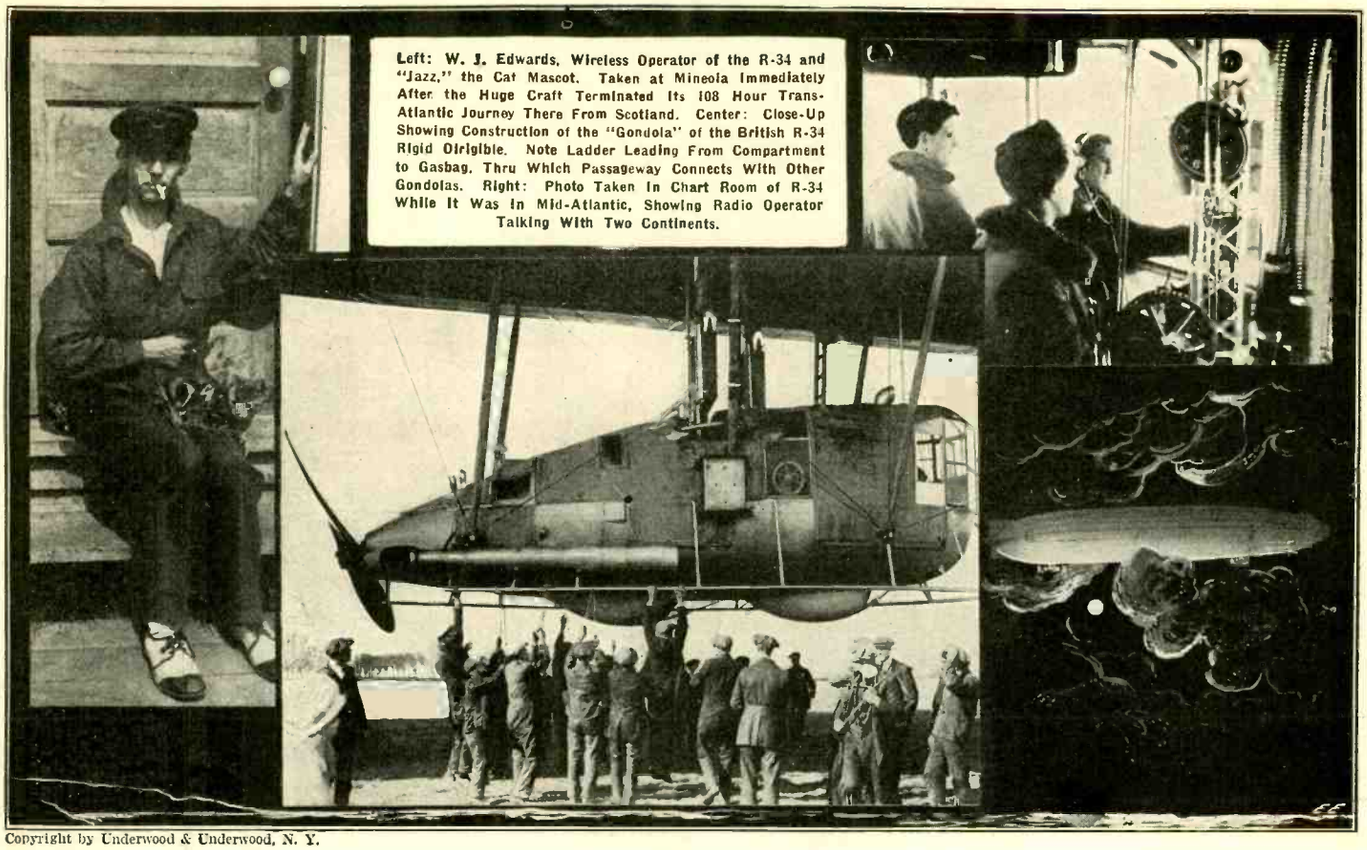


THE "INSIDES" OF THE TRANS-OCEANIC AIRSHIP—THE R-34. THE FIRST DIRIGIBLE TO FLY ACROSS THE ATLANTIC

Imagine a gigantic airship resembling a huge sausage floating lazily thru the air over your head. This wonderful invention of man, measuring 672 feet in length, is nearly as high as the fifty-five story Woolworth Building in New York City, or three-quarters as high as the Eiffel Tower. The giant British airship, which successfully made the trip across the Atlantic Ocean from England to Mineola, L. I., N. Y., and return, was piloted by Major G. H. Scott and a crew of thirty men. On the trip over from England to America, her commander unconsciously carried a stowaway, a former mechanic who had worked on the ship in England, and who would not be cheated out of the first trans-Atlantic trip. The ship also carried a tabby cat as a mascot. The English Government has plans under way to build several new dirigible gas-filled airships similar to the R-34, but about twice its size. The R-34 carried approximately 2,000,000 cubic feet of gas. The accompanying illustration shows comprehensively some of the novel features in this first "Leviathan of the Air". The crew dined, slept and exercised in the long compartment running along the lower side of the gas envelope. The dining room is placed amidships and is 20 feet long by 8 feet wide. All the four suspended gondolas carried propellers and petrol motors for operating them, and the members of the crew had access to any of the gondolas as occasion required, by means of covered ladders leading down from the 600-foot walk and passageway at the base of the gas envelope. The crew slept in hammocks suspended from the framework of the envelope, just above the 600-foot walk, as shown in the diagram. In rising from the ground at the start, ships of the R-34 class do not operate their engines, but simply throw off their mooring cables, when they rise rapidly to a considerable height,—8,000 to 9,000 feet elevation. The big ship then finds her natural "equilibrium" point, and the commander gives the order to start the engines and propellers. The giant blimp, termed a "fileted rigid" by her commander, Major G. H. Scott, then comes under perfect control. To cause the ship to descend, is simply a matter of shifting the water ballast and raising or lowering the horizontal tail rudders. The ship is kept on an even keel by vertical tail rudders. Astronomical observations, such as "shooting the sun" with a sextant, are carried on by one of the officers, who climbs up an 80-foot ladder to the top of the airship, there being two of these ladders, fore and aft. The range of the special wireless apparatus is remarkable, signals having been transmitted from the R-34, 1200 miles, from off the Azores to England. Signals from England and America were copied in mid-ocean. Four distinct wireless sets were carried, including one "wireless telephone" set. The Dirigible has a much greater lifting capacity than the NC planes, and can not only carry a higher powered radio set, but can support a longer antenna when desired.



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Very truly yours,

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Under-Water Surveying by Reflected Sound Waves

By H. WINFIELD SECOR

ASSOCIATE MEMBER AMERICAN INSTITUTE ELECTRICAL ENGINEERS

LOCATING invisible objects at distances of several miles under water is not such a new scientific fact, as several schemes for carrying out the detection of submarines by these sound waves, radiated from the propeller and engine of the undersea craft, were conceived and applied more or less successfully during the progress of the World War, and enemy submarines were trailed by means of submerged microphones or electrical sound detectors. But it has not been possible heretofore to utilize ordinary apparatus, such as a *single* sound detecting instrument located at a *single* point, to *accurately locate any object at an appreciable distance to within a few feet.* However, a New York inventor and electrical engineer, Mr. E. E. Ries, has been working for a number of years on a most ingenious *reflected-sound* scheme for locating various objects such as submarines, icebergs, charting ocean and river beds, etc., and the present article deals with the remarkable principle of sound wave triangulation, as evolved and perfected by Mr. Ries.

Our readers may probably remember having read several years ago of an "iceberg detector" operating on the sound wave principle, devised by Mr. Ries, in which two sensitive microphones fitted with horns were mounted at the extreme ends of a yardarm high up on the mast of a ship. To locate the distant iceberg, even in a fog or at night as well as day-time, a powerful siren placed exactly midway between the

The Ries Under-water Sound Detector and How it Works.

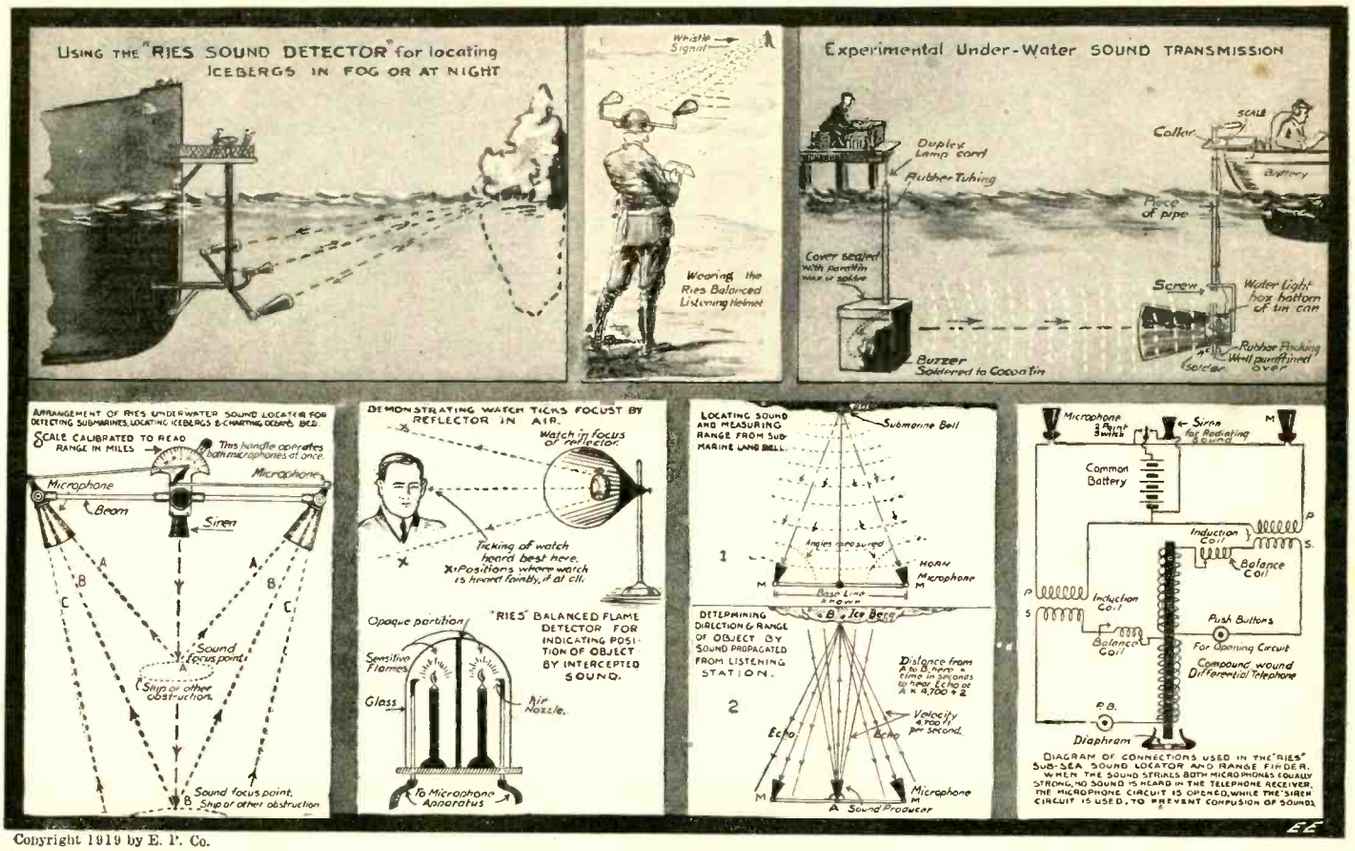
microphones on the yardarm or spar, was sounded. The yardarm carrying the microphones was then swung on the mast as an axis, until the "echo" reflected from the iceberg was picked up several seconds later in the microphones. By a special scale device attached to the pivoted microphone elements, the angles which they subtended when both were focust on the spot from which the echo rebounded, showed the distance in feet or yards, as the case might be.

Before going further into the details of Mr. Ries's most ingenious and promising system of "Subaqueous Surveying" by means of reflected sound waves, it will prove interesting to look into some of the principles of sound wave physics underlying the functioning of this latest scientific achievement. Moreover, as Mr. Ries pointed out, his system of sound wave triangulation overcomes all the weaknesses of the single, straight-line sound detectors, by utilizing a greater base line in his triangular determination of the source of the sound or echo, and by this means he confidently believes that ships, submarines, icebergs or other obstructions, including the depth, contour and nature of the ocean bed or rocky coast, *can be located quickly and precisely to within a few feet, even at a distance of eight to ten miles or more.* This seems all the more probable when the wonderful principle on which his system operates is more fully understood.

SOUND WAVES IN AIR AND WATER.

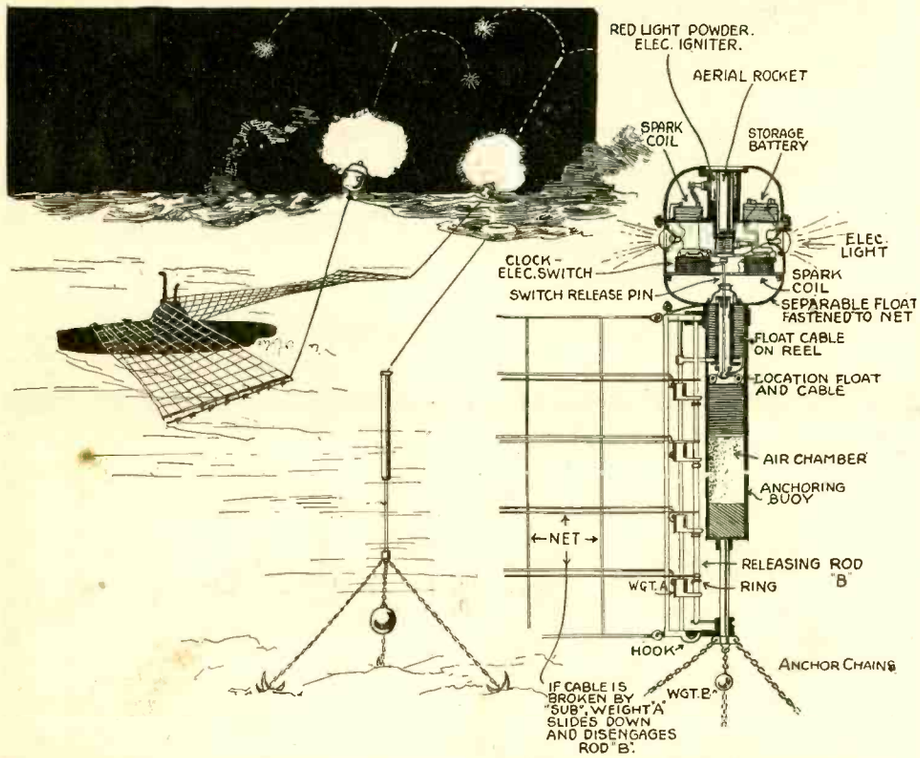
In the original scheme for locating icebergs or other objects projecting above the water, as devised by Mr. Ries some years ago, the propagation and reflection of sound waves, i.e., the echo, was based on the phenomenon of sound wave transmission thru the air. Sound travels thru the air at a speed of approximately 1,120 feet per second; it is well to keep in mind also that a sound traveling toward a certain point such as a rock or iceberg and rebounding from the surface of said object by reflection, will cause an echo traveling at the same speed also, or 1,120 feet per second. Hence, when listening for the echo, which you may sometimes do in parks or in mountainous regions where there is a rocky formation which will give a good clear echo at a considerable distance, you may time the distance with an ordinary watch provided with a second-hand, by counting the seconds required to hear the echo. But the time noted should be divided by two, and then multiplied by 1,120 in order to get the distance in feet. Sound wave propagation thru water is very much the same as that thru air, with the difference, however, that sound travels thru water at a much greater velocity than thru air, owing

(Continued on page 454)



The "Ries" Improved Under-Water Surveying and Locating Scheme, Utilizing Reflected Sound Waves Propagated thru the Water, Promises to Solve Many of Our Greatest Problems. Among These We Find the Locating of Sunken Ships, the Charting of River and Harbor Beds, Detecting and Locating of Enemy Submarines to Within a Few Feet of Their Actual Location, Etc. The Principle of Triangulation Employed Makes the Invention Extremely Feasible and Precise.

A Telltale Submarine Net



Submarines Will Have to Become Almost Human to Get Thru the Under-Water Nets and Mines Barrages of To-morrow. Here's a Telltale Net That Entangles the "Sub" and Sends up Rockets Signaling the Fact. Electric Light "Markers" Are Also Brought into Play.

THE vast experience gained by naval designers and inventors during the progress of the great war has taught them many things. The various means of protection against submarines have been quite extensively tried out, and while many theorizers have predicted failure for *anti-submarine nets,* still many hundred miles of nets were constructed and successfully employed during the war. A new form of *telltale submarine barrier* or net was recently invented and patented by one John P. Geraghty, of Jersey City, N. J. His invention covers a system of detecting submarines solely by the use of protective nets, so that anti-submarine operations can be carried out directly, and a few dozen "ash cans" (depth bombs) let go on the spot where the submarine is eventually located by the sub-sea microphones, et cetera, as now used by all of the leading navies.

The outstanding features of Mr. Geraghty's invention are that as soon as a submarine touches the net and tries to cut its way thru, or else bumps the net so hard that it carries it away, telltale signals will instantly be given, and which are effective either by day or by night. At night, rocket signals are shot forth from the anchor buoys of the net as soon as the net has been damaged or carried away by the lurking enemy sub-sea craft engaged on a surreptitious visit to the harbor or bay thus protected.

In this form of anti-submarine protective net, the net, which is of special design, is detachably fastened to sturdy anchoring devices, so that when a submarine strikes the net it can, with ordinary pressure, tear the latter away from the anchorages, which immediately causes signals or telltale means to be operated so that patrol boats, such as submarine chasers and destroyers, can at once give battle to the unseen enemy. The anchoring devices are provided with clever releasing catches, which when a certain amount of pressure is applied to the net, collapse and allow the net to be released from the anchorages. As soon as this happens, however, the collapse of the catches

(*Continued on page* 483)

Electrocuting Huge Leopard

It was a "shocking" affair, but those members of the Los Angeles moving picture colony who are in the habit of working with animals are breathing sighs of relief, for David, the big leopard of the "movie" jungle is no more. Sentenced to death by a jury of his peers, the big cat paid the extreme penalty by being electrocuted. According to Mr. Edwards, manager of the film company who owned the beast, most of the animals used in film work are very tame, but David had been acting treacherously for several months, and rather than risk the injury of anyone who might be acting with him it was decided to end his career. At first shooting with a high-powered rifle was considered, but fearing that this would disfigure the beautiful pelt which the company wished to preserve, the engineer of a large electric power station nearby was consulted and electrocution was decided upon. A large steel plate was placed on the floor of the cage and connected to a 6,000-volt power line at the power house. David was then placed on the plate, and another wire fastened to his leg, the juice turned on, and David was no more.

The execution of animals has received considerable investigation, especialy in the city of Boston, Mass., where there is located a specially equipt institution for electrocuting horses, cats, dogs, etc. The apparatus and special provisions arranged to carry out this work were described some time ago in the ELECTRICAL EXPERIMENTER. The method is not only advantageous in many different ways, such as the ease and certainty which which the animal may be killed, but also has received the highest commendation from humane investigators and scientists. The theory of electrocution tends to show that the high velocity of the current travels faster than the nerve wave itself, and therefore the animal is dead before any shock can be felt.

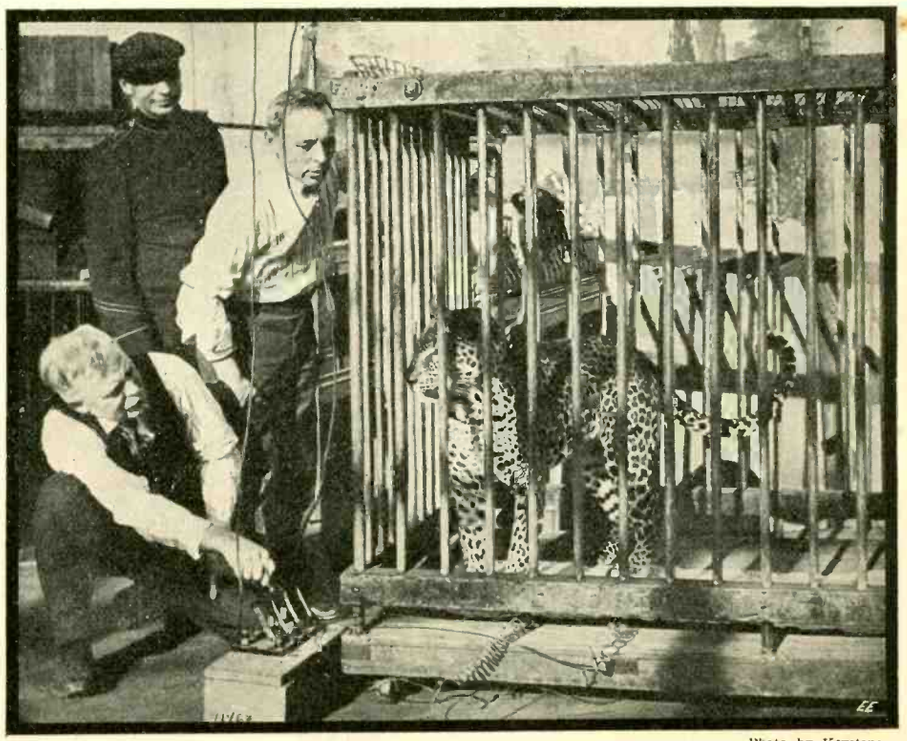


Photo by Keystone

"David"—the Big Leopard of the "Movie" Jungle—About to Breathe His Last. One Throw of the Switch and He Paid the Final Penalty for His Treachery, Which Had Endangered the Actors' Lives.

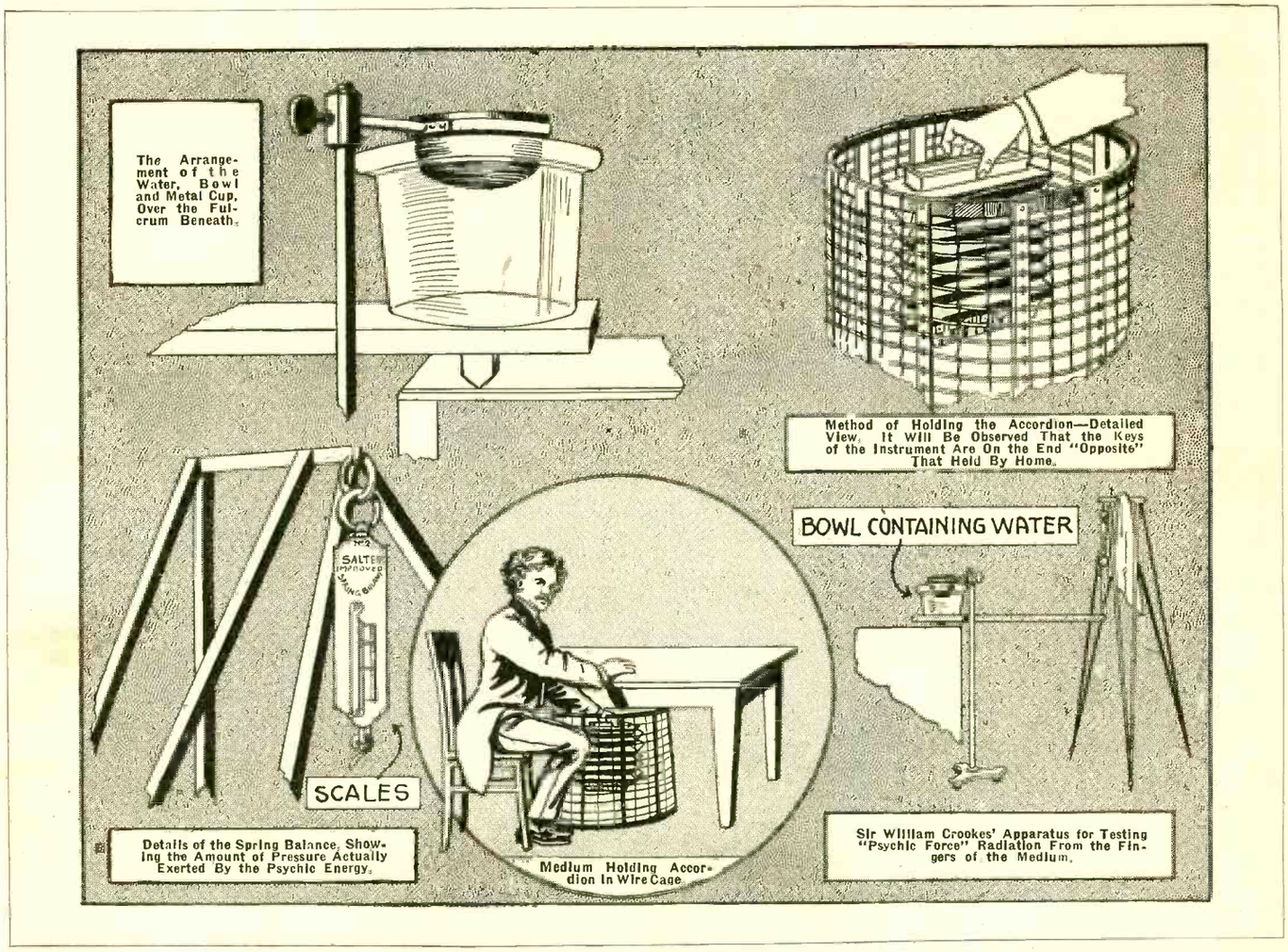
Sir William Crookes' Psychical Researches

By HEREWARD CARRINGTON, Ph. D.

THE late Sir William Crookes, O.M., F.R.S., will always be regarded as one of the greatest scientists—as he was one of the greatest "psychical" students—of all time. His achievements in the fields of chemistry and physics alone insure the perpetuation of his name in scientific circles. He was the discoverer of the element thallium; he it was who first investigated many of the phenomena of radiation, which led to the ultimate discovery of the "Crookes tubes"—named after him—and which in turn have led to many important discoveries in the realms of chemistry, physics and medicine (the X-rays, etc.). He made many valuable contributions to the study of radium; he invented the "radiometer," which we now see in nearly every oculist's shop; he wrote many standard works upon chemical analysis, sugar manufacture, dyeing, printing, metallurgy, sewage, diamonds, and many other topics—thereby establishing his name as one of the finest, most ingenious and most practical scientific minds in the world, and leaving to posterity a veritable monument, in the shape of lasting and valuable achievement, of great practical benefit and value to mankind.

Sir William Crookes, however, was known not only for his interest in the problems of physics and chemistry, but also by reason of his interest in "psychic" phenomena, and his book "Researches in Spiritualism" is a classical manual on the subject, oft quoted, and a model of clarity and impartiality. Curiously enough, his researches into the phenomena of spiritualism were being undertaken during the very years (1870-74) when, in the opinion of many physicists, Sir William was doing his best work in chemistry, so that the charge cannot be brought against him that "he only became interested when in his dotage"; on the contrary, he was then in his prime—about forty years of age. It is true that Crookes maintained his interest to the day of his death, but he *wrote* very little upon the subject, contenting himself with patient research and investigation, which tended but to confirm his earlier researches. A brief summary of these cannot fail to be of interest.

Scientific Proof of Psychic Force or Spiritualism



IN publishing this article, we are aware that it is a very unusual subject to appear in a scientific magazine. We however, have approached the matter with an open mind, neither condemning nor upholding it. The reader must be the judge. We do not publish it with the mental reservation that "there might be something in it, after all," but we do believe that anything at all in science over which there has been a great controversy should be discussed as intelligently as it is possible. The author of the present article, Dr. Hereward Carrington, is a member of the Society of Psychical Research, and he is also the author of several interesting books, among others "Death: Its Causes and Phenomena;" "The Problems of Psychical Research;" "The Coming Science;" 'Psychical Phenomena and the War."

Sir William Crookes, one of the greatest scientists that ever lived, became converted to spiritualism after long and exhaustive experimental evidence which today seems irrefutable. Dr. Hereward Carrington clearly describes some of Sir William's experiences in this article, which should prove of unusual interest to our readers, whether it will convince them or not.

The majority of these experiments—which were chiefly conducted in Sir William's own home or laboratory—were made with the medium Mr. D. D. Home—a medium who produced extraordinary "physical" manifestations, and who was never detected in fraud in all his long career (Home was an intelligent man, who wrote several excellent books upon the subject himself). One of the earliest experiments was that with an accordion, held lightly between the thumb and fingers of Home's hand by the end *opposite* the keys. His other hand was visible and rested on the table. The accordion, thus held, was placed within a circular wire cage, which could be charged

(*Continued on page* 440)

Ever Hear the Tale of the Man (and Oh! Lawdy! the Woman) in "Upper Ten?" The Worries of the Traveling Public That Must Sleep En Route in Those Sardine Box Atrocities Known as "Berths" Are Finally Reduced to a Minimum; by Means of This New Telephone Checking System the Chance of Finding Your Berth Already Occupied by a Duplicate Ticket Holder Is Obliterated, Forever, We Hope.

Telephone Solves "Lower Berth" Squabble

THOSE of you who have tried in vain to obtain a *lower berth* on a railroad train, only to find out that a friend of yours purchased one from a different window *after* you applied for yours, will doubtless be interested in the new method of booking applications which is in use at the present time at one of the large railroad terminals in New York City.

According to the old method, diagrams of each pullman car, with blank spaces for each berth, were distributed among the various stations and ticket offices. When you purchased your ticket, the number of your train ticket was entered in the space representing your berth, In this way the ticket agent knew just what berths were occupied and which were not. Yes, he did!

When the train left the station these cards were handed to the pullman conductor, who settled disputes as to the occupancy of the berths, according to the ticket number entered on his card. If two people claimed the same berth, the one whose ticket number appeared on the card was the fortunate individual.

(*Continued on page* 481)

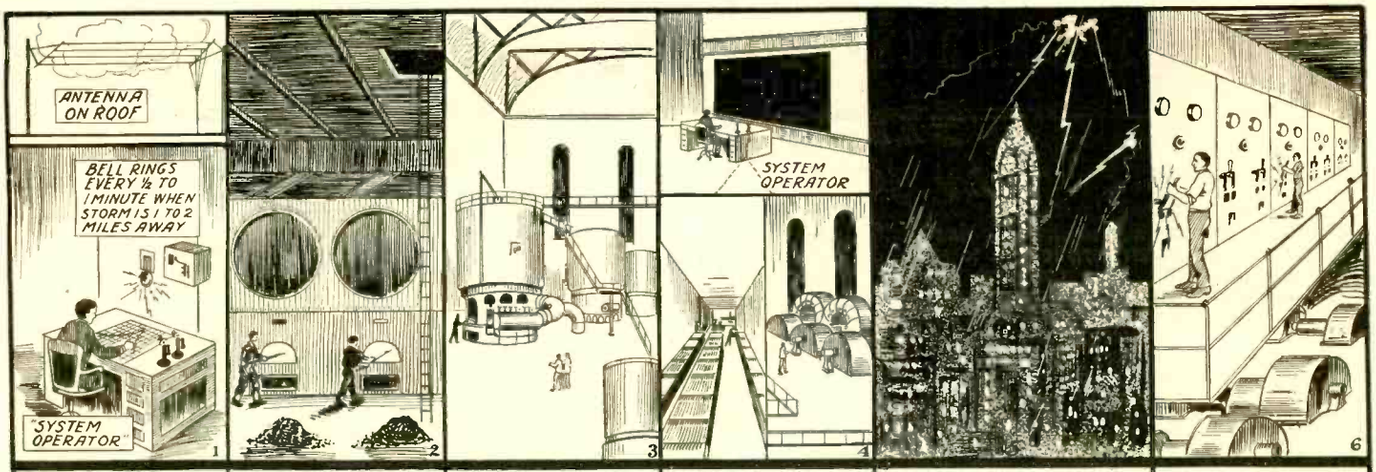
New Continuous Panorama Advertising Display

It is undoubtedly a fact that the long suffering public has been wont to see many advertising devices both good and bad exhibited in store windows, etc., designed with the intention (?) of securing their attention. Of these some have been rather unique and served their purpose admirably, but there have been many that have fallen by the wayside.

With these few words of introduction to our plot we come up against the difficult task of describing this new advertising device that to all intents and purposes eclipses them all. The main difficulty is to find a way that will make the explanation reasonably clear. It is called the "Endless" display machine, and as an advertising specialty it seemingly surpasses anything heretofore shown, in that it presents to a manufacturer, dealer or storekeeper a very neat and attractive way of telling the history of the manufacture of the goods he may be selling, with a wonderful grouping of photos much the same as a moving picture or panorama. It is only by some such means that customers are usually interested, as the eye readily transmits a picture to the mind that is bound to stick. In addition to the continuous moving picture there are a number of shelves provided at the base for the display of small wares.

A Mystifying Show Window Attraction—the Scene on the Revolving Disc Constantly Changes.

The circle covered by the moving disc is thirty inches in diameter, and is capable of showing three separate pictures on each sheet. It is adapted to display any advertising matter which is now used or has been used in posters, car cards, phrases, and in fact all written, printed or photographic matter. Each machine can hold 20 or more sheets each thirty inches in diameter; they are notched around the edge with a tough linen border which precludes their becoming torn or mutilated while passing thru the machine. The discs are slit and joined end to end in a flat pile inside the machine with the two free ends joined in a sort of twist, thereby enabling the action to be continuous both back and front. They are held in place both by a pivot in the center and also by the driving motor, which is of 1/40 horse-power and so geared that two friction pulleys bear on each side of the machine. Between these pulleys are set the edges of two discs and by a simple gearing process, each set of friction pulleys works in the opposite direction, thus making possible the continuously moving panorama.

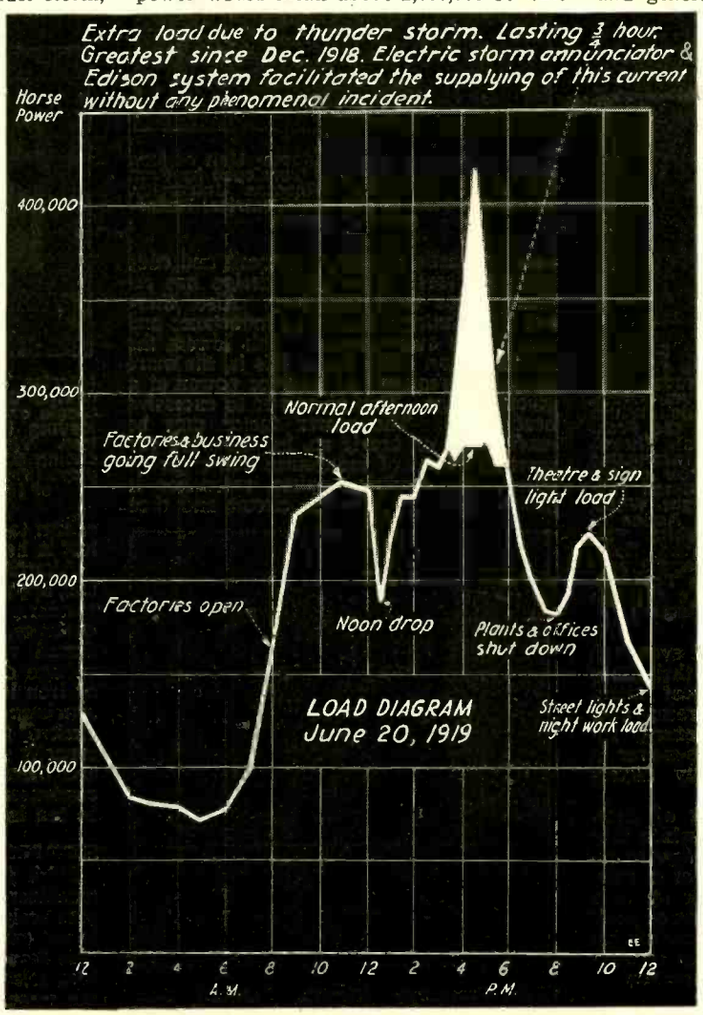


200,000 Horse-power in One Hour

ON Friday, June 20th, 1919, the electric light and power service of the New York Edison Company was put to the severest test which the Waterside Station had ever experienced since December, 1918. This was a day on which a summer thunder-storm, coming up in midafternoon enveloped the city in darkness equal to that of 10 o'clock at night, the consequence being that about 2,000,000 electric lights were turned on almost instantaneously and the Edison Company had to meet this demand for more "juice." It occurred when factories and offices were going at full swing, hundreds of which suddenly switched on all the lights when the storm broke. Several factors enabled the company to supply the enormous demand for current. One of these we have described in a previous issue of the ELECTRICAL EXPERIMENTER — the "wireless storm announcer," which again stood in good stead.

This consists of a slightly modified form of an early model wireless receiving station, using a *coherer* and a bell as a decoherer, together with the necessary relays. In addition in the aërial circuit, are two spherical balls resembling a spark gap. These are placed 1-64th inch apart, and are used to prevent the causing of a false alarm by the surges emanating from nearby wireless telegraph sending stations. A condenser is placed in the ground circuit to prevent stray currents and a short-circuiting switch is used to silence the bell and protect the apparatus from heavy surges due to electrical storms, which may harm the apparatus and materially impair its usefulness.

The demands of this generating station were raised by this increase in the use of current from approximately 250,000 horsepower, which is the normal daily business load, to nearly 425,000 horsepower, and due to the fact that all offices and factories were "carrying on" at the time, this load would naturally be almost exclusively of a lighting nature. From these figures an increase of 175,000 horsepower would mean about 2,000,000 50-watt lamps being turned on suddenly. Naturally enough, something had to be done in order to meet this demand, and inasmuch as the change from normal to the *peak* load came within less than an hour, it involved a close race against time to get the boilers and generators into operation in time to meet the approaching darkness that the coming storm would bring.



This Daily Load Chart Shows How the New York Edison Company's Output Increased Nearly 100% During a Recent Thunder-Storm.

At a large generating station such as at Waterside, there is generally one man and his assistants, who are able to conduct the affairs of the station with remarkable skill and precision—the "system operator," as he is called at Waterside. The system operator invariably keeps posted on the demands that are or may be made on the station for power and light, so as to direct the disposal of all generating machinery. Thus the station will afford the highest quality of service and will operate with maximum efficiency, i.e., he ascertains how many boilers should be maintained under load, and how many should be "banked," which machines shall carry the load and which shall remain idle. He also directs the switchboard operators as to which feeders shall be used to dispose of the output. As this routine is an everyday affair, it is conducted quite automatically, but the life of the system operator also has some of its thrills, especially when a storm approaches the city at a rate of about 45 miles an hour. The little thunder-storm detector, a view of which is reproduced here, does its share of the work. When a storm is approaching, and about one to two hours away, the gong on this storm announcer will strike about every fifteen or twenty minutes. This is only a "warning," and not much attention is paid to it, as it is very probable that the storm

(*Continued on page* 450)

Possibilities of High Frequency Currents

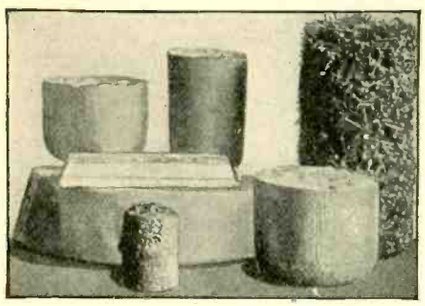
By JOHN E. PRITCHARD

IN all branches of human endeavor there has been that characteristic trait to attain perfection. This condition has never been reached and never will; but like a variable approaching a limit, the difference between perfection and non-perfection can be made very small.

In the early development of electrical application, it was generally conceded that direct current transmission was a marvelous advance toward the ideal method of power delivery. Its flexibility over all others was evident, at that time. This advancement opened a new field of industrial engineering. Investigators were spurred on by successes, so naturally the field became extensive. Then the *disadvantages* of direct current became prominent. Economy demanded that power units be centralized. It was found that to transmit large currents long distances at low voltage, required very *large conductors* to reduce the heat losses, which are equal to the current squared, multiplied by the resistance. This draw-back was partially surmounted by the high voltage direct current generator; but due to the mechanical as well as current transformation difficulties, it has not been widely adopted.

LOW FREQUENCY ALTERNATING CURRENTS

Low frequency 60 cycle A. C. machinery, thru persistent research, has to-day reached



Melts From the High Frequency Furnace, Some of Which Resist Fusion Up to Temperatures as High as 1700° Centigrade. Such Include Tin, Lead, Zinc, Aluminum, Brass, Copper, Iron Cast and Electrolytic (Which Was Melted in Vacuum Without the Presence of Carbon, Even in Traces), Nickel, and High Silica Glass. As an Interesting Indication of the Unique Character of the Induction Possible, a Mass of Small Iron Nails Is Shown at the Extreme Right, Which were Cintered Together by the Action of Powerful "Eddy Currents." While This Action Is Proceeding, During the Early Stages of the Melting, Small Arcs and Sparks Tend to Weld the Many Particles Together. This Effect Is Obtained Only In a Crucible That Is Electrically Non-conducting.

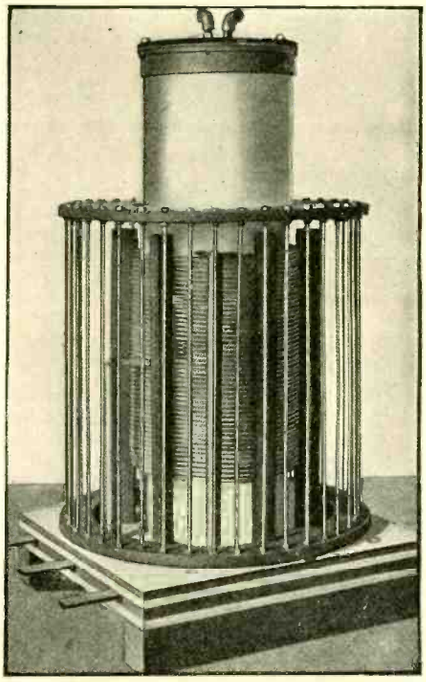
a high degree of perfection. But even with our great power houses and their long transmission lines lighting great cities, propelling ponderous electric trains over high mountains and furnishing energy for every conceivable form of prime-mover in the industries, there exist many factors detrimental to perfection.

The reason for the great use of alternating currents is the ease with which they can be *transformed from one voltage to another*. They can be generated at a comparatively low voltage and stept up to a higher voltage. In the transmission of great power at *high voltage* there is required but a *small current*, and this, in turn, requires only *conductors of small cross-section*.

RESONANCE IN A. C. CIRCUIT.

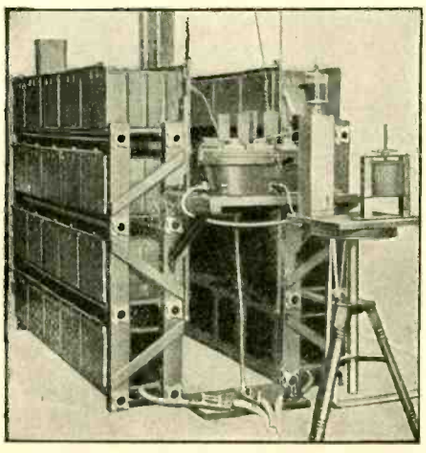
Transformation is accompanied with

The High Frequency Furnace and Electric Power Transmission



Typical Vacuum-Type Inductor Unit of New High Frequency Furnace Developed by Prof. Dr. E. F. Northrup, Princeton University, Marking a New Era in the Electrical Refinement of Metals.

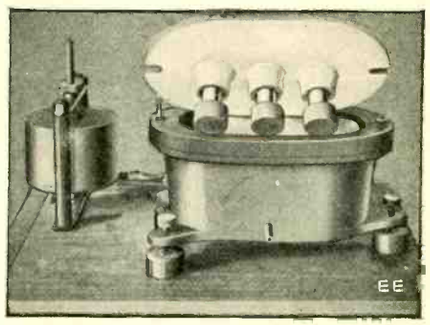
heat, magnetic leakage, hysteresis and eddy current losses. First class design has reduced these to a minimum. Also, there are *disadvantages* caused by inductance and capacity in every circuit. This lowers the *power factor*. The lower this is, the more current is required to produce power at a given voltage. This gives rise to excessive heat losses. The power factor may be made unity or nearly so, by *balancing* the reactive effects of inductance and capacity. When this condition exists, resonance is said to take place in the circuit and then



High Frequency Electric Furnace Condensers and Spark Gap. These Furnace Outfits Have Been Built In Sizes Up to 50 Kilowatts.

Ohm's law holds true, C=E/R. It is very desirous not to have this in practise, due to the great strain placed on the circuit. The voltage, as well as the current, may reach abnormal values under such conditions. In fact, the potential on a long transmission line may be 10 per cent higher at the distant end than at the generator end, due to these resonance conditions. In one case a 10,000-volt A. C. transmission line showed 11,000 volts at the distant or load end of the circuit.

This phenomenon may be illustrated by the mechanical analogy of a pendulum six feet long, on the foot of which is hung a weight of one hundred pounds. Strike the weight with a force of ten pounds. Call this the *positive* impulse. When it has traveled the full length of its arc, give it another ten pound blow. This is the *negative* impulse. Now the pendulum will oscillate freely. The time for a single vibration will always be equal, regardless of the length of its arc; therefore the impulses will occur at equal intervals of time and will be analogous to an alternating current delivered to a resonant circuit. The amplitude of the swing will get greater and greater until finally the energy represented in the moving weight is *many times larger than the individual impulses*. These are called *free vibrations*. But if the forces are not applied at the instant of the weight's



Interior View of Discharge Gap. The Discharge Gap Shown Is Adapted for Either Single or Two-Phase Operation. It has No Moving Parts and Is Substantially Noiseless. The Gap Is Very Effective in Producing Strong Oscillations and May Be Employed for the Conversion of Large Amounts of Power Into Oscillatory Currents.

return to center, part of the energy will be lost in heat. These are *forced vibrations*.

Alternating currents, in present day practise, applied to induction motors and transformers, are impeded by resistance, inductance, and capacity; giving rise to these forced vibrations. This condition causes voltage drop, low power factor, hysteresis or iron losses, and eddy current losses. A *synchronous motor* on the line with an over-excited field, furnishes an equivalent of capacity and tends to neutralize inductance and thereby makes the vibrations free. A condenser would do the same, but it would be too large to be practical.

HIGH FREQUENCY ALTERNATING CURRENTS.

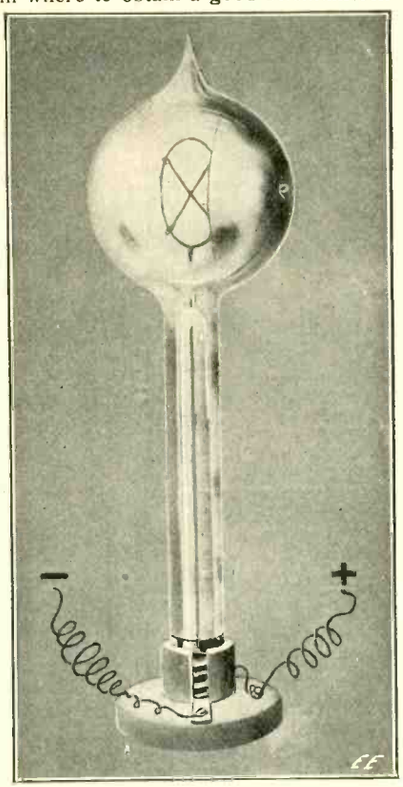
High frequency alternating currents and machinery for producing them are comparatively new. This field of application is not extensive. There has been considerable development on the large scale in wireless telegraphy and telephony. But here the power has not, up to the present time, exceeded a few hundred kilowatts, and it

(*Continued on page* 474)

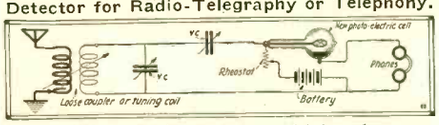
NEWEST ELECTRICAL DEVICES

PHOTO-ELECTRIC CELL SUPPLANTS SELENIUM.

Experimenters in many fields of science, including those interested in astronomy and certain branches of the electrical and radio arts, have very often faced the problem where to obtain a good selenium cell—



New Light-Sensitive Photo-Electric Cell and Below—a Diagram for Using the Cell as a Detector for Radio-Telegraphy or Telephony.



the well-known instrument which, when exposed to light, lowers its electrical resistance, thereby causing a relay connected with it to operate one or more local circuits. Not only was the question of where to obtain the cell often unanswerable, but the best selenium cells which have been available now and then on the American market have left much to be desired. This is so for several reasons. First, the element *selenium*—even tho it possesses a most wonderful natural quality of changing its electrical resistance in proportion to the amount of light thrown on it, and raising its resistance as the degree of darkness is increased—does not do this instantaneously, nor anything like it.

The newest advance in science is the *photo-electric cell.* This device, which has only recently been perfected so as to be available on the commercial market, is shown in the accompanying illustration and diagram. Not only is it useful where *light-operated* circuits are necessary and desirable, but it can moreover be used for receiving radio signals, as its designers have pointed out. Its arrangement in the radio receiving circuit is shown in the accompanying diagram.

The photo-electric cell apparatus is somewhat similar in principle to the selenium cell, in that it changes its inherent electrical resistance in proportion to the amount of light falling upon it. As its designers and builders state, the cell is not liable to lag as in the case of selenium, and there is no dark current whatsoever. It is said to be very constant and reliable in its action, and can be used to great advantage in stellar photometry. The applied potential for this cell is 220 volts. A cell of this type has a wider field of usefulness in many respects than a selenium cell, and it will carry a considerably larger current.

This photo-electric cell is very cleverly made up with a screw base fitting a candelabra socket. The rubidium screen inside the bulb connects to one terminal of the screw base, while a wire leads down from the silvered glass electrode facing the screen to the second contact member of the screw base. All that is necessary in connecting up the cell is to attach the two circuit wires to each of the two terminal screws on the base.

MAKING YOUR OWN FLASHLIGHT BATTERIES.

One of the latest advances in the flashlight art is the home-made battery outfit illustrated in the accompanying photograph. These outfits are priced so as to give about 25 per cent reduction in the cost of the batteries if purchased in the regular way, and each outfit will make three *two-cell batteries* or two *three-cell batteries,* there being suitable materials included to make up six flashlight battery cells. The outfit is supplied in two styles—one battery outfit includes a tubular flashlight, while the second outfit has a renewal equipment only, comprising the necessary parts, chemicals, etc., to make the six single cells as aforementioned.

As the makers point out in their instruction brochure accompanying the battery outfit, one of the principal advantages of this set is that the cells do not deteriorate in the least while they are standing, and so the person using these flashlight batteries has the satisfaction of knowing he is adding from 50 to 100 per cent to the life of his flashlight battery, which ordinarily is wasted, so far as the life of the battery is concerned, by standing on dealers' shelves, and in transit between the factories and dealers.

The liquid solution used in mixing the paste for the cells is placed in a graduated bottle. The proper quantity for each cell is marked off on a graduated label, which shows just what quantity to pour into each cell. Next, a chemical powder is placed in the solution and stirred well with a mixing stick accompanying the set. The carbon element, after being immersed in water for a few moments, is placed down

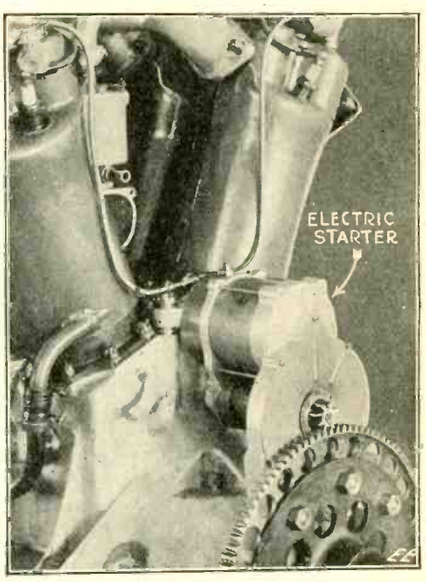
The Latest in Flashlights! Make Your Own Batteries.

into the zinc cylinder containing the solution, which has been thoroly stirred, and by pressing the cork supporting the carbon element down flush with the zinc cup, it is held firmly in place by bending over three zinc prongs. A cardboard cylinder suitable for holding three cells accompanies the outfit.

NC PLANES HAD ELECTRIC SELF-STARTERS.

It is not generally known that the NC flying boats which accomplisht the successful trans-Atlantic flight were the first heavier-than-air machines in this country to be equipt with electric self-starters for each of their big Liberty engine motors.

The result of the Navy Department's decision to so equip its seaplanes undoubtedly aided the success of the enterprise, for the NC-3, lost in the sea and fog near the



The Famous "NC" Planes Had Their Liberty Motors Fitted with Electric Self-Starters, as Shown in the Photo Herewith.

Azores, all her engines stalled, wet and cold, would never have been able to taxi into Ponta Delgada under her own power without the assistance of mechanical means for starting her propellers.

The picture shows this little starter attached to the propeller shaft of one of the big Liberty motors which drove our seaplanes thru the air.

This little device consists of a small 12-volt electric motor operated by a storage battery, connected thru a geared reduction to an automatic screw drive. On the end of the screw shaft is cut an 8-tooth pinion which meshes with a larger gear mounted on the propeller shaft. The starter will turn over the engine at 40 to 50 R.P.M. with a consumption of 100 to 110 amperes and a maximum of 1,300 foot-pounds is available on the engine crank shaft, for breaking loose a cold engine. When the engine begins firing the screw drive automatically demeshes from the crank shaft gearing. The storage battery weighs 26 lbs., and has a rating of 24 ampere-hours—or sufficient to supply enough current to make 150 starts on one charging.

An interesting incident of the American trans-Atlantic flight was that all three planes carried extra propellers, intending if one should break to descend to the water, change propellers, and start off again. They depended on the starter to make this possible.

It is also said that the C-5 (Blimp) met such strong headwinds on her trip from Montauk Point, Long Island, to Newfoundland, that the force of the wind stopt her propellers, and it was necessary to ascend to a higher level to avoid them, the starter with which she was equipt starting the engines while in mid-air.

Photo courtesy Westinghouse Electric and Manufacturing Company.

Even This Chinese Chef Likes to Cook on the Modern Electric Range. Meals Are Prepared on This Range for Workers on a California Ranch.

How Cool and Orderly the Electric Range Kitchen Looks. No Heat Wasted Here in Warming Up the Kitchen and No Smoke, Gas or Smell.

Electric Cookery—A Snap!

By GRACE T. HADLEY

Society for Electrical Development

THE history of human culture might be said to be largely the science of food preparation. Thru the ages the arts of fire were slowly developed. Wood, coal, oil and gas have been successively used in the production of artificial heat for the purpose of cookery. Until the last century fire was the most useful thing in the service of man.

To-day electricity is doing all that fire ever did, and is doing it better. Electric cookery is as superior to fire cookery as the electric light is to the tallow dip. Electricity is performing tasks beyond the limits of flame. Fire to-day yields motive power with many times the economy it did one hundred years ago. This motive power is the source of modern electric currents. This power as electric current enters silently and swiftly into the modern home and is the source of electric heat in the modern cook stove.

As refinement of living increases, electric cookery solves the problem of easy control, of elimination of waste, the uncertainties of temperature. The heat can be regulated with almost mathematical precision. When it is no longer needed the current can be turned off and no waste occurs. The time is close at hand when cookery will cease to be carried on by "guess-work." Many women already realize that it pays to put this work on a more scientific basis.

The temperature factor in cookery is one that ought to be thoroly standardized. In the art of baking a loaf of bread, for instance, there are many factors that must be precise, in order to insure best results. There is no reason, if conditions are exactly the same, especially temperature conditions, why the cook should not be successful with her baking, regardless of "wind in wrong direction."

The objects of cookery are to render food more digestible, to make the food more appetizing and to improve its appearance. In the cooking of animal food, the improvement of appearance and flavor is most important. Cooking foods rich in protein may decrease digestibility to some extent, but the increased attractiveness of well-cooked meat may render it more digestible by causing greater flow of digestive juices.

ROASTING.

Roast Beef.—Remove the baffle plate. Turn both oven switches to *High* and let oven heat twenty minutes. Place the roast on the rack in the dripping pan, rub with salt and dredge the meat and pan with flour. Put in the roast to sear for about four minutes to each side. Then put in the baffle plate and turn *lower* oven switch to *Medium*. After twelve or fifteen minutes turn the *upper* oven switch to *Medium*. The total time of roasting should be fifteen minutes to the pound. If the meat is lean, put drippings or hot water in pan for basting.

There is said to be a saving of about 15 per cent in roasting meat electrically. Considering the price of meat to-day, this is quite an item. The following actual test of a 4 pound roast is interesting, illustrating the exact steps in the process of roasting the meat and the actual loss of weight by shrinkage:

Weight of roast, 4 pounds.

Preheat oven to "4," requiring twelve minutes at 110 volts.

Prepare roast; turn upper unit off.

Roast on "Full" five minutes per pound (lower unit).

Roast on "Medium" five minutes per pound (lower unit).

Roast on retained heat one hour.

Weight after roasting process, 3 pounds, 7 ounces.

Time of roasting, 1 hour 40 minutes.

Watts, 990.

Roast Chicken.—Turn the oven switches on *High* for twenty minutes in advance. Rub the chicken over with soft butter and salt, dredge chicken and pan with flour. When the flour is well browned reduce the oven heat to *Medium;* baste well. When the breast meat is tender the chicken is sufficiently cooked. A chicken requires about one and a half hours, or about twenty-three minutes to the pound.

BAKING.

Biscuits.—The best results are obtained by having a hot oven to start with, so turn oven switches on *High* for thirty minutes in advance. If pans are placed on middle grate the biscuits will bake an even brown on top and bottom in ten minutes. If placed on the top grate the pans will need changing to the bottom grate as soon as the biscuits are well browned on top. Leave the oven switches on *High* during entire baking.

Bread.—Turn oven switches on *High* for thirty minutes in advance. The loaves should begin to brown in the first fifteen minutes of baking, after which the heat should be reduced to *Medium* for thirty minutes.

Muffins.—Turn over switches on *High* for twenty minutes. Bake twelve to fifteen minutes on *Medium* heat.

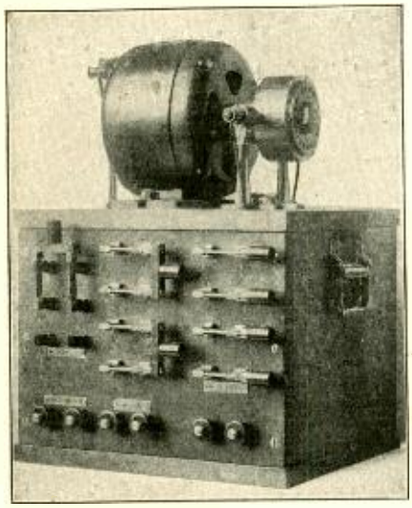
Sponge Cake.—Place the cake in a cool oven. Turn the oven switches on *High* for ten minutes, then to *Medium,* and bake from thirty to forty minutes longer. The cake is done when it falls back to a level and springs to the touch.

Cup Cakes and Pastry Shells.—Turn the

(*Continued on page* 451)

New Things Electrical

A NOVEL ELECTRIC FAULT LOCATER.



A Novel and Efficient Fault Locater for Electrical Testing of Cable and Transmission Circuits. It Detects and Locates Faults On Cables Carrying As High As 15,000 Volts.

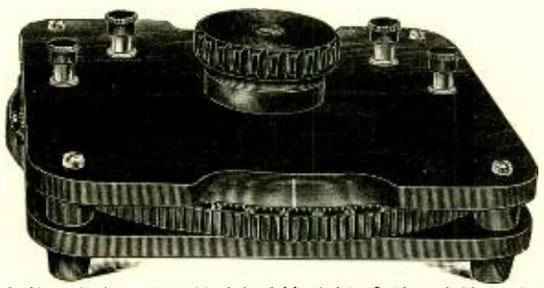
The new electric *fault locater* is a device designed for the purpose of locating all kind of faults that are inherent on overhead electric lighting and power lines carried on poles, and also on lead covered cables insulated with paper, rubber or cambric, which may be drawn into underground conduit systems.

The device is claimed to be capable of detecting and locating the faults upon cables carrying a working pressure up to 15,000 volts, alternating current, 60 cycles frequency. This apparatus is fitted with a special analyzer and interrupter.

Another valuable feature of this apparatus is that it readily locates grounds and short-circuits on steel taped armored cable, two or three conductor, laid directly in the earth.

A VARIABLE SELF AND MUTUAL INDUCTOMETER.

The inductometer illustrated herewith consists of two pairs of stationary coils and one movable coil, the latter being mounted on a disk placed between two outer plates holding the stationary coils. The disk may be rotated and has two scales, one calibrated in millihenries reading self-inductance and the second in degrees. The instrument is ordinarily provided with a maximum inductance of 50 millihenries, but instruments with higher maximum values or lower values can be obtained.



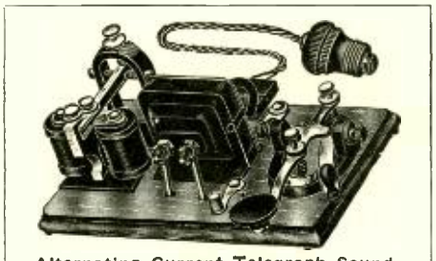
A New Laboratory Model of Variable Self and Mutual Inductance, Having a Maximum Inductance Value of 50 Millihenries. Larger Sizes of the Inductometer Are Available.

The inductometer has six link-shaped coils. The four fixt coils are mounted in pairs in the two outer fixt plates, which are held together by four screws and separating pieces to form the body of the instrument. The two movable coils are mounted on the inner disk and are placed with their long axes at right angles to a diameter. The outer plates and the disk are made of molded bakelite. To use the instrument as a variable mutual inductometer the fixt and movable coils are used as primary and secondary respectively and no connection is made between them. The mutual inductance is found by subtracting a constant from the scale reading and dividing the remainder by two. This constant is given with each instrument, altho it may be readily determined by the user at any time. It is claimed that errors due to stray field effects are eliminated and that the meter has a desirable ratio of maximum inductance to minimum inductance.

ALTERNATING CURRENT TELEGRAPH INSTRUMENT.

This A. C. telegraph instrument consists of A. C. sounder, steel lever key, and step-down transformer, mounted on base, as shown in illustration, with cord and attachment plug. No battery is used with it. It can be used on the 110 volt, 60 cycle alternating current lighting circuit by screwing the attachment plug into lamp socket.

Two or more instruments may be connected in series, just the same as instruments with batteries, by attaching the primaries of the transformers in multiple to the 110 volt 60 cycle lighting circuit with the secondaries and the sounders all in series. which is done by simply screwing the attachment plugs into lamp sockets and connecting the instruments in the usual way, thru their binding screws or terminals. Two terminals or binding posts and a single point switch are mounted on the base of each instrument.



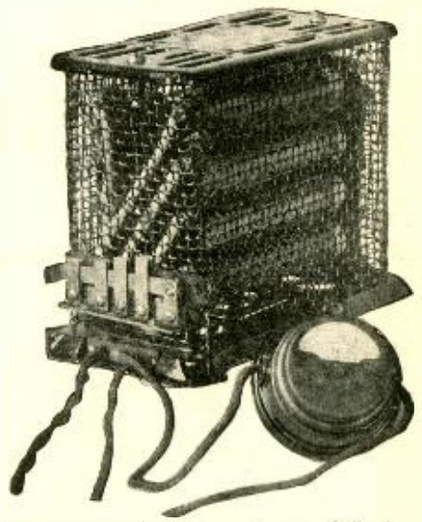
Alternating Current Telegraph Sounder, Key and Step-Down Transformer. Operates by Plugging In On Any 110 Volt, 60 Cycle A.C. Lighting Circuit.

In working two or more instruments on a line, polarity of impulses must correspond. If instruments work independently (with switches closed) but do not work together with the switches open, simply reverse one of the connecting blocks and they will respond properly.

When it is desired to operate two or more instruments on a line, the terminals are used for connecting the instruments in series: when used this way, the single point switches should be left open. Closing a switch localizes the instrument, so that it can be used for practise without interfering or being interfered with by other instruments on the line.

These alternating-current telegraph instruments are coming rapidly to the fore in commercial as well as private practise. They save the initial expense and the heavy maintenance cost of batteries.

NEW D. C. BATTERY CHARGING RHEOSTAT.



Do You Have to Charge Storage Cells from Direct Current Circuits? If So, You Will Find Extremely Valuable This Latest Battery Charging Rheostat and Ammeter. A Switch Varies the Current Strength.

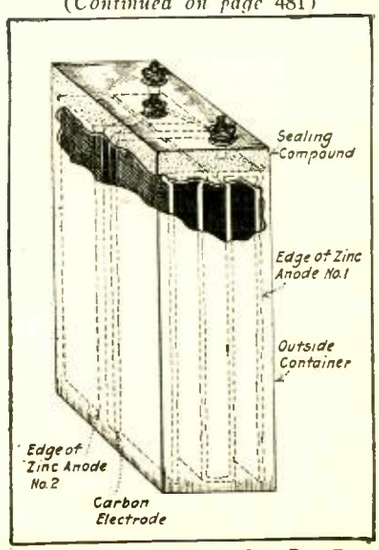
It is the purpose of this new charging rheostat to control the flow of direct current thru the battery, where the voltage of the charging circuit or line is much higher than that of the battery to be charged. This is done by means of a series of special high resistance coils made up in portable form, together with a current regulator switch giving charging rates of 1½, 3, 4½ or 6 amperes.

The voltage range of the rheostat takes in a single cell of battery up to 9 or 12 cells of 18 or 24 volts. The back pressure from a battery of higher voltage than this would cause a slight reduction in the ampere charging rates.

TWIN CELL DESIGN OF DRY BATTERY.

A new design of dry battery which is known as the "Twin Cell" is here illustrated. This design as shown in the illustration contains three electrodes, one positive flat carbon electrode, 7/16 in. thick by 1¾ in. wide, by 6 in. long, and two negative electrodes,

(*Continued on page* 481)



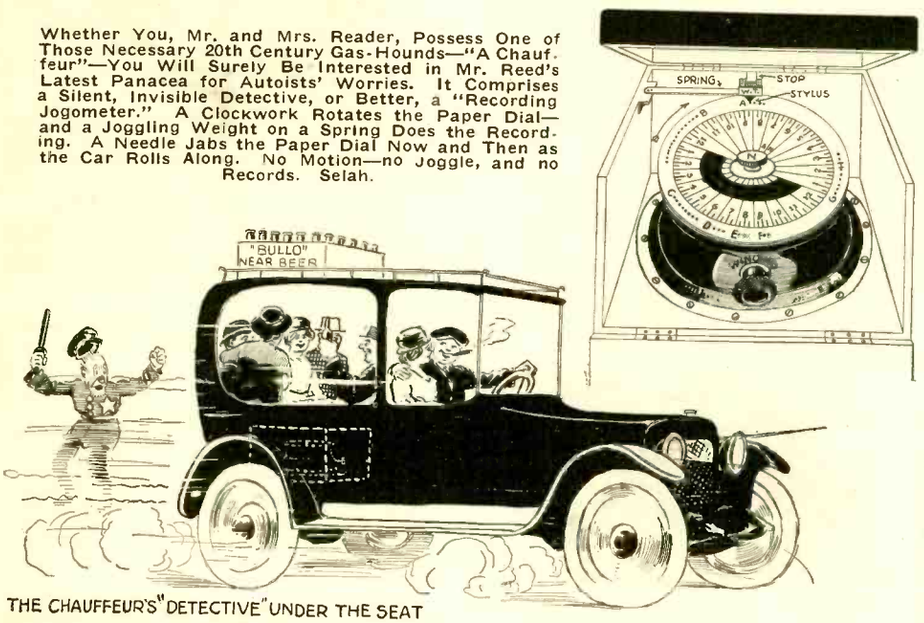
Novel Design of Twin-Cell Dry Battery. It Develops a Voltage of 1.5 to 1.55 Volts On Test and On Short-Circuit a Current of 35 Amperes.

Recording Your Chauffeur's Joy Rides

By Thomas Reed

MY neighbor, Theophilus Marbleback, had a chauffeur named "William," which innocent-sounding name was camouflage for a most guileful nature. "Circumstantial evidence" indicated that he was much addicted to joy-riding, and "Marbleback" desired me to invent an instrument for recording, unknown to "William," the moments devoted to this practise. He said that keeping tabs on the speedometer register was useless. That usually reliable instrument recorded only sorrows, not joys, for "William" deftly disconnected it during his mirthful moments. He didn't disconnect the gasoline bill, which came in at the end of the month robust and hearty, showing (if you integrated it only with the legitimate journeyings) a mysterious mileage of about five to the gallon; but apart from that, he was a busy and efficient little disconnector, and I was advised that my detecting device had better not depend upon the car's mechanism in any way, or it would be sure to reverse the excellent principle of the cascaret, and *sleep while "William" workt.*

Whether You, Mr. and Mrs. Reader, Possess One of Those Necessary 20th Century Gas-Hounds—"A Chauffeur"—You Will Surely Be Interested in Mr. Reed's Latest Panacea for Autoists' Worries. It Comprises a Silent, Invisible Detective, or Better, a "Recording Jogometer." A Clockwork Rotates the Paper Dial—and a Joggling Weight on a Spring Does the Recording. A Needle Jabs the Paper Dial Now and Then as the Car Rolls Along. No Motion—no Joggle, and no Records. Selah.



THE CHAUFFEUR'S "DETECTIVE" UNDER THE SEAT

"Marbleback" had a grand theory that if he could once get the goods on "William"—show them to him all registered up on some neat mechanism that would appeal to his fancy—the faithless "gas-hound" would be touched with repentance and mend his punctured conduct. Of course it was a perfectly chimerical idea, because the only result of touching a chauffeur is to make him leave you and go jumping off over the landscape looking for another car-owner who is sane and normal, and will stand for the things he has to stand for. Still, the problem interested me by its very difficulty. You know, if you have a certain amount of success in dealing with relatively simple things like high-frequency currents, you get sort of cocky, and feel like tackling a really complex and baffling job like putting something over on a chauffeur. So I took the matter under advisement.

Falling into the glassy-eyed and muttering condition common to inventors, my reflections were about as follows: "H-m, recording-thing got to move whenever car's going. What'll move it? Can't use gas-explosions, spark-discharges, rotation of wheels; 'William' put kibosh; must be concealed from 'William.' What other motive-power inseparable from car in motion? Aha, rush of air! Nix. 'William' spot anemometer, stick match in works. Oh, hum. What? Say, that's the system—the joggle! Some joggle always present, even on smoothest roads. Pervades every part of car. Hidden joggle-recorder what's wanted. A 'jogometer'—how's that?"

Fig. 1 shows the *recording jogometer* complete. It's an auto-clock in a locked box of strong "William"-resisting material (3-inch armor plate will do) attached immovably inside the tonneau, or caboose, or whatever you call that part of the car where the passengers sit. The clock has no hands, but the hour-arbor is adapted to carry a paper dial, printed with time-divisions, which can be changed by unscrewing the nut N. The hand-gears must be altered so that the dial will revolve once in 24 hours instead of the usual 12.

Poised over the dial is the weight WT, attached to the end of a thin flat spring, free to vibrate between the dial and the stop placed just above. The lower side of the weight is sharpened off into a point, which embosses the paper dial as the weight drums upon it under the influence of the car's vibration.

Now then, let's conduct "William" thru a sample day, and see how it works. Look at the short line of dots "A" between 8.15 and 9 a. m. That's "Marbleback" riding down to his office on a bright sunny morning, full of hope and "pep."

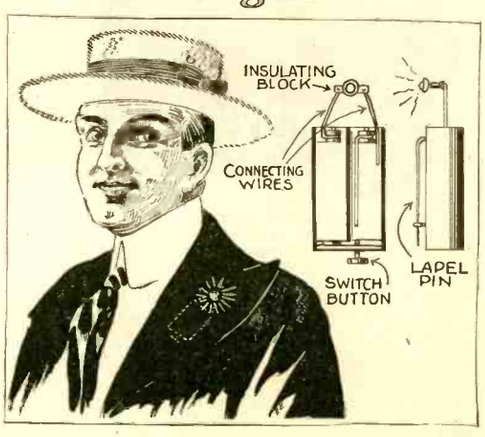
"B," from 11 to 2, shows Mrs. Marbleback shopping among the stores and beauty-parlors, flitting like a bee from flower to flower, so busily that the line appears continuous, and releasing with each fairy touch a little bill, which wings its way toward "Marbleback's" office.

At 2 o'clock ("C") she goes to the matinee, and the car is quiet till 4.30 ("D"), when she takes a turn around the park to see if any fashions have escaped her, calls for "Marbleback," and brings him home before he can "contract" any poker-games or leg-show stare, arriving at 5.30.

Now sound the "creepy music," for here is where the sleuthing starts. On the day in question, the "Marblebacks" past the evening at home, and from the point "D" onward, the record should have been a blank. But what do we see? the telltale arcs "D," "E," "F," "G," and "H," which betray "William's" nocturnal society life! Naughty, naughty "William," we are onto you! At "D," after an hour in the garage to make sure of dismissal, you were riding home to supper. Snatching a hasty meal, you hied yourself at 7.30 ("E") to the home of your blonde enchantress—Sadie Spasm, coffee-pusher and near-movie-queen. But from 8.45 onward ("F") whither, oh whither tends this hour's continuous journey, while Sadie leans back on the silken cushions, with all the inside lights lit, rehearsing "Theda Bara" on her way to the Duke's warehouse after another keg of pearl necklaces? Whither, prithee, but to the Rat's-Nest Inn, hospitable home of the joyous jazz, 40 short miles adown the pike. That blank till 1 a. m. means soup on the tablecloth at Childs' tomorrow, "William," beans for the gent who ordered "ham and," and for you a "head," a grouch, and perchance the can; but what boots it when youth and beauty drive? At "G" the relentless *jogometer* pictures "Theda" returning with the keg and "William" with the jag, and at "H" the car garage-ward plods its weary way. Selah!

A Button-Hole Flashlight

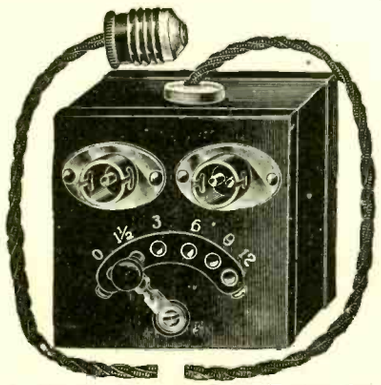
One of the latest innovations in the always convenient and invaluable electric flashlight is the one here illustrated, which fits in your coat lapel. A patent was recently issued to Mr. Edwin Frank Thomas of Meriden, Conn., on this extremely small model flashlight, which operates on a specially built and very compact style of dry battery. The casing holding the battery is fitted with a lapel pin of the same form as that used on brooches and other jewelry, enabling the wearer to easily attach the flashlight to the coal lapel or other garment. The lamp is turned on and off when desired by a simple turning of the switch button fitted in the bottom of the battery casing. The battery is a two-cell unit, and current is carried to the miniature incandescent lamp thru the supporting wires in the manner apparent.



Try These on Your Auto

AUTO BULB-TESTING DEVICE.

A new electrical automobile lamp-testing device is here shown. The tester is designed for all sizes of auto electric lights



A Handy Electric Bulb Tester for Private or Dealer's Use.

fitted with Ediswan bases. When a dealer sells an electric light bulb, he can test it before the customer's eyes, showing that the bulb is good and obviating any dispute afterward when the purchaser puts it in his car and happens to burn out the bulb thru some fault of his own.

PUSH THE BUTTON AND GET YOUR "GAS."

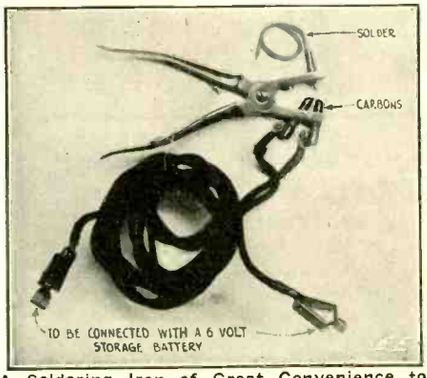
In the accompanying illustration an electrically operated outfit is shown which is intended for use in garages and service stations for pumping gasoline. This outfit is electrically operated, and is controlled by a push-button switch. The electrical control is arranged so that when the push-button is deprest, the pump continuously discharges gasoline at the rate of 25 gallons a minute, or may be reduced to a mere drip. When the button is released, the pumping stops automatically. The rate of flow is regulated by a speed control handle. The electric motor provided is enclosed in a strong iron case which is impervious to moisture or gases, permitting the outfit to be located out of doors. A large filter is built into the outfit to remove water and foreign matter which may be in the gasoline.

I Want 5 Gallons of "Gas." Alright, Deposit Your Coin, Push the Button and Get Your Gas.

A NOVEL 6-VOLT SOLDERING TOOL

This new soldering tool, which has recently been patented, embodies some features never before employed in an electric soldering device, its inventor claims. The one shown in the photograph is made to be attached to a 6-volt storage battery. It can even be attached to the storage battery in an automobile, or on ordinary lighting voltages in connection with a step-down transformer.

All of the heat is applied at the exact point where it is needed, and just for the instant needed, so it does not require one-tenth of the electrical energy that is used by other soldering irons of equal capacity. One of the features which appeals to the user is that it is always ready for instant use; no waiting to heat up the tool before it can be used. Wire can be soldered together in less than 10 seconds; it is not only soldered but sweated right in.



A Soldering Iron of Great Convenience to Autoists. It Works on a 6 Volt Storage Battery.

This soldering tool is light and simple in construction and the solder is always ready for instant use, as it is carried in the tool.

YOU CAN LOOK RIGHT INTO THIS BATTERY

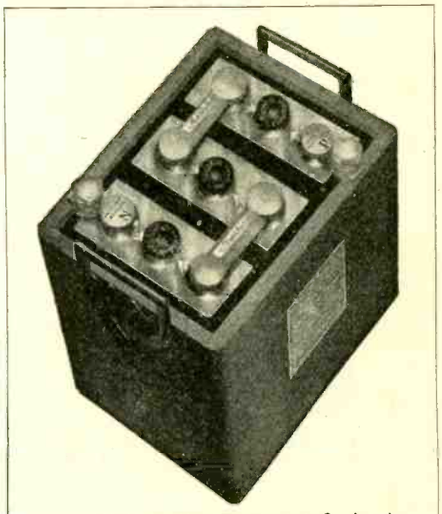
No one would think of buying or living in a light-tight, windowless house. Windows in a storage battery are just as essential. Every battery user will easily recognize the importance of knowing the exact condition of his plates and separators and the quantity of electrolyte in the battery at any moment. This great improvement in storage battery design makes it possible to know always what is going on inside your battery.

In the ordinary storage battery each cell has a hard rubber cover, and when the cells are sealed into their case the only possible view of the interior is thru the small vent hole in the cover. No satisfactory index to the condition of the vital parts can be obtained in this limited way.

The new storage battery here illustrated has a strong transparent cover on each cell. This window is actually stronger than the hard rubber used on other batteries, so there is even less danger of breakage. It is not affected by acid, and the tops and connections can be more readily kept clean and free from corrosion.

The solution, or electrolyte, in a storage battery must always be kept about ¼ inch (but no more) above the tops of the plates. Under no circumstances should the plates be allowed to project above the liquid.

Peep thru the window in this battery and



How High Is the Electrolyte? Look in the Window and See.

two red arrows will be seen projecting inward from the terminal posts. These indicate the exact level to which the electrolyte should rise in the cell.

A NEW CAM REGULATOR FOR AUTO DYNAMOS.

By William H. Easton.

Every automobile electric generator must have some means for keeping its voltage fairly constant under all normal operating conditions. Without such a device, the voltage would vary with every change in the speed of the engine and every alteration in the load of the generator and the current generated would be useless for either lighting or battery charging.

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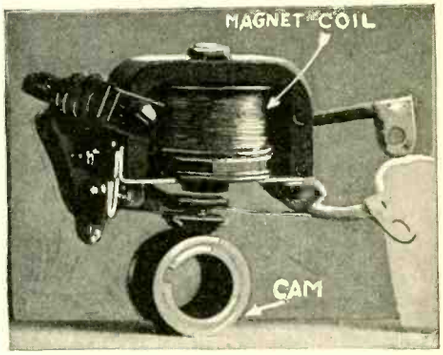
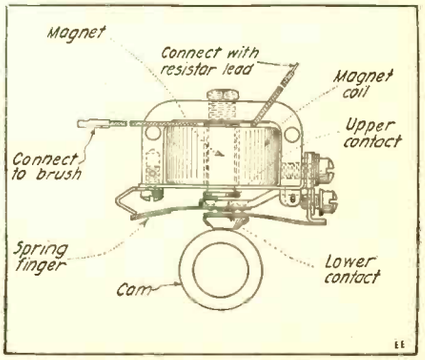




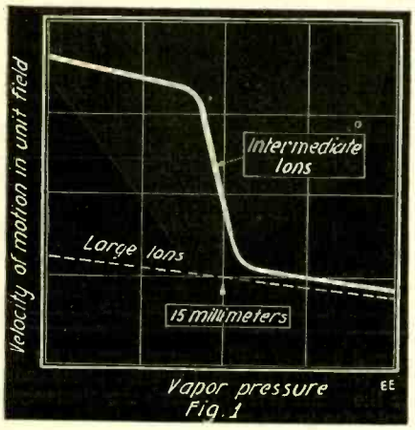
The Simplest Auto Generator Regulator for Maintaining Constant Voltage—a Magnetic—Cam device. Can Be Used With or Without Storage Battery.

The Mystery of Atmospheric Electricity

By ROGERS D. RUSK, M. A.
Late of the Meteorological Section, U. S. Army Signal Corps.

The Physics of Nature's Electricity Simply Explained

THE air is in a continual state of electrification because it contains at all times small particles charged with electricity. Even the scientists themselves do not know just what these particles consist of because they are different from the electrified particles found anywhere else. We are seldom aware of the existence of these particles because of their very small size and due to the further fact that all bodies at or near the surface of the earth *are at practically the same potential as the earth.* However, if all the electricity in the air could be collected for use at one time, there would be more, by far, than we would know what to do with. Benjamin Franklin startled the scientists of his day by bringing lightning down on a kite string, but we can go him one better today.



This Curve Shows Clearly How the "Intermediate" Ions of the Air Change Their Velocity Like Magic at 15 Millimeters Vapor Pressure, and Become "Large" Ions. An Interesting Discussion on This Phenomena Is Here Presented.

ELECTRICITY OUT OF A CLEAR SKY.

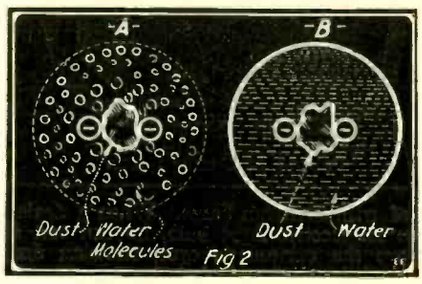
Even on the clearest day, if we send a kite up a few thousand feet, a distinct difference of potential can be noticed between the ends of the kite wire, often enough to give a severe shock. The cause of this electrification has been the subject of much discussion, but the biggest problem is to find just what these minute charged particles consist of.

Ions or small particles charged with electricity can easily be produced in most any gas by means of an electrical discharge or by the influence of X-rays or radium, but the ions found in the air are different from these; in fact, they are different from those found anywhere else, hence it is that they present a puzzling problem to the scientist. In general there are three types of ions which are found in the atmosphere called the *large, small and intermediate.* The small ones which have been known to exist for a long time are the same as those produced in any gas by the means above mentioned. When either an electric discharge, X-rays or radium rays causes an electron or element of electricity to be detached from an atom or molecule to which it belongs, then it leaves that atom or molecule charged with the same amount of electricity of the *opposite* sign, and the charged particle is called an *ion.* Sometimes these particles group themselves together, thus forming ions of larger size. Instead of these, however, there are still larger ions found in the air which could hardly be formed from even large groups of small ions, for reasons to be mentioned later.

The larger ions of the air and the intermediate ones are closely related and are the ones which so far are puzzling the scientists. Aitken, whose work along this line is justly famous, believes that the larger ions of the air are not aggregations of smaller ions, because when the smaller ions are formed by radium in a dust-free gas, the larger ions never appear. For this reason he believes the larger ions are really *dust particles* which have caught a charge of electricity. The word dust, however, is a convenient word to cover up our ignorance of just what the large ions actually are. In fact, they exhibit some properties which make them very interesting, and which show that they are far from being simple particles of dust.

WHAT ARE ATMOSPHERIC "DUST" PARTICLES?

These *dust particles,* if they are such, must not be confused with ordinary wind dust particles such as those blown up from a street. They are much finer and smaller, so much so in fact that they are capable of remaining suspended in the air for a very long time. Such particles are too small to be detected by ordinary means of observation and they can best be observed and counted by the famous *cloud method.* This method is to take a sample of the air and put it under reduced pressure which allows it to expand until the moisture in the air begins to collect around the *dust nuclei,* making them visible. In determining the relative size of the original particles another method must be used, and that is to compare their *mobilities. The mobility of an ion is its rate of motion in an electric field of one volt per centimeter, and is a measure of its mass.* The larger the mass the slower the particle will move under the given force.



A.—An Intermediate Air Ion Consisting of Negatively Charged "Dust Particle" Surrounded by Dense Atmosphere of Water Molecules.
B.—A Large Ion Formed by Water Vapor Condensing to a Liquid About the "Dust Particle."

By this method the larger ions are found to be *over a thousand times larger than the small ions and the intermediate ions about half way between.* It is argued that if these were *dust particles* only, then all sizes would be found instead of *three* distinct types. Recent discoveries tend to show there is something more than dust and electricity in the large ions and that it is this something else which causes the formation of the large ions which are not found anywhere else. It is all due to the discovery, a few years ago, that water vapor may condense in two ways on a rigid surface under certain conditions. Either it may condense in the ordinary way as a pure liquid, or it may condense more slowly and form a very dense atmosphere of separate water molecules about half way between a gas and a liquid, which will suddenly change to a liquid with an increase of the vapor pressure.

Now the significant thing is that if the mobilities of the ions are measured carefully while the pressure of the water vapor in the gas is being increased, a point is reached where the intermediate ions suddenly begin to move slowly like the large ions as shown in Fig. I, and this has suggested to J. A. Pollock and others the following explanation: The larger ions and the intermediate ones are formed of minute, rigid dust-like particles about which a small amount of water vapor has already started to condense. About some of these

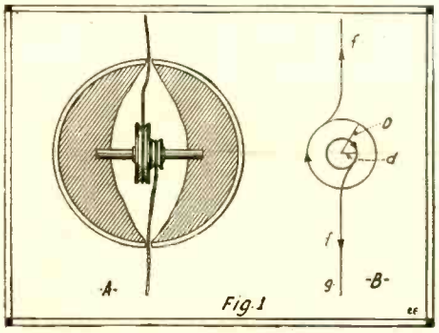
(*Continued on page* 473)

Experiments in Physics

By JOHN J. FURIA, A. M.
DEPARTMENT OF PHYSICS, N. Y. UNIVERSITY

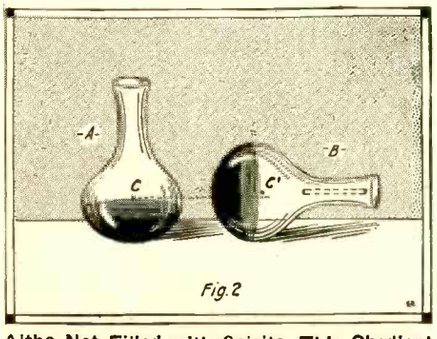
2--Illusions

PRACTICALLY all of the so-called "illusions" that are brought before the public, whether on the stage, at private entertainments, or sometimes in swindles, are based on fundamentals of physics. Hence it is fitting in a series of articles on "Experiments in Physics" to deal with this topic. Illusions may be divided into four classes: (1) Optical, (2) mechanical, (3) chemical, and (4) slight-of-hand. The first two types are of especial interest to us from the standpoint of pure physics.



The "Obedient Ball" and How It Is Made from a Wooden Crochet Ball Hollowed Out as Shown. In This Space Are Placed Two Small Silk Spools with Strings Attached. The Ball Rises or Falls on the String at Command.

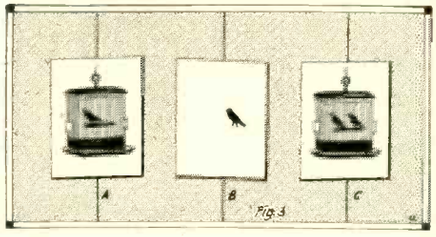
Perhaps the most mysterious of the magician's tricks, and one which appeals to all boys, is the *obedient ball.* All ball players appreciate the value of an obedient ball, especially the kind of ball that will "come to papa." As usually presented to the public from the stage the magician passes a piece of string thru the center of a good sized wood ball and then holds the string vertical. At his command the ball slides up the string, down the string, or else remains stationary. The *obedient ball* can be easily made at practically no cost. Divide a crochet ball in half by the use of a very fine saw. Carve out enough of the insides so as to have enough room for two small silk spools to revolve freely, see figure (1) A. The spools are glued together and fastened to the inside of the crochet ball by a dowel rod used as an axle. String is wound around each of the spools and the ends led out thru holes at the end of a diameter of the ball, perpendicular to the axle. The ball is glued together, sandpapered, stained and shellacked, and if a good job is made of it no one will suspect that the ball has been cut open.



Altho Not Filled with Spirits, This Obedient Bottle Will Lie Down and Stay Down Only for Its Master—the Magician. How Does It Work? Read on!

Figure (1) B explains why the ball will rise, fall or stand perfectly still. If the string is held loosely, the ball will fall, due to the pull of *gravity* on it. As force is applied to the ends of the string, gradually a point will be reached where the force of gravity is just overcome by the advantage gained by pulling the upper string (since the diameter of the spool to which the upper string is attached is larger than the diameter of the spool to which the lower string is attached). Greater force will cause the ball to move upward. It should be noticed that as one spool winds the other unwinds in each of the cases where the ball rises or falls. Hence the total length of the string in view changes according to the difference in the diameters of the spools. It remains for the performer to detract the attention of his audience away from this fact. The illusion is one of pure physics, more particularly mechanics. The equation for the motion may be written as follows:

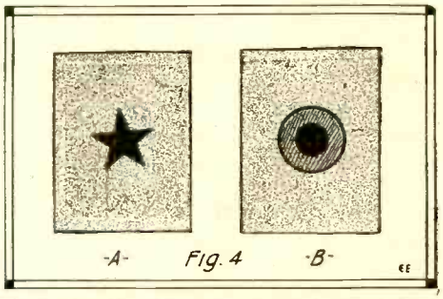
Let g represent the force of gravity, f the force applied to the string by the performer, and D and d, respectively, the diameters of the spools. $Df - d(g + f)$ causes the motion. When f is zero (when the performer holds the string loosely) the tendency to move upward (Df) is zero and tendency to move downward is dg, and the ball moves downward. When f is such that $Df = d(g + f)$, the tendency to move upward equals that to move downward,



If Two Cards Are Drawn to Resemble Figures A and B, Placed Back to Back on a Cord and Then Spun Rapidly, Two Birds Will Appear in the Cage, as at C.

and the ball remains stationary. When f is large enough so that Df is greater than $d(g + f)$, the tendency to move upward is greater than that to move downward, and the ball moves upward.

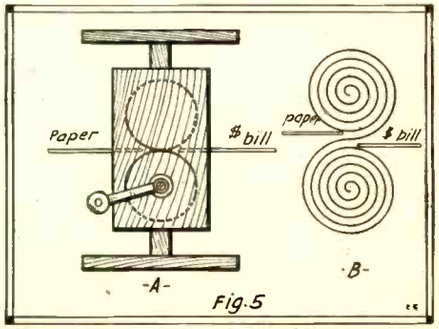
Speaking of the *obedient ball,* the event of July 1st (last) leads us naturally to the *obedient bottle.* A small wood bottle (empty since July 1st) of the shape indicated in figure (2) A, is placed on the table and told to "lie down—and stay down," and the bottle does so. (Nothing remarkable.) The performer then picks up the bottle and passes it around, defying anyone else to cause it to "lie down—and stay down"! No one is able to do so. The performer then takes the bottle again, coaxes it and causes it to lie down as before. This is another case of pure physics, more particularly mechanics. The bottle is weighted with lead as shown in figure (2) A, so that its center of gravity C is very low. It is seen from figure B, that placing the bottle on its side causes the center of gravity to be raised to the position c'. It is well known in mechanics that a body is in stable equilibrium (will return to the same position when displaced) when its center of gravity is at its lowest. Hence it follows that the bottle will always return to its stable equilibrium position (standing up). How, then, does the performer cause it to lie down. He keeps concealed up his sleeve or "palmed" a long narrow weight which he slips into the neck of the bottle whenever he wishes it to lie down. The addition of this long narrow weight causes the center of gravity for the upright position of the bottle to be high, so that placing the bottle on its side causes the center of gravity to be lowered; hence this will now be the position of stable equilibrium. In picking up the bottle before passing it to the audience for examination, the performer allows the weight to drop back into his hand again.



An Interesting Illusion Experiment Based on the Persistence of Vision. A Black Star Drawn on a Blank Card, When Spun Rapidly, Will Change Into Two Circles—One Gray and One Black.

In order not to disappoint those accustomed to "seeing double," the following is inserted for trial any time after July 1st. Draw a bird in a cage on one side of a blank card. On the *reverse* side draw another bird. Attach a piece of thread to the top and bottom of the card and twirl the card about this thread as an axis. TWO *birds will be seen in the cage.* Many variations of this illusion can be tried. The cage alone on one side and the bird on the other; a glass of "Bevo" on one side and an open mouth on the other, etc., etc. The result obtained is due to physiological rather than physical reasons. The phenomenon is known as *persistence of vision.* The retina of the eye retains any image thrown upon it for a moment after the object has been removed. Hence when

(*Continued on page* 479)



Making Money by Magic. A One-Dollar Bill Run in One Side of the Machine Comes Out a Ten-Dollar Bill, or a Piece of Paper Changes Into "Real Money." Ain't It Wonderful? Yes, It Is—NOT!

Practical Chemical Experiments

By ALBERT W. WILSDON

Cleaning and Washing Agents
Part II

WATER and a few other solvents are commonly used to remove dirt, sometimes called "matter out of place." Some of these substances readily dissolve in water; others like the fats, will dissolve in ether

Fig. 1

Showing the Simple Apparatus Required to Perform Experiment No. 1. A Bunsen Burner, a Beaker, Tripod, Gauze and Heating Dish.

or gasoline; and still others, for instance the resins, will dissolve in alcohol. Some form of alkali, such as wood ashes, was formerly used with the water, to assist in removing the dirt. This, it was discovered, possest a very destructive action upon the goods, so a *saponified* fat, the product produced by the action of an alkali on a fat, or what we now call *soap,* came into universal use. This, as is well known, when made of good materials will not injure the goods. Soap was used instead of lye from the lixiviation of ashes, long before the chemistry of the process became known. It was not until 1813 that Chevreul publisht his scientific researches on the composition of fats and the processes of soap-making.

Manufacture of Soaps.

The raw materials used in the manufacture of soap are an alkali known as *caustic alkali,* which may be either sodium or potassium hydroxid. The sodium hydroxid will produce a hard soap, while the potassium hydroxid produces a soft soap. These are made by boiling the carbonat with slaked lime, following out the equation

Sodium Carbonat + Calcium Hydroxid = Calcium Carbonat + Sodium Hydroxid.

From this mixture the calcium carbonat settles out, and the solution of the caustic alkali is boiled down to a solid, and is put upon the market under the name of *concentrated lye,* or the concentrated solution is used directly by the soap-maker.

Recently the caustic soda has been made directly by the electrolysis of sodium chlorid. The sodium deposited at one pole is dissolved in water, and the chlorin is used for making bleaching powder.

The second ingredient of a soap is either a vegetable or animal fat or oil, or a resin. Such oils as that of the palm nut, cocoanut,

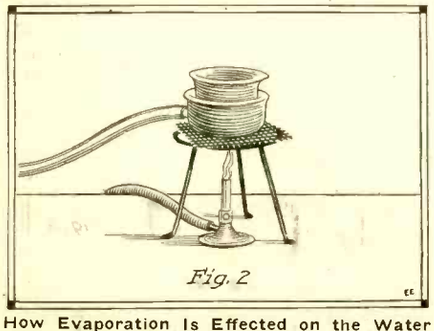


Fig. 2

How Evaporation Is Effected on the Water Bath of the Solution Obtained from Experiment No. 1. Apparatus Shown Is Used in Experiment No. 2.

olive, hemp seed, linseed, cotton seed, fish or lard may be used, and fats like beef tallow, mutton tallow, lard, or house grease.

The process of *saponification* may be occasioned either by the action of water or steam at high temperatures and pressure (especially in the presence of a dilute mineral acid), by the action of caustic alkalies, or sometimes by the use of lime. The fats may be briefly described as consisting of ethers of the triatomic alcohol-radical, containing *glycyl.* By treatment with alkalies or high-pressure steam, they yield *glycyl alcohol* (glycerin) and stearic or other fatty acid. The name given to the compound of the acid and glycerin is *stearin, palmitin,* or *olein.* In the case of stearin, the equation representing the saponification would be:

$$\underset{\text{Stearin}}{C_3H_5(C_{18}H_{35}O_2)_3} + \underset{\substack{\text{Caustic}\\\text{Potash}}}{3KOH} = \underset{\text{Glycerin}}{C_3H_5(OH)_3} + \underset{\text{Soap}}{3KC_{18}H_{25}O_2}$$

With palmitin or olein, the reaction is similar. If the fat or oil is solid, it contains a preponderance of stearin or palmitin, but if liquid, there is an excess of olein.

In making soap on a large scale, a kettle, provided with both a closed and open steam coil, so that the soap may be boiled either by the heat or the free steam, is used. A

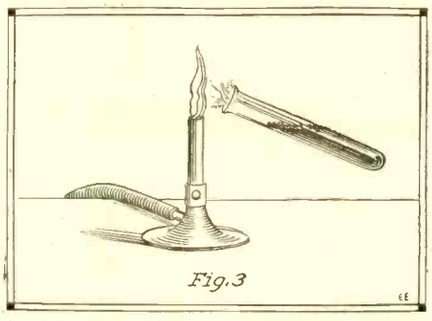


Fig. 3

Applying the "Sodium Test" in the Flame of a Bunsen Burner. Experiment No. 4.

kettle that will hold 100,000 pounds of soap is 15 feet in diameter and 21 feet high, and is made of ⅜ inch boiler plate. The melted fat and lye are run into the kettle and mixed by the aid of free steam and boiled for some time, or until the soap has a dry, firm feel between the fingers; it is then *salted out* by adding common salt. In boiling, the saponification represented in the above equation has taken place, and when the salt is added this causes the soap to separate from the caustic lye and glycerin. After boiling, to mix thoroly, the mass is permitted to stand in the kettle till the soap rises to the top, and then the lye may be drawn off at the bottom of the kettle. Some more strong lye is then added, and the boiling is continued till the material is fully saponified, which the experienced soap boiler knows by sight. feel, and taste, and then the content of the kettle is again allowed to stand for a while, and the additional lye is drawn off. The soap is then boiled with some water, and is permitted to settle again, to allow the separation of more alkali, dirt and impurities, called *nigre.* After standing several days, the soap is pumped into the *crutcher* which consists of a broad, vertical screw working within a cylinder, which is placed in a larger tank. Here it is thoroly mixed, and any perfume or scouring material may be added. The soap is then drawn off into rectangular *frames,* holding about 1000 pounds where it is allowed to solidify. The sides of these frames are removed and the

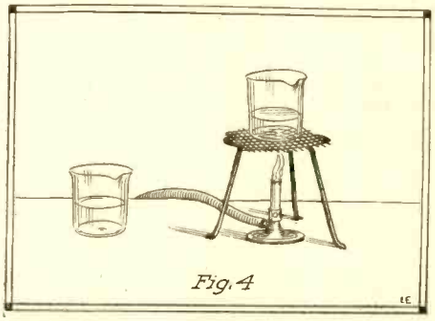


Fig. 4

Simple Apparatus Used in the Preparation of "Prussian Blue," as Described in Experiment No. 5.

soap is cut, by means of wire, into slabs and then into bars. If put on the market in the form of cakes, the bars are prest into the desired shape.

For making white soaps, tallow, palm oil, and cocoanut oil are used. Castile soap, if genuine, is made from olive oil, sometimes with the addition of cocoanut or rape seed oil. It is useless to attempt to make a good soap out of an inferior material. In making lower grades of soaps, cheaper fats are used, and frequently those that have a rancid odor. This is sometimes *corrected* by the addition of a strong perfume, like oil of *mirbane,*—nitrobenzine, made from coal tar. Yellow soaps almost always contain considerable rosin; that is they are made by the usual process, except that quite a large proportion of rosin replaces the fat. This has valuable soap-making qualities, and would not be classified as an adulterant of soap. Cocoanut oil saponifies without boiling, so it is used in making the *cold process* soap. This material also admits of the use of a larger quantity of water, so that the soap will be hard and still contain as much as 70 per cent of water. Soap is mottled by stirring into it, while warm, some coloring substance, such as copperas, ultramarin, or an anilin color.

Sand soap, pumice stone, and compounds of a similar character are made by incorporating sand or powdered pumice, with the ground soap, and this ought to lessen the price of the soap very materially. These substances can act only mechanically; that is they *sandpaper off the dirt.* A silicated soap is made by mixing with the ordinary soap some silicat of soda or

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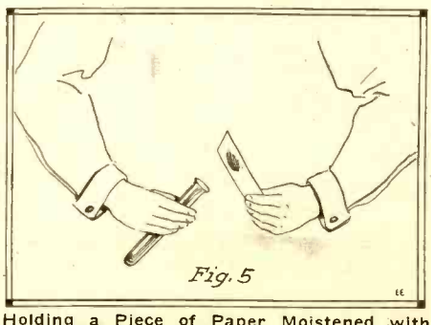


Fig. 5

Holding a Piece of Paper Moistened with Lead Acetate and Permitting the Gases to Act Upon It, Showing the Presence of Hydrogen Sulfid. Experiment No. 7.

THE CONSTRUCTOR

Thermo-Electricity Experiments

By THOMAS W. BENSON

IT was first noted by Seebeck, of Berlin, that when a juncture of dissimilar metals was heated a current of electricity would flow. This phenomena was studied by Cumming, Sturgeon, Pellaci and many others, for it gave promise of providing a means for *developing electricity direct from heat, without the use of steam engines and generators.*

Altho no practical application has been made of the discovery, beyond its application to *pyrometry* for heat measurements, several interesting devices can be easily constructed to demonstrate the phenomena.

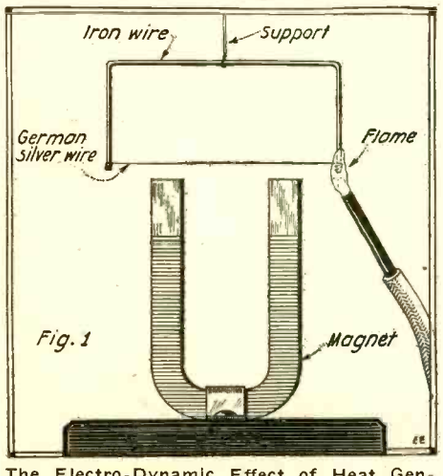
The most powerful currents are generated by heating junctures of the more crystalline metals, such as antimony and bismuth, the other metals lying between these in regard to the strength of the current generated with a given rise in temperature. The following list gives the thermo-electric order of the more common metals:

+Bismuth	Tin	Zinc
Platinum	Gold	Iron
Mercury	Silver	—Antimony
Lead	Copper	

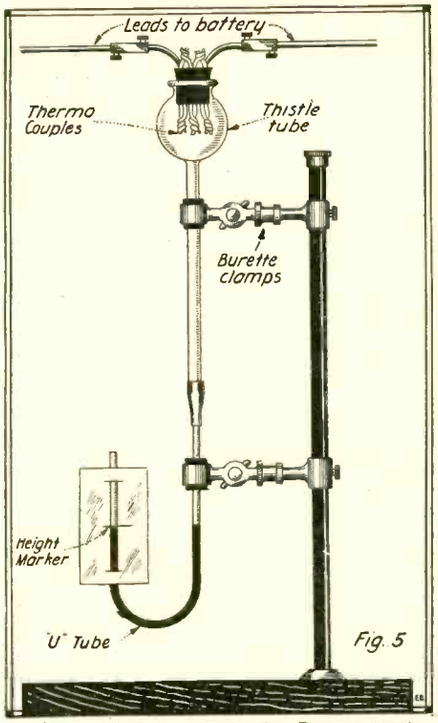
Any two of these metals when joined together and the junction heated results in a current flowing thru the exterior circuit from the metal highest on the list to that lower. The *reverse* is true should the junction be cooled. The further apart the metals are in the table the greater will be the electromotive force.

It is seen that bismuth and antimony will give a so-called "couple" having the highest E.M.F. These are rather difficult to obtain and handle, so for experimental purposes we will substitute iron and German-silver wire. These two metals are employed in the construction of thermo-couples for electric pyrometers, and will serve our purpose admirably.

The electro-dynamic effect of *heat generated* currents can be shown by a device similar to that illustrated in Fig. 1. Three sides of the wire rectangle are composed



The Electro-Dynamic Effect of Heat Generated Currents Can Be Shown by the Simple Device Here Illustrated. An Iron and German Silver Wire Rectangle Is Suspended Above a Magnet. The Loop Turns When Heated.



An Interesting Apparatus for Demonstrating the "Peltier Effect," or the Production of "Cold" by Electricity.

of iron, the fourth of German-silver. The frame is suspended over a permanent magnet and heat applied to one corner as shown. The frame will turn thru an angle of 90° due to the currents flowing in the loop.

A large number of turns of wire could be made to form a *heat compass.* The details of such a device are shown in Fig. 2. A small bundle of soft iron wire is bound with paper glued into place. Take a number of lengths of iron and German-silver wire and wrap them in the same direction on the core, in alternate coils as shown. Twist the ends of the wire together so that every other joint is on top. The ends of the more distant coils being connected together by a loop of wire, thus forming a sling to support the compass.

When this apparatus is suspended over a hot copper or brass plate, the currents flowing around the windings will cause it to act as a *compass* and the core will place its axis in a line with the natural magnetic field of the earth.

A form of *thermo-electric motor* can be constructed as shown in Fig. 3, to demonstrate electro-magnetic rotation. Here we have a ring of iron wire attached to which are a number of vertical German-silver wires, bent over at the top and joined at the center to a pivot. The latter rests in a tiny depression in the pole of a horseshoe magnet, allowing the cage to turn freely.

By applying a small flame to the frame at the juncture of the G.S. and iron wires between the legs of the magnet a current will flow thru the vertical wires and rotation will result from *magnetic repulsion.* The device will attain quite a high speed if carefully constructed.

A thermo-battery can be cheaply made that will deliver a fairly heavy current in the following manner: Take a 1" pine board 6" square and drill with small holes at the intersection of lines drawn in both directions ¼" apart. The board is then impregnated by placing in melted paraffin. Alternate 2" lengths of iron and G.S. wire are pushed into the holes and their ends tightly twisted together on both sides of the board, the end wires being led to binding posts.

When the battery is stood with one side in the sun, the other being shaded, an appreciable E.M.F. will be generated. **If laid on a block of ice in the sun it will ring a vibrating bell!**

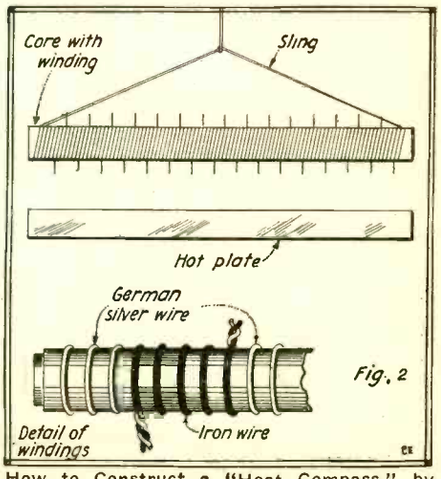
A somewhat similar form of *thermo-pile,* comprising antimony and bismuth bars, in the hands of Forbes and Milloni led to the beautiful discovery of the polarization of heat.

Andrews noted that a current was generated when platinum wires are inserted in a bead of fused borax, potassium chlorid, chlorids of potassium and strontium, iodid of potassium, sulfate of soda, and even when boracic acid is used. These results, however, are due to a *thermo-chemical* action and formed the basis for the work of Edison and others on the *heat cells.* The action differs from the *true* thermic action of dissimilar metals.

Conversely we have electro-thermic effects whereby heat and cold result from an electric current passing between dissimilar metals. The production of cold by this means is rather startling and is known as the *Peltier* effect.

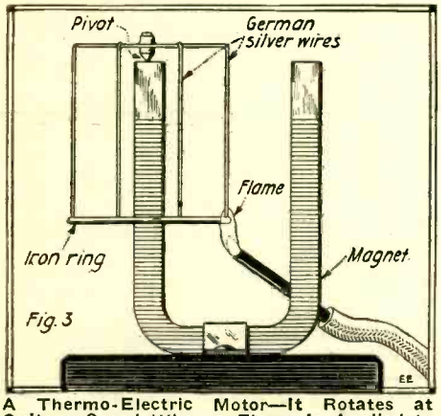
Apparatus to demonstrate the latter effect can be assembled as shown in Fig. 5. A large thistle tube has connected to its lower end a U-tube with a small bore, by means of a length of rubber tubing. The U-tube is partly filled with colored water.

A cork that fits the mouth of the thistle tube has six holes bored thru it into which



How to Construct a "Heat Compass," by Winding Turns of Iron and German Silver Wire About an Iron Wire Core. In Use It Is Suspended Above a Hot Brass Plate.

are inserted short lengths of iron and G.S. wire, about five strands of wire being put in each hole. These are twisted together to form thermo-couples and the cork inserted in the mouth of the thistle tube. A little paraffin wax melted over the cork will seal the whole effectively.



A Thermo-Electric Motor—It Rotates at Quite a Speed When a Flame Is Applied to the Armature, Made Up of Iron and German Silver Wires. A Most Interesting and Little Known Device.

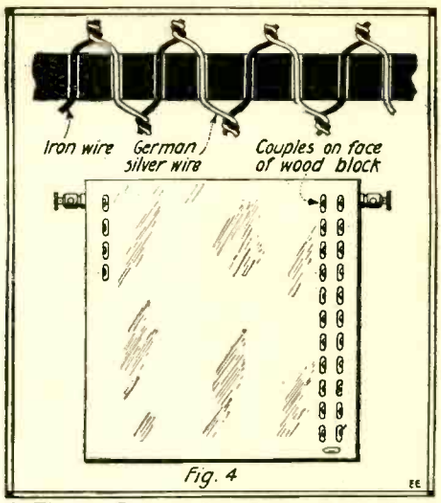
When the positive and negative poles of a battery (gravity type preferred) are connected to the iron and G.S. wire respectively, the junctures inside the tube will drop in temperature and the air contracting will cause the water in the open leg of the U-tube to drop. For best results the current should be regulated by a rheostat so that it is not sufficient to heat the wire used in the couples.

A current having a fairly high E.M.F. and low amperage gives the best results.

The exact cause of the current generated in a thermo-couple is still an unsolved problem. It is not due to any oxidization or chemical effect for it has been found that a bar of the same metal with different temperature of its opposite ends will give a slight current, the cold portions becoming *negative*, the hot parts *positive*. A thoro understanding of the phenomena demands more complete knowledge of matter structure and the inter-atomic forces.

A fuller realization of the forces in action may revolutionize present methods of current generation and perhaps refrigeration.

Thus there is a very fine field open for experimentation by the industrious student. By experiment we learn many things heretofore undreamt of.



A Thermo-Battery Can Be Made U. Quite Cheaply by Mounting Iron-German Silver Wire Couples on a Board as Shown. Laid on a Block of Ice in the Sun, It Will Ring a Bell.

A "Selective" Electrolier Switch

By Albert H. Beiler

The writer recently tried to make an electrolier switch which could control from one to five lamps. The lamps were on a chandelier and it was undesirable to turn each lamp on or off at its socket. They were placed on the chandelier as shown in Fig. 1. Owing to the fact that it was desired to make the lamps light in a symmetrical arrangement, it was not necessary to control each lamp singly, but merely to get a switch which could light one. two, three, four or five in a *symmetrical order*.

Number of Lamps	Number of Each Lamp	Control Circuit
1	3	B
2	1, 5	A
	2, 4	C
3	1, 3, 5	A, B
	2, 3, 4	B, C
4	1, 2, 4, 5	A, C
5	1, 2, 3, 4, 5	A, B, C

For example, if two were desired, it would not look well to light one and four, or two and three, but a combination like one and five, or two and four would do nicely. Accordingly, the wiring to the lamps was arranged as shown in Fig. 2. With this wiring the circuits would have to be controlled as summarized in the table above.

There is thus a common wire going directly from one main to one terminal of each lamp and three control wires which go to the *selector switch*. This switch is constructed as described below.

Secure a piece of hard wood 5 x 5 x ⅞ inches. Lay out a hexagon of 3 inches diameter, as shown in Fig. 4. Drill ⅜-inch holes at the eight points indicated about ¼ inch deep. The seven numbered holes should have small holes go clear thru the wood and just large enough to permit a No. 14 wire to pass thru (No. 50 drill). The unnumbered hole is a blank whose purpose will become apparent later. Twist some bare No. 14 wire into little spirals, as shown at 3A, and put one in each of the seven numbered holes so that the end passes out thru the bottom. Then stop up the small holes where the wires protrude with sealing wax, so that each ⅜-inch hole is a sort of liquid-tight cup with a conductor lying along its bottom. The wiring is shown in Fig. 3 running to four binding posts, which had best be labeled as indicated in India ink to avoid confusion later. The base may now be chamfered and stained to make it look well. The holes should then be connected by the lines shown and the triangle so formed should be labeled as indicated in Fig. 4.

The bridging arms should now be made. These are two triangular pieces of ⅜-inch fiber or hard rubber, the triangles measuring 2 inches on a side (Fig. 5). The holes are drilled ¼ inch from each vertex, and are tapt to receive 8-32 machine screws. A ⅞-inch machine screw is put into each hole at a vertex. These three screws are then connected to each other by No. 16 wire twisted around each and neatly forced into grooves, scratched into the fiber for the purpose by a sharp awl or scriber. A small porcelain knob is fastened to each triangle by a washer and screw fitting into the center hole.

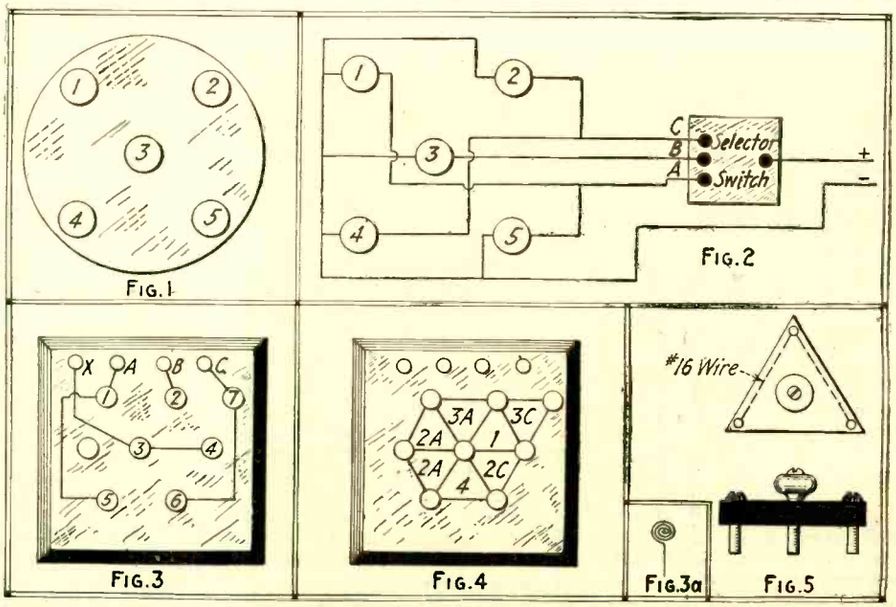
If the triangles are constructed properly each will fit into any three holes at the vertices of an equilateral triangle in the baseboard. The numbered holes should then be filled with mercury to about 3/16 inch from the top. Binding posts A, B and C are connected to control wires A, B and C, and the common wires goes to the other side of the main (Fig. 2).

It is obvious then that any combination noted in the table may be obtained by covering the triangle whose number indicates the number of lights to be lit. For example, to light *four* lamps, one of the triangles is placed in holes 3, 5, 6, so as to cover triangle No. 4, etc. Up to and including four lamps, only one triangle need be used, but for five a combination like 2A and 3C or 4 and 3C is needed, requiring two triangles.

The arc formed when a triangle is lifted out is inappreciable, being broken simultaneously at two places. Should it be desired, however, to break a circuit carrying more than about 5 amperes, it will be better to construct a base of fiber.

This switch may be made at a cost of about 25c, whereas an electrolier switch of commercial manufacture to satisfy this wiring costs upwards of $4.00.

Many modifications of this novel switch can be worked out with a little ingenuity on the part of the builder. This switch lends itself well to many laboratory circuit requirements.



The Construction of a Selective Chandelier Switch for Turning on or off Various Combinations of Lamps, Is Here Described by Mr. Beiler. Special Arrangements for Larger Groups of Lamps Can Be Worked Out Easily.

Making a Machine for Telegraphing Pictures

Part I

By LE ROY J. LEISHMAN

Expert In Telephotography

IT is a very simple matter to *telegraph pictures.* A crude machine for this purpose was suggested seventy years ago. The idea is therefore not entirely new to students of electricity, but the science has been so neglected that it is still nebulous to the average person.

How little the general public knows of *telephotography* is shown by the fact that when two of my machines were exhibited on the Orpheum and Pantage's vaudeville circuits two years ago, the demonstration was fascinating, baffling and uncanny to the audiences everywhere. Even most of the newspapers had never heard of such a thing before.

A person with an electric picture transmission machine may therefore entertain and baffle his friends and townspeople, besides conducting a great deal of experimenting which will be instructive and highly beneficial to himself.

By the time this article appears, popular interest in telephotography will be heightened by the use of telegraphed pictures by many of America's leading newspapers. Several papers have already publisht "news pictures" periodically, *and pictures have been telegraphed across the continent at regular intervals and displayed on bulletins.* The practicability of the scheme is shown by the fact that excellent pictures have been transmitted 4,856 miles! Many newspapers have recently subscribed for a service that will supply one hundred and fifty news pictures a year, *making it possible for them to publish a picture of an event the day it happens, regardless of geographical location or distance!*

So the person with the necessary apparatus to telegraph pictures will find himself the center of interest everywhere.

It has often seemed puzzling to me why more electrical students have not experimented with telephotography. Many letters which I have received lead me to believe it may be due to a popular misconception that such experiments are too costly. I therefore recently designed some *Picture Telegraphing Instruments* which are low-priced enough to suit every experimenter who may be interested. To further interest the readers of this magazine in this fascinating and instructive field, I am explaining in this article how a simple telephotographic set can easily be made. However, the chief fascination and instruction is in the operation of the finished machines and in the various experiments that can be made with them.

No exact dimensions will be given for any of the various parts, as the material at one's disposal sometimes makes it advisable to change some of them; and then the others must be altered accordingly.

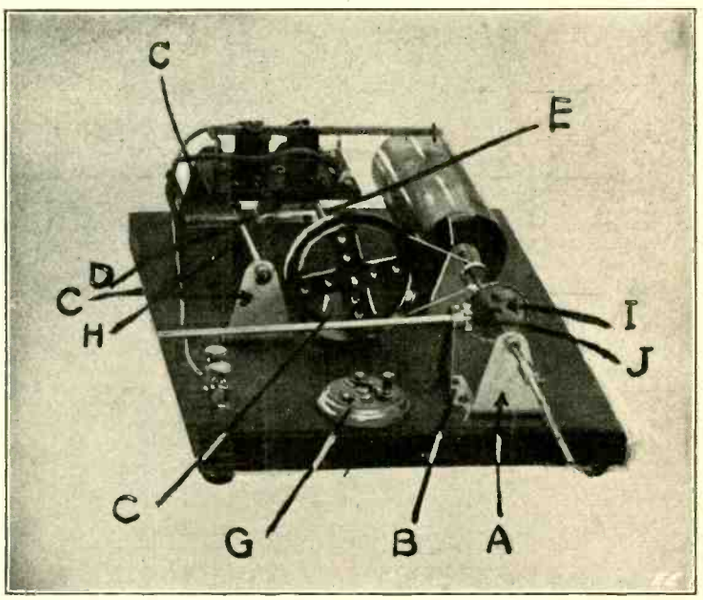
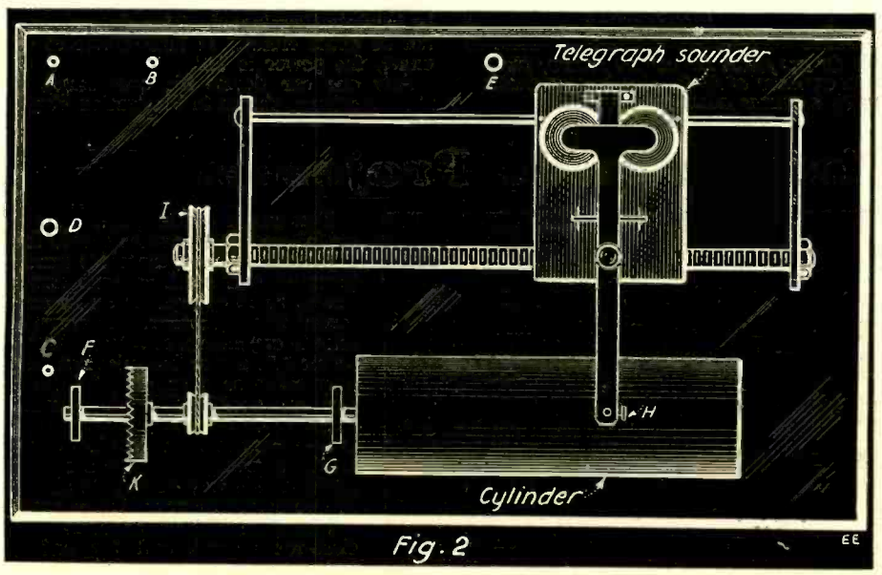


Fig. 1.—The Telephotographic Machine Here Described. It Opens up a New Era in Scientific Experiments for the Electro-mechanical Student and Provides a Stepping Stone to this Newest Branch of Applied Science.

GENERAL DESIGN FEATURES OF APPARATUS

Let us first get an idea of the general appearance of the device we are going to make. A glance at figures 1 and 2 will show that the machine resembles very much an old style cylinder phonograph. The cylinder of the picture transmitting machine holds the pictures to be telegraphed in the same manner that the phonograph cylinder holds the record to be played. The sending and receiving carriage corresponds with the phonograph reproducer, and it passes slowly from one end of the cylinder to the other on a threaded shaft as the cylinder revolves. In this manner the carriage needle finally touches every part of the picture. The threaded shaft on which the carriage travels *must* be absolutely parallel to the cylinder. The reproducer on a cylinder phonograph has a half nut that rests against the threaded shaft, so that the reproducer may be lifted up and moved to the other end of the cylinder. This necessitates another shaft, parallel to the threaded one, on which the reproducer pivots. A picture transmitting machine is similarly equipt.



Top View of Telephotographic Machine Here Described in Detail. The Parts Required in Building It Are Few and Simple, But Should Be Made with as Great an Accuracy as Possible.

The size of the complete apparatus depends upon the dimensions of the pictures to be telegraphed, as this determines the size of the cylinder; and the shafts and base must be proportioned accordingly. A convenient size for the picture is about 5 by 6 inches. As plenty of margin must be allowed, this necessitates a cylinder about 2 inches in diameter and 5½ inches or 6 inches long. Electrical contact must be made with the rolled copper plate which is slipt on the cylinder, so it is most convenient to make the cylinder from metal tubing. Ordinary pipe will not do, as the cylinder must be very true and perfectly uniform thruout. Brass or nickel-plated fixture tubing is excellent. A metal bar or disc must be soldered in each end, and holes *accurately drilled* in the *exact centers* to fit the shaft. As the cylinder is light and supports no great weight, the shaft may have a small diameter, so a rod can be selected for this purpose which will fit the gears available. Erector, Meccano or other rods are satisfactory, and can easily be fitted with gears which are obtainable in the regular sets or at any hardware store. The cylinder rod should be 3 or 4 inches longer than the cylinder and must be *perfectly straight.* Place it thru the holes in the cylinder ends and solder it so that one end is flush with one end of the cylinder.

After the cylinders have been made, the length of the base can be decided upon, as this dimension should exceed that from one end of the cylinder to the other end

(*Continued on page 446*)

Home-Made Compound Microscope

By Carl F. Muckenhoupt

A COMPOUND miscroscope is beyond the reach of many experimenters because of its prohibitive price. Since such an instrument is very useful, and desired by many experimenters, I describe below the theory of the microscope, and the method of building one cheaply.

Fig. 1 shows how the tiny object OP is enlarged by the objective at O'P', which image in turn is re-magnified by the eye-piece, and seen as at O"P". To avoid complexity, only the rays from the head of the little arrow are shown, but rays from the other end would pass symmetrically oppo-

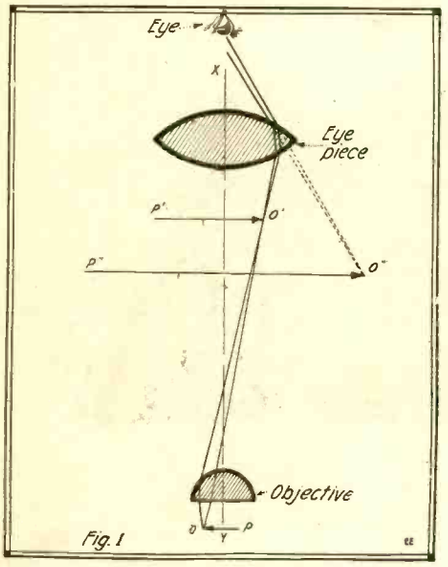


Fig. 1. This Diagram Shows the Path of the Focal Rays Thru the Optical or Lens System of the Home-Made Compound Microscope Here Described and Illustrated. The Eye-Piece Lens Shown Is a Double Convex One, While the Objective Lens Is of the Plane-Convex Type. Most Good Microscopes Have Two Lenses in the Eye-Piece.

site the main axis XY, and come to final focus at P", just as those shown focus at O". We see that by placing the object just outside the focus of the short-focus lens, an enlarged image is cast at some distance, which in turn is magnified by the eye lens. A good microscope has two lenses in the eye-piece, instead of one, to make a field free from chromatic and spherical aberration.

A good microscope is shown at Fig. 2. The tubes are preferably of thin sheet metal, rolled over a stick to the proper diameter, and then soldered. They may, however, be made of pasteboard. The main

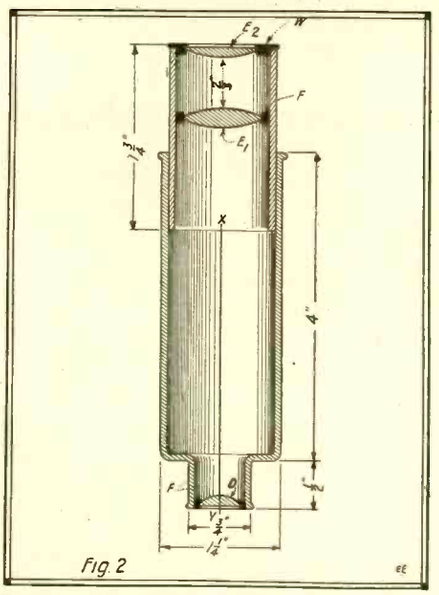


Fig. 2. This Sectional View of the Microscope Shows How the Metal Tubes of Brass, Copper, or Other Covering Are Arranged to Slide Within One Another; the Objective Lens Being Placed at O, and the Two Image-Magnifying Eye-Piece Lenses at E-1 and E-2.

tube is 4 inches long by 1¼ inches in diameter. A ring is soldered to its bottom end, with a ¾ inch hole in it. In this, in turn, the little objective tube, ½ inch long by ¾ inch diameter, is soldered. Make sure everything is well soldered, and then paint the inside of the whole affair a dull black, *not* shiny black. For the eye-piece, make a tube 1¾ inches long, and of a diameter to fit the main barrel snugly. This may take some time, for it must not work too tightly, or be too loose. Paint this black inside as well.

Power	Focal length of E_1 and E_2	Distance between E_1 and E_2	Distance between O and E_1
50	$2\frac{2}{3}$ inches	$1\frac{7}{3}$ inches	$6\frac{1}{3}$ inches
75	$1\frac{2}{3}$ inches	$1\frac{1}{3}$ inches	$5\frac{1}{3}$ inches
100	$1\frac{1}{4}$ inches	$\frac{5}{6}$ inch	$5\frac{1}{8}$ inches
130	$\frac{8}{3}$ inch	$\frac{9}{16}$ inch	$4\frac{7}{8}$ inches
		Note: For low powers the eye piece tube is very long	

Data for eye pieces for various powers; the letters are those of fig. 2. E_1 is always double, and E_2 is always plano convex.

The lenses naturally come next. O, the objective, is a ½ inch focal length, *plano-convex* lens. These can be secured from your optician. E_1 is a 1-inch focus, double convex lens. E_2 is a 1-inch focus, plano-convex lens. Take care to have these last two of the same kind of glass. O is mounted by making a ring to fit the bottom of the objective tube, and with a hole slightly smaller than the ½ inch focus lens. Center the lens over the aperture as shown, and glue a ring of felt F, with a hole smaller (slightly) than the lens, to the metal ring. When fast, clean the lens thoroly, and solder carefully to the little objective tube as shown by Fig. 2.

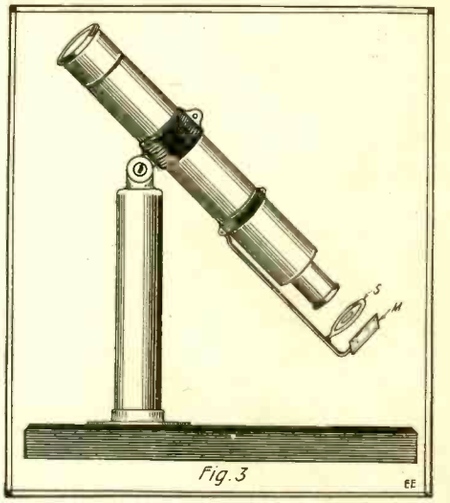


Fig. 3. A Simple Arrangement for the Home-Made Microscope Which May Be Modified and Improved by the Ingenuity of the Constructor, by Adding a Rack and Pinion or Other Precision Focusing Gear.

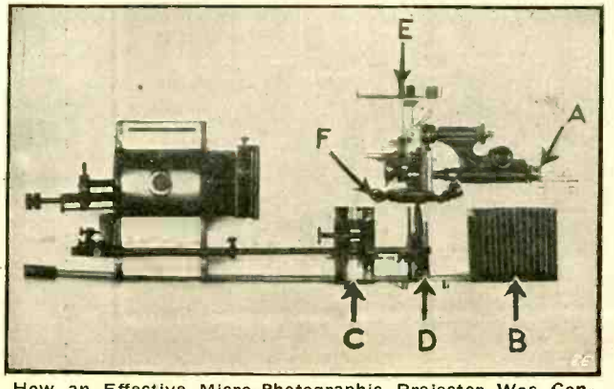
In one end of the eye-piece tube, fasten a ring of wood W, with a hole smaller than the plano 1 inch focus. Cut out the wood until the lens fits well, then screw a cap on the end with an aperture of about ½ inch. Mount E_1 2/3 of an inch from E_2, by forcing a ring in the tube, at right angles to it, and gluing felt around the lens. Push the eye-piece in until E_1 is about 4⅝ inches from O. This need not be exact unless you want to know the power exactly. The objective should be about 9/64 inch from object, which must be brightly illuminated. This distance need not be exact either. If both distances are exact, the power is 112.

Any one can devise his own stand, or use the scheme shown in illustration Fig. 3.

A Micro-Photographic Projector

The ease with which this apparatus is constructed is its main feature, provided, of course, one has the microscope and an ordinary projection lantern. I will proceed to the explanation of the letters in the picture.

Remove the entire front combination of lenses C, and the bellows, B. Bend the tube of the microscope, on the hinge provided, until it is at right angles to the foot E. Turn upside down and fasten to the front support D by two ordinary small wood clamps. Remove the eye-piece A, and you have a most excellent projector. It is much more satisfactory if one has a sub-stage condenser as shown in the photograph.



How an Effective Micro-Photographic Projector Was Constructed from a Stereopticon and a Microscope.

This unique arrangement of physical laboratory apparatus should find a great many uses, especially among lecturers and teachers, who find it necessary to enlarge or throw on a screen micro-photographic views of minute organisms, et cetera. Either an electric arc or incandescent lamp may serve as a source of light or else an acetylene light. Careful focusing of the complete apparatus is necessary to obtain a clear image on the screen. Drawings are often made in this way of minute objects by projecting them on white paper.

I have used this apparatus for class-room work and for making pictures of microscopic objects with fine satisfaction.

Contributed by E. K. GIFFEN.

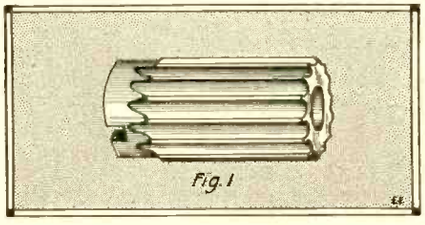
Experimental Mechanics

By SAMUEL D. COHEN

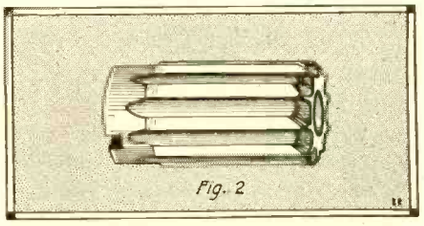
LESSON XIV

REAMERS CONTINUED.

IN order to save the material which would be used for the shank, the shell reamer having a hole thru its center by means of which it is mounted on the arbor, is largely used. By making the reamer in this manner *one* arbor can be utilized for a number of sizes. The general appearance of a shell reamer is illustrated in Fig. 1. This type is known as a *fluted shell* reamer. In Fig. 2 a *rose shell* reamer is shown. The cutting edges, fluting, and back taper of this latter type are the same as those of the rose reamers. However, in all other particulars, the tool is the same as an ordinary fluted shell reamer.

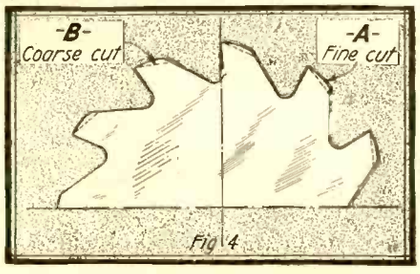


The Shell Reamer—This Form Is Widely Used in All Machine Shop Work. It Is Used on an Arbor.



A Typical Rose Shell Reamer. This Tool Has a Cutting Edge Provided on the End of Each Tooth as Shown.

The arbor used with the shell reamer is shown in Fig. 3, the shell reamer being provided with a keyway, which freely fits the key B. The reamer, when at work, is rotated by means of this key and keyway. The hole thru the reamer tapers, the taper being ⅛ inch per foot. Manufacturers of reamers have adopted certain standard sizes of arbors, and each arbor corresponds to a certain number of sizes of reamers; thus several sizes of reamers are provided with the same size hole, and can be used with the same arbor. The arbor as well as the hole in the reamer must be ground after hardening to insure the true running of the reamer. The outside of the reamer is provided with flutes and cutting edges for the greater part of the length. The short length at the end provided with a keyway, is turned down below the diameter of the cutting edges. This is done to prevent any burr which may be set up by the driving key on the arbor from interfering with the hole being reamed or disfiguring the cutting edges of the reamer.



Showing Two Ways of Grinding Reamer Teeth.

The fluted shell reamer type as shown in Fig. 1, is provided with a greater number of flutes for the same size than are ordinary fluted chucking reamers, because the flutes must be shallow on account of the hole thru the reamer. The flutes are cut, however, with the same kind of fluting cutters as are used for reamers generally. The corners at the end of the fluted shell reamer are slightly rounded.

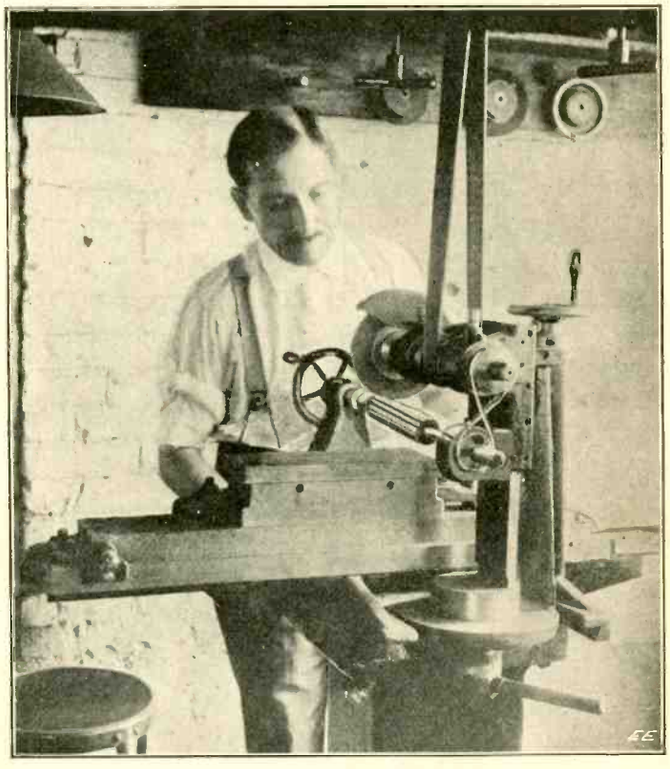


Fig. 5. Reamers Are Usually Ground to Final Size on a Precision Grinding Machine of the Type Here Shown. With Such a Machine the Reamer Can be Ground to Any Taper Desired with an Accuracy of One-Ten Thousandth of an Inch.

The arbor used for driving shell reamers consists of a stem or arbor proper C, as illustrated in Fig. 3, provided with a collar D, fastened to the arbor by means of a taper pin. A tongue B is milled at the end of this collar, which constitutes the key fitting the keyway in the reamer. Precaution should be taken during the "milling process" to ascertain the exact centering of the tongue in the collar. Care should also be exercised in milling the keyway in the reamer. When grinding the outside of the reamer to size, this work should be done on an arbor similar to that on which it is to be used. The arbor as well as the driving collar should preferably be made from tool steel and the collars should be hardened. The arbor as generally manufactured, is made in fourteen sizes, the diameter of each being measured at E, half-way between the end of the key and the solid part of the body of the collar, D. The arbor has a flat milled on the shank for the set screw by which it is clamped and held in position in the machine where it is used.

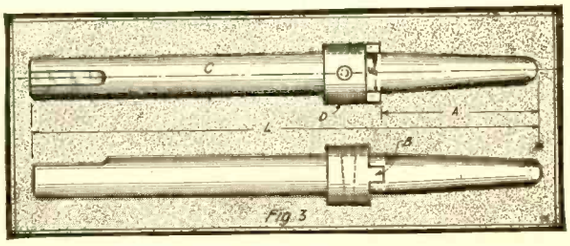
Too great or too little clearance on the teeth of a reamer will tend to produce unsatisfactory results, the first invariably causing the reamer to wear to a greater extent, as the shavings get in between the cutting edges and the work to be reamed, thus slowly grinding away the cutting edges. Also there is a tendency to bind the reamer in the hole, consequently injuring the hole as well as the reamer, and causing more exertion in performing the reaming operation.

The Steel Arbor Used for "Driving" Shell Reamers Consists of a Stem C, Provided with a Collar D, Fastened to the Arbor by Means of a Taper Pin. A Key or Tongue B Is Milled on the Collar to Hold the Reamer.

The *flat relief* or *clearance*, altho mostly used, is not the most desirable, because the cutting edge is not properly supported. Best results are obtained by a clearance, as shown in Fig. 4. The difference between this clearance or relief and the flat is obvious from the illustration, where the relief is shown by dotted lines "B." It is usually termed the *eccentric relief*, and its use is strongly recommended, as it adds greatly to the capacity of the reamer for producing a smooth hole. The relief is produced by placing the reamer in a grinding machine as usual, not on centers in line with the spindle, but on auxiliary centers provided with adjustable side ways, so as to enable them to be set at different positions for different relief required on various sizes and kinds of reamers. The reamer is thus held eccentrically. A rocking motion is then imparted to the spindles holding the auxiliary centers, and in this manner, the grinding wheel traveling back and forth along the reamer, will produce an eccentric relief.

The eccentric relief, however, is not in

(*Continued on page* 438)



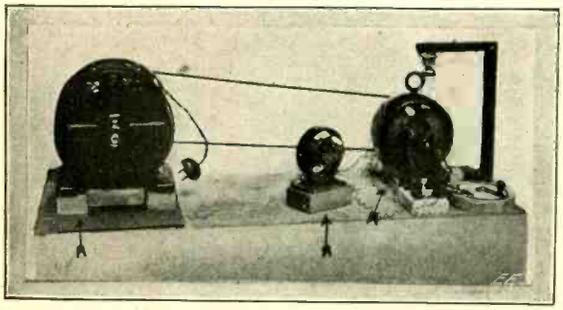
HOW-TO-MAKE-IT

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

MOTOR AND GENERATOR SILENCER.

In carrying on experiments in electricity and having only 110 volts alternating current at my disposal, I recently added a motor-generator set to my equipment. As my experiments were necessarily performed at night, due to work in the daytime and having due consideration not to annoy the people on the opposite side of the house at late hours with the humming of a motor and dynamo, the selection of a quiet running piece of apparatus became of prime importance.



Do You Have Trouble With Noisy Motors? Eliminate It! Mount the Offending Machine on Sponge Rubber As Indicated by the Arrows.

A high grade, 6 volt, 6 ampere dynamo was obtained which proved reasonably quiet, but when firmly secured to a 1½-inch board with a one-eighth horsepower motor likewise mounted, driving it, the noise was quite offensive. Most small motors of the alternating current type are very quiet when well bolted onto a concrete or iron foundation, but when mounted on a wooden plank 1½x12x30 inches it is another story. The first motor of 1,750 R.P.M. type was very good, but a little too noisy, and by obtaining a similar machine running at but 1,140 R.P.M., the noise was cut down fully two-thirds.

Of course, these results were encouraging, but my progress was still retarded by the noise made which I knew was not good to put "kids" to sleep by.

It finally occurred to me to use some soft silencer such as cork or rubber, and after numerous experiments with everything I could think of, I was finally successful. For the ⅛ H.P. 1,140 R.P.M. motor I secured three pieces of regular *art gum* from a 10 cent store. These blocks of soft "rubber" measured exactly 1x2x3 inches. They were mounted with LePage's glue to both the base of the motor and dynamo, and when placed on the board, the two machines could be operated with an exceedingly tight belt tension with no "walking" of the apparatus, even after hours of operation.

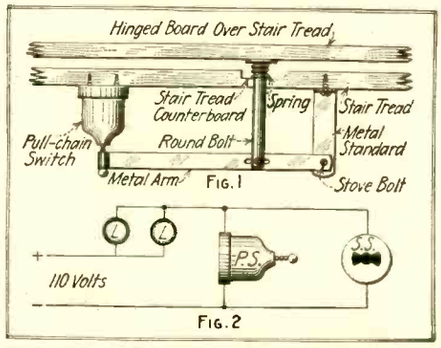
Contributed by C. V. TURNER.

[*Editorial Note—Those having noisy phonograph motors will find it efficacious to mount the feet of the motor on art gum or "sponge rubber." Tests have shown excellent results.*]

SECOND PRIZE, $2.00

CONTROLLING THE CELLAR LIGHTS.

The arrangement with which this is accomplished is shown in Fig. 1. A pull-chain switch of proper size to handle the lamps on the circuit is mounted on the *under surface* of the uppermost stair tread. The chain is shortened to an inch or so, and is attached to a metal arm pivoted on a metal standard which is screwed to the tread a short distance from the switch. At a point near the standard the metal arm is slotted to take a small stove bolt which fastens the slotted round bolt movably to it. This bolt passes thru a hole in the tread which is also counterbored to allow the bolt head to lie flush when the coiled spring under it is fully deprest. A board cut to the same size as the tread should be hinged to the riser above it so that the board will lie flat against the top of tread when stept upon. Coiled springs should be placed between the two at each end, to keep the front edge of the board separated about half inch or so from top of tread. This is all that is necessary as the small movement of bolt is increased by the leverage of the metal arm. The action of the device is obvious. As the top board is trod upon, it is deprest, moving the bolt downward against its spring, which movement is amplified and communicated to the pull-chain of switch by the metal arm, thus turning the switch "on." When weight is released, the board and other parts return to their original positions. When the board is again trod upon, the action is repeated, this time turning the switch "off." No dimensions are given as the sizes of the various parts will vary according to the size of switch and other conditions. As it is sometimes desired to leave the lights (LL) "on" while repeatedly passing up and down the steps it will be well to install a snap switch (SS) in the usual position and connect it in multiple with the pull-chain switch (PS) as depicted in diagram Fig. 2.



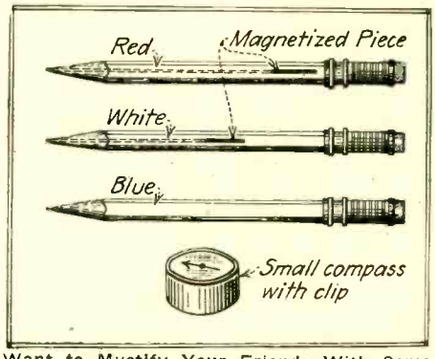
The Cellar Lights Are Turned on and off Automatically by This Stair-Tread Switch Wrinkle. The Moving Tread is Attached as Shown to a Pull-Chain Socket.

Contributed by J. A. WEVER.

THIRD PRIZE, $1.00

THREE MAGIC PENCILS—A MAGNETIC HOAX.

EFFECT: Three colored lead pencils are given out for examination, red, white and blue, for example. The performer leaving the roon. tells anyone to choose any color pencil they wish. while he is out of the room, and to wrap it up in any color piece of paper or cloth, and to hand it to him securely wrapt when he returns to the room. Upon receipt of same the performer passes hand over pencil and tells exact color.

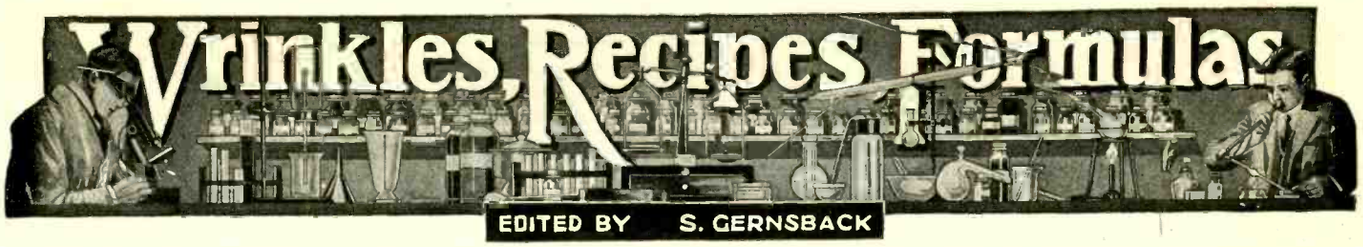


Want to Mystify Your Friends With Some Hindu Pencils? Here's How: With a Magnet Placed at Different Positions in Two or More Pencils, Conceal a Small Compass in Your Cuff. The Rest Is Easy—You Can Tell at Once Which Colored Pencil Is Inside an Envelope, Even Tho It Was Wrapt up While You Were Absent from the Room.

SECRET: Two of the pencils are "faked" in this manner. One of them is drilled with a 1/16 inch drill in the rubber end about 1 inch, and the other one is drilled half-way down or in the middle. Two pieces of Stubb's drill rod, ½ inch long by 1/16 inch diameter, are hardened, magnetized and inserted in the drilled holes and a piece of lead is inserted after the magnetized pieces and are made flush with top of wood in rubber end of pencil, the rubber is placed on top and the trick is ready; the third pencil contains no fake whatever. In leaving the room the performer attaches to his shirt cuff, inside, a small compass (some of these compasses can be obtained as small as a dime, or even of less diameter), which aids him in detecting what pencil is wrapped up or concealed in the cloth or paper in this way: He slowly passes pencil in front of compass and watches needle until it quivers, which it will do when that part of pencil containing the magnetized steel passes needle. If the needle moves when the *end* of pencil is near it, the performer knows it is the *red* one. If it moves when near the *middle* of pencil, he knows it is the *white* one; if needle does not move, it must of course be the blue one. As the back of hand faces audience, the compass is invisible.

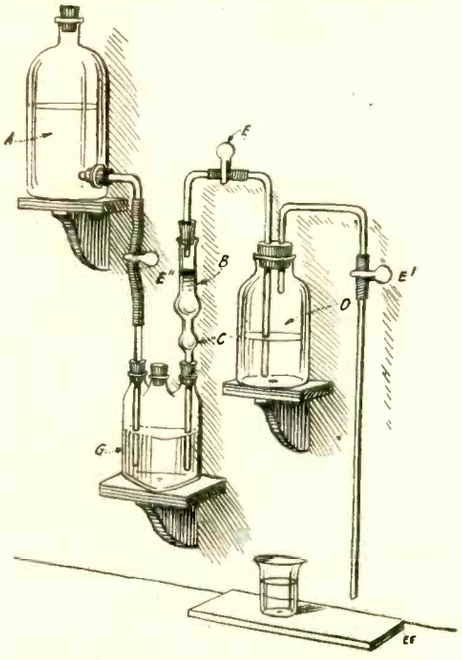
Many variations of this magnetic trick will suggest themselves to the wide-awake experimenter. Such as the magnetic "brass" ball—the inside of the ball is filled with iron filings and the small filling hole stopt up with brass.

Contributed by R. S. MYERS.



A NEW FORM OF HYDROGEN SULFID GENERATOR.

From time to time, in various issues of your splendid magazine, I have noticed *hydrogen sulfid generators* of numerous



This Highly Efficient Hydrogen Sulfid Generator Can Be Made Up from Glassware Found About Every Amateur Chemist's Laboratory.

types and styles described, but I have come to the conclusion that none of them work as easily or are constructed so simply as the one I now have in use in my chemical laboratory. I give herewith a drawing of the same, and will try to render a coherent explanation of its manipulation.

I will first make a notation of the apparatus used:

1 Aspirator bottle.*
1 Woulff bottle (three neck).
1 Calcium chloride drying tube.
1 Large bottle.
Glass tubing.
Rubber tubing.

I will now give a list of the apparatus and liquids denoted by the letters in the drawing:

"A"—Hydrochloric acid.
"B"—Iron sulfid.
"C"—Mineral wool or asbestos.
"D"—Water.
E, E', E"—Pinchcocks.
"G"—Hydrochloric acid.

I don't think it will be necessary to go into detail in reference to the construction of the apparatus, as I believe the sketch fully covers that, but give here a few points on the manipulation:

Open the pinchcock E" and allow the HCl to flow into the Woulff bottle; this will compress the air in the Woulff bottle. When the HCl stops flowing from the aspirator bottle, owing to the compression of the air, close the pinchcock E". Now open the pinchcock E and the HCl (G) will rise in the calcium chloride drying tube, thereby covering iron sulfid (B). (If the compression of air is not sufficient in the Woulff bottle to do this, again open pinchcock E" until the HCl rises in the drying tube sufficient to cover iron sulfid (B). Open pinchcock E and the gas generated will pass over into the large bottle containing the water (D). In this bottle the gas will be washed, and will also form a supply of the gas above the level of the water. Open the pinchcock E' and the gas will flow in a steady stream.

When one is thru with the gas all that is necessary is to close pinchcock E' and then close pinchcock E. Gas will continue to generate and will, owing to no outlet being open, force the HCl, covering the iron sulfid, back again into the Woulff bottle.

When the strength of the HCl, "G," becomes exhausted it can be removed from the Woulff bottle and, owing to the filtration caused by the mineral wool "C," is ready for evaporation for the recovery of the ferric chlorid. Another feature is that one has at all times hydrogen sulfid water on hand owing to the washing of the gas in the large bottle thru the water D. The reason for using a three-neck Woulff bottle is this: that when the pressure in the Woulff bottle, caused by the compression of the air, and also the gas liberated when pinchcock E, is closed immediately after use, will sometimes become too great for the strength of the glass, and so as a "safety first" measure, the three neck bottle is used so that the cork in the center, not in use, will act to liberate the surplus pressure.

Contributed by
WILLIAM N. NUSHAWG.

* An Aspirator bottle is not necessary, as the liquid (A) can be syphoned out of any ordinary bottle.

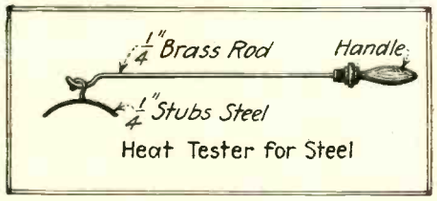
MAGNET TEST FOR HEAT OF STEEL.

One of the best and little-known methods of determining the correct heat at which to quench a piece of steel to obtain the best results, without the use of a pyrometer, is the following:

Take a piece of ¼" Stubb's steel about 2" long, tap a small hole in the center for a small screw eye, then harden and magnetize after bending to the shape shown in illustration. Place in screw eye and hang on the end of a brass rod bent to the shape shown in sketch.

The principle of the method is based on the fact that a piece of steel will not attract a magnet after a certain temperature is reached (about 750° Fahr.).

The little magnet is held over the heated steel every few minutes until the heated steel no longer attracts it, when it is then quenched and the degree of hardness it attains will be perfect.



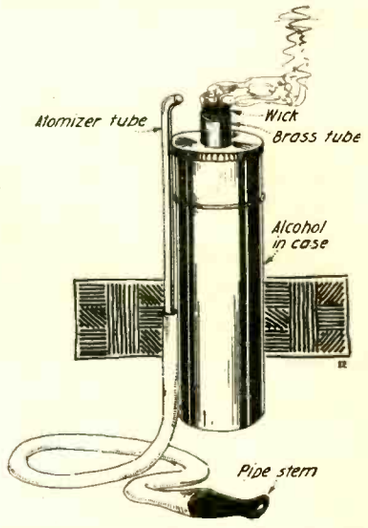
The Principle of This Steel Heating Tester Is That Above a Certain Temperature Steel or Iron Will not Attract a Magnet. Hence: When Is a Magnet not a Magnet? Answer. When It Is Red Hot.

Of course, the steel is to be drawn again to the required color. The above method is known to a very few mechanics.

Contributed by T. W. BENJAMIN.

AN ALCOHOL BLOW-TORCH FROM JUNK.

Want a nice little blow-torch? Below are given the details of an easily made blow-torch that will give as good results for soldering, etc., as the regular torch. It is constructed from a nickel-plated shav-



Who Wants an Alcohol Blow-Torch? Every Electrical Man, and Here's How to Make One from a Shaving Stick Case for Nothing. If You Are a Religious Prohibitionist You Can Burn Gin or Whiskey In Your Torch.

ing-stick case. The top of this case has a hole about three-quarters of an inch cut into it, and a piece of brass tubing inserted and soldered. Thru this runs the cotton lamp wick, dipping into the alcohol, contained in the case. Cotton wicking can be purchased in any hardware store. A piece of an atomizer tube, bent as shown in the illustration, is soldered or otherwise secured to the side of the case, connecting with a rubber tube. At the end of this a mouthpiece from "Pop's" old pipe stem is fastened. This makes a good, neat torch, welcome in any work shop or "lab."

Contributed by GEORGE H. TRUITT.

MAKING CHLOROPHYL.

Chlorophyl is the green coloring matter common to growing plants. Take a handful of parsley and triturate in a mortar with enough alcohol (95%) to cover the mass. Decant the green liquid and allow it to evaporate spontaneously. The chlorophyl remains as an intensely green substance. This may be used to color candies and as cake icings.

Dye from Onion Skins: Take the outer skins from half a dozen onions (medium-sized) and boil in water until the color is extracted. This is a very suitable yellow dye.

Test for the Purity of Olive Oil: Shake equal volumes of the oil and nitric acid. Pure oil should turn from pale to dark green in a few minutes. If it changes to brown, red, or orange, the addition of a foreign oil is indicated.

Heat for five minutes in a water bath at 100°C. It should become pale yellow to orange yellow. On standing it will, if pure, become a yellow solid.

Contributed by FRITZ ZILLESSEN.

RADIO DEPARTMENT

The "Fog Warning" Radio Telephone

THE accompanying illustrations show the interior mechanism used in the wireless telephone "fog warning" signal installed at the Point Judith Light near Narragansett Pier, R. I. This is one of the most treacherous sections on the Atlantic coast for ships to negotiate. For some time the DeForest "Radiophore" has been in use at this lighthouse station. It comprises an old type cylinder phonograph fitted with a record and repeating mechanism, which operates an Oscillion vacuum bulb, in such a way that the following warning is sent out by wireless telephone waves from an antenna, to ships as follows: "Point Judith Light," which is repeated three times. Then the skipper on the boat, or his wireless operator, hears, "You are getting closer, keep off," at about ⅕ volume of the first warning. Until the vessel approaches the danger limit, it does not hear the necessary final warning, but simply the first "location" warning.

The energy used in operating this warning signal is one-fourth kilowatt. The Oscillion vacuum tube generator of the radio frequency oscillations, is a 3¾-inch bulb. Heretofore the wave length was varied automatically for the different signals by a motor-driven variometer, but owing to the difficulty experienced by the ship radio operators in trying to pick up the constantly changing wave length signal and to hold it, the warning is now sent out on a fixt wave length of 600 meters, whereas with the constantly changing wave length previously used, the final message, "You are getting closer, keep off," was liable to be mist.

The first real test of this apparatus has been taking place at Point Judith Light (near Narragansett Pier), and the apparatus is arranged on a very compact scale so that it can be attended to by the regular lighthouse keeper and assistant. A regulation gasoline engine connected with a 36-volt direct-current generator and storage batteries is used to supply the energy, to which is coupled a motor-generator set which operates the transmitting apparatus.

This apparatus is entirely enclosed in a compact cabinet measuring about 18x18x18 inches. On the front of the cabinet is the Oscillion bulb and necessary switches for regulating it; also connection posts for aërial and ground wires. On the side of the cabinet is a small door which gives access to the mechanism inside.

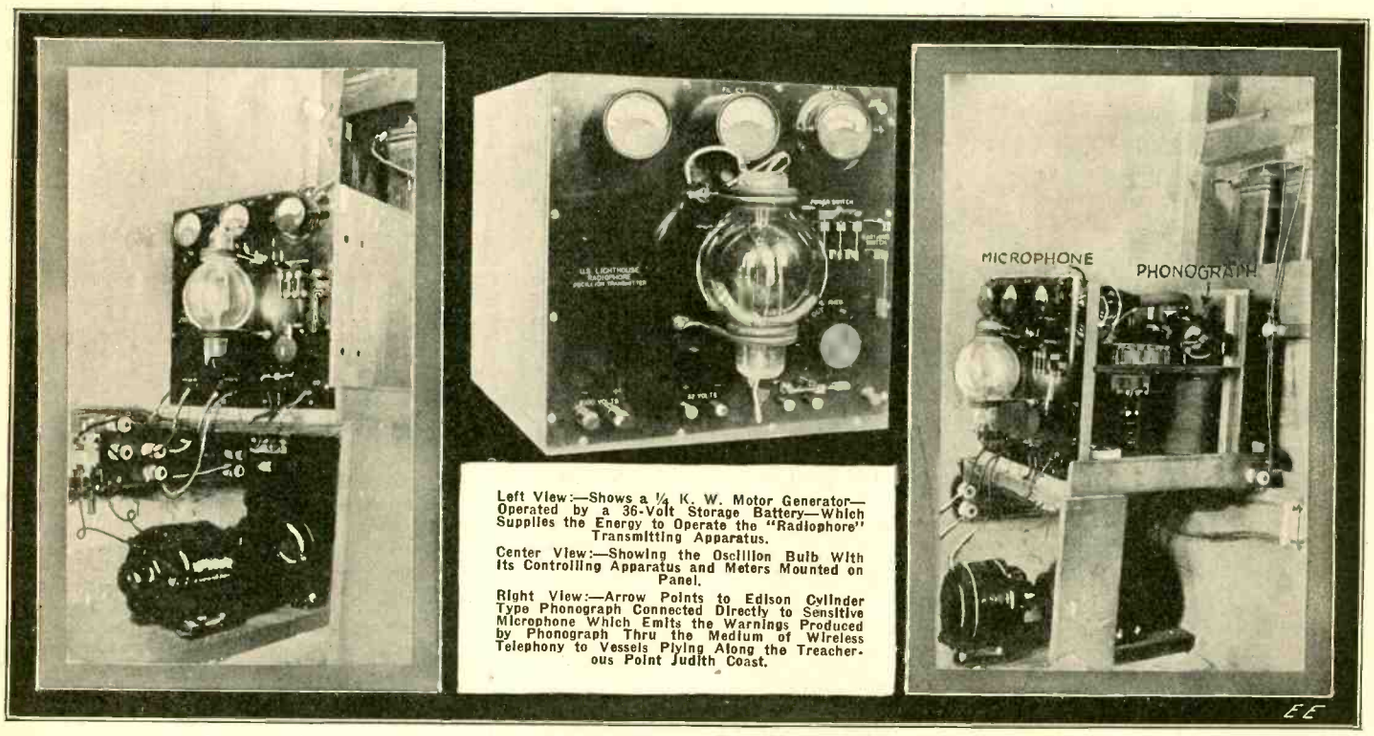
All the working parts are mounted inside the cabinet, including a motor-driven phonograph (see photographs herewith), speaking directly into a microphone. The arrangement of the cylindrical records is such that they repeat automatically, the saffire needle being set back to the beginning each time after it has traveled the length of the record. Each record has an average life of about 60,000 repetitions.

In the circuit diagram may be seen the relative layout of the various horns, microphones, and the Oscillion bulb generator of the radio frequency oscillations used to propagate the vocal message.

Several other modifications of the underlying principles may also be utilized as described in Dr. de Forest's patent. The transmitting apparatus is so arranged that speech can be sent out from the large fog horns, as also musical notes, bell signals, et cetera; on the same prearranged schedule as the radio signals. In this scheme the phonograph with records containing speech, is coupled to a microphonic arrangement and the speech is intensified by means of audion amplifiers and the sound waves sent out thru the fog horns, thereby enabling the captain or other officer to hear the same by ear, *without* the aid of wireless apparatus.

The one big feature of the Point Judith Light equipment is that when a ship is within a range of eight miles of the lighthouse, it will hear the following words flashed by wireless every five seconds: "Point Judith Light;" and after every

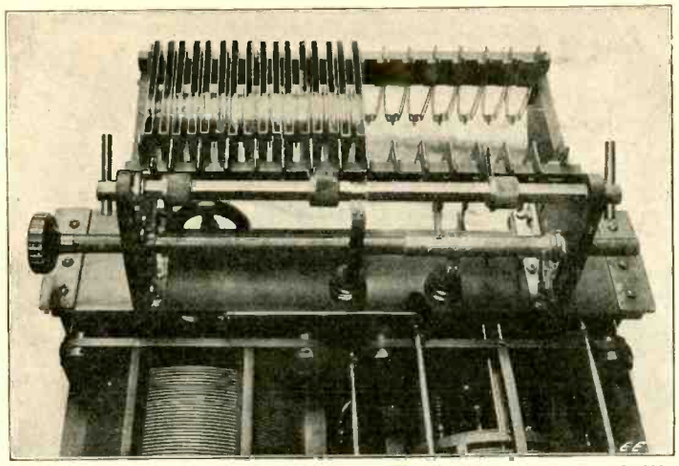
(*Continued on page* 462)

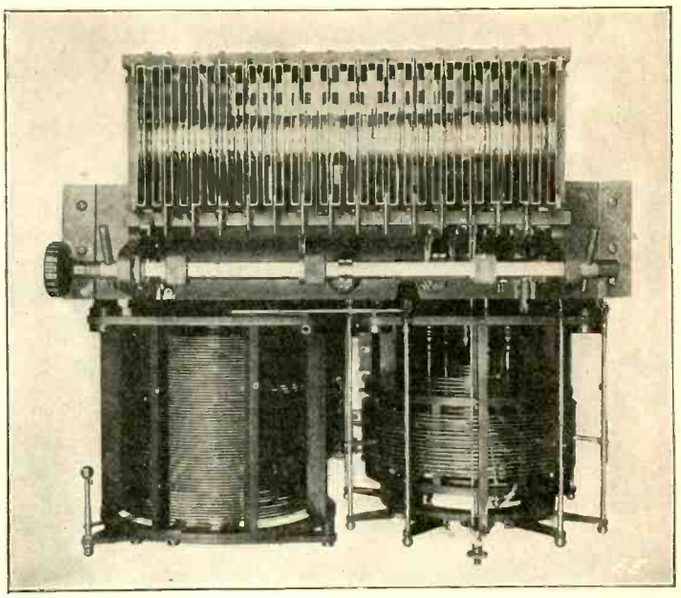


Left View:—Shows a ¼ K. W. Motor Generator—Operated by a 36-Volt Storage Battery—Which Supplies the Energy to Operate the "Radiophore" Transmitting Apparatus.

Center View:—Showing the Oscillion Bulb With its Controlling Apparatus and Meters Mounted on Panel.

Right View:—Arrow Points to Edison Cylinder Type Phonograph Connected Directly to Sensitive Microphone Which Emits the Warnings Produced by Phonograph Thru the Medium of Wireless Telephony to Vessels Plying Along the Treacherous Point Judith Coast.





Two Views of the Navy Type Quenched Gap Used on New 1 K. W. Panel Radio Transmitter. The view at the Left Shows the Quenched Gap With Several of the Units Removed While the View at the Right Shows a Top View of the Panel and Quenched Gap, With All of the Gap Units in Place. The Long Rod Placed at the Side of the Gap and Provided With a Large Insulated Knob at One End, Controls a Power-changing Switch, Which Switches In or Out of Circuit More or Less of the Gaps, as Required for Various Transmitting Powers.

New 1 K.W. Quenched Gap Transmitter

By Lester F. Ryan

THE 1 K. W. panel radio set as is described in the following article, is identically the same in principle and operation to the one described in the July issue of the ELECTRICAL EXPERIMENTER, except for the spark gap. The panel consists of two bakelite-dilecto pieces, the upper panel having the hot wire ammeter, wave changing device and the spark gap mounted upon it. The lower has the volt and ammeter control switches and automatic starter mounted upon it. The voltmeter is of the double scale type. The motor-generator is of the Crocker-Wheeler type, and is driven counter clockwise from the motor end by direct current at 120 volts. It is rated at 2 1/10 horsepower and 1.25 K. V. A. or 1000 watts, at 80 per cent power factor. It is a 500 cycle machine and has 15 field poles. The motor field is controlled by a Ward Leonard 18 point rheostat. This varies the frequency between wide limits. The automatic starter consists of five parts, two solenoids, and two contact discs and plunger, also a common resistance box.

The transformer used with this set is of the closed core dry-type and is rated at 1000 watts, 500 cycles and 150 volts at the primary winding terminals. The ratio of transformation is 38 to 1. It is insulated to stand electric stresses of 30,000 volts and will stand a 50 per cent overload.

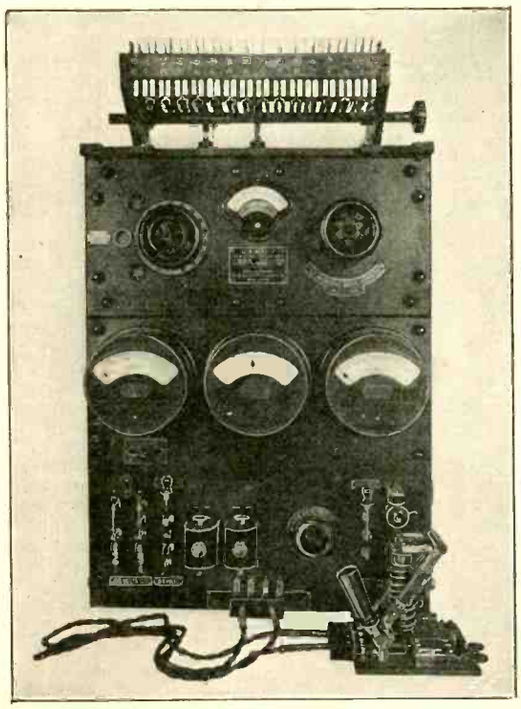
The condensers used are of the Dubilier type of .004 microfarad capacity each, connected in parallel. They are made of selected mica and tested for 100 per cent overload which is more than is ever used.

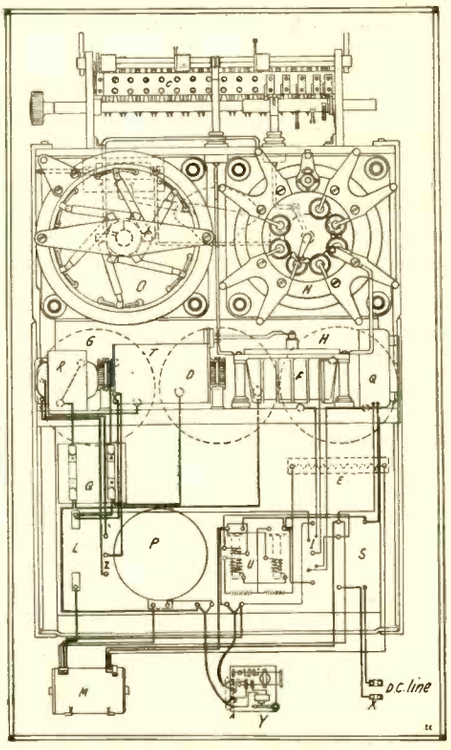
The spark gap which is used with this set is mounted on the top of the panel as shown in figure. The gap consists of a *gap holder* and *power changer*. The gap is horizontal and has a row of fifteen pockets; each pocket accommodates a gap unit as shown in photos. When a gap unit is inserted in a pocket it separates two leaf springs. The pressure of these springs against the gap insures perfect contact. The springs come together as a gap is removed and in so doing bridge the break in the gap holder circuit.

A switching mechanism is also associated with this holder. It consists of two shafts, one above the other and parallel to the row of gap pockets. Each shaft is provided with switch jaws which engage knife blades fitted to the gap holding pockets as shown in figure. The top switch shaft is used for the changing of power. Each movement of its handle inserts or removes gap units in groups. The switch jaws slide over this shaft so that the operator may vary the number of the gaps in a group at will. The three positions of this switch are *Low, Intermediate and High.*

The second and lower switch shaft allows five gaps to be inserted one at a time. The switch engages knife blades projecting from the rear of the first five gap pockets as will be seen. This

(*Continued on page* 471)





Front and Rear Views of 1 Kilowatt Quenched Gap, Panel Radio Transmitter. This Set Has Been Extensively Adapted by the United States Navy and Has Given Excellent Satisfaction. The Quenched Gap Units Are Easily Replaced at a Moment's Notice and Can Be Quickly Repaired When Necessary. The Gap Plates Are Separated by Thin Fish Paper Gaskets. The Set is Noiseless in Operation.

Valves

By PROF. A. U. DION, G.R.I.D., D.C., A.C., H.F.C., T.S.F., etc., and MR. LETIT LEAK, E.M.F., O.T., etc. (Local Plumber)

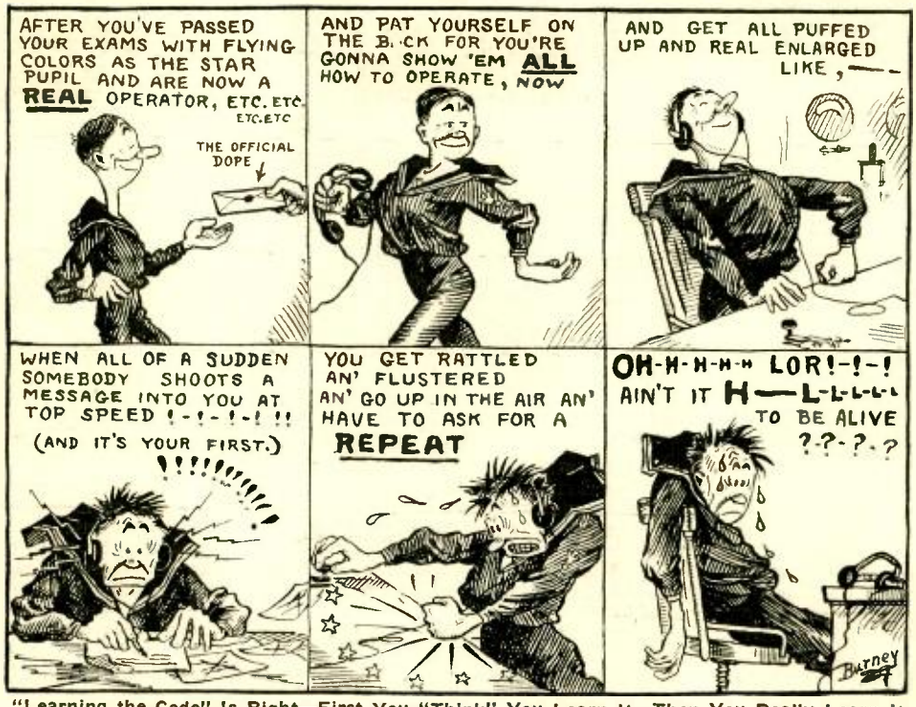
Introduction

In this little article I have tried to set down a few facts and fancies regarding the valve as used in the practice of wireless telegraphy.

They are the direct result of information collected whilst acting in the capacity of W/T operator in one of Britain's aërial dreadnoughts, although much of the advanced technical matter is the result of Mr. Letit Leak's untiring research, and to this gentleman I publicly extend my heartfelt thanks for his invaluable assistance in compiling this treatise.

Author's Note

Thru long association I had come to look upon the W/T valve as the only valve in the wide, wide world, so vividly were its advantages and merits imprest upon me at Cramwell College. I am assured by Mr. Letit Leak, however, that this is quite a fallacy. He tells me that there are H.P. and L.P. steam valves, gas valves, ball valves, and bi-valves, not to mention innumerable others, besides the common or garden dot-and-dash variety.



"Learning the Code" Is Right—First You "Think" You Learn It—Then You Really Learn It All Over Again, As Mr. H. B. Burney Here Illustrates In His Own High Frequency Style.

Valves W/T may be placed in four categories:

(1) The Round Valve (deriving its name from the inventor, not from its shape).

(2) The Hard Valve (has slightly longer life than the soft valve when exposed to the tender mercies of the new operator thirsting for knowledge).

(3) The Soft Valve (so called because it is satisfied with fewer volts than the foregoing instance, and therefore does not require so many ration books).

(4) The "Q" Valve (better known as the "Hush, Hush" valve). By simple proportion it will readily be seen that 31,967 such valves would receive signals from the planet Jupiter.

All four types are much of a muchness in general principle, differing only in detail.

Taking them collectively, a valve consists of a chunk of vacuum surrounded by a layer of glass. A most essential part is the small tip generally found on top of the vacuum. Its precise use has yet to be determined, but Mr. Letit Leak assures me it is a most important *point*. I do not intend to trouble my readers with smaller details, but, in passing, it is imperative to direct attention to a fundamental necessity, which valve manufacturers dare not overlook—viz., the necessity for placing some small parts within the vacuum. These are:

(1) *The Filament.*—A very fragile piece of tungsten made up of 10^{55} negative electrons. Its function is to illuminate the vacuum in order that the student may see how the other parts work.

(2) *The Grid.*—Consists of a number of holes joined together by small pieces of metal. Acts as a shade over filament to protect student's eyes.

(3) *The Sheath.*—A sheet of metal enclosing both the filament and the grid. Prevents small pieces of vacuum, dust or dirt from falling on the filament and affecting its lighting capabilities.

At the bottom of the valve are a number of tags, generally four, although a few more or less should not worry the student. I was under the impression that these were to form a convenient method of holding the valve without making the glass dirty, but Mr. Letit Leak emphatically insists that these tags exist for the sole purpose of ensuring connection with the internal economy of the valve.

To Test Valves.—Carefully examine, and any cracks in glass bulb should be caulked with shellac to prevent the vacuum getting out.

To Test Filament.—Grasping the valve by the tags previously referred to, bang the valve several times in rapid succession against the edge of a bench (unless an anvil is handier), when it should give forth a clear, bell-like note. Should the filament fail to glow after this test, don't waste more time with it, but get another from the stores.

To Test H.T. Circuit.—Connect up to several thousand volts and forget the exact amount. A faint bluish glow will indicate that the H.T. has successfully run the gauntlet of the vacuum and is looping the loop between the filament and sheath, a process known technically as *oscillation*. Should no blue glow be detected and the valve and student still survive, throw the valve away—it is a dud.

To Test Vacuum.—Knock off small tip mentioned previously, and if vacuum is good a faint hissing noise is heard. When the hissing ceases, it denotes that Nature, which abhors a vacuum, has discovered the escape. It is not advisable to apply this test except as a last resource, owing to the extreme difficulty of re-packing the vacuum thru the small hole thus made in the glass.

From the foregoing remarks the student must draw his own conclusions as to the advantages of valves. Our W/T officer says that their tendency to disappear completely and mysteriously is not so marked as that of the carborundum crystal. He attributes this to the post-war amateur not being possest of sufficient filthy lucre to purchase enough high tension to operate the valve, while the current price of volts is so excessive.

Finally. — Mr. Letit Leak informs me that, owing to the super-sensitive qualities of the valve as a detector, it is probable that Scotland Yard will shortly assume the entire control of the valve industry, and every detective will be fitted with seven valves. Police constables, on the other hand, will only be provided with amplifiers.—*Wireless World.*

DE FOREST DEFENDS HIS 3-ELEMENT AUDION

In the interest of fair play and scientific fact Dr. Lee de Forest, acknowledged among scientists as the inventor of the 3-electrode audion or vacuum tube which has made possible the present development of the radio telephone, has made public an open letter to the Editor of the *London Morning Post,* England, protesting against the reported unfair statement of Dr. J. A. Fleming, British scientist, in connection with his series of Cantor lectures in the theatre of the Royal Society of Arts.

The letter written by Dr. de Forest is based upon an article publisht in the *London Morning Post* of February 25th entitled "The Future Telephone—Imperial Conferences by Wireless" in which the perfection of the three-electrode audion is credited to Marconi. The article reads as follows:

"Dr. J. A. Fleming yesterday concluded his series of Cantor lectures in the theatre of the Royal Society of Arts with an account of the thermonic and crystal detectors, which, as he said, have taken an important part in the war. He described how the radiant point from which wireless messages are sent, could be determined by angles taken from two receiving stations, so that the exact position of ships and Zeppelins could be ascertained, and that means whereby electric oscillations could be detected thru the telephone in an airplane above the sound of the engines. Thermionic detection has been enormously developed, and the audience was interested to hear how these instruments, which are the basis of wireless telephony, arose from the discovery by the lecturer himself of a method of utilizing the curious fact that an ordinary filament lamp when incandescent

(*Continued on page* 460)

Vacuum Valve Construction

By R. H. Shaw

By reading this article carefully any Amateur should be able to construct a vacuum detector which will give excellent results. The completed valves are shown in Figs. 1 and 2 as well as connections for them. Several other connections may be used, but those shown have been found best.

In the construction of the valves an incandescent filament is used to produce the electron flow. For this purpose a miniature incandescent lamp with a carbon filament using about three volts should be used.

Having obtained such a bulb place a very thin strip of copper around it, as shown in Fig. 3. Fasten this plate by means of the nut and bolt (B). The plate connection is also made to this bolt.

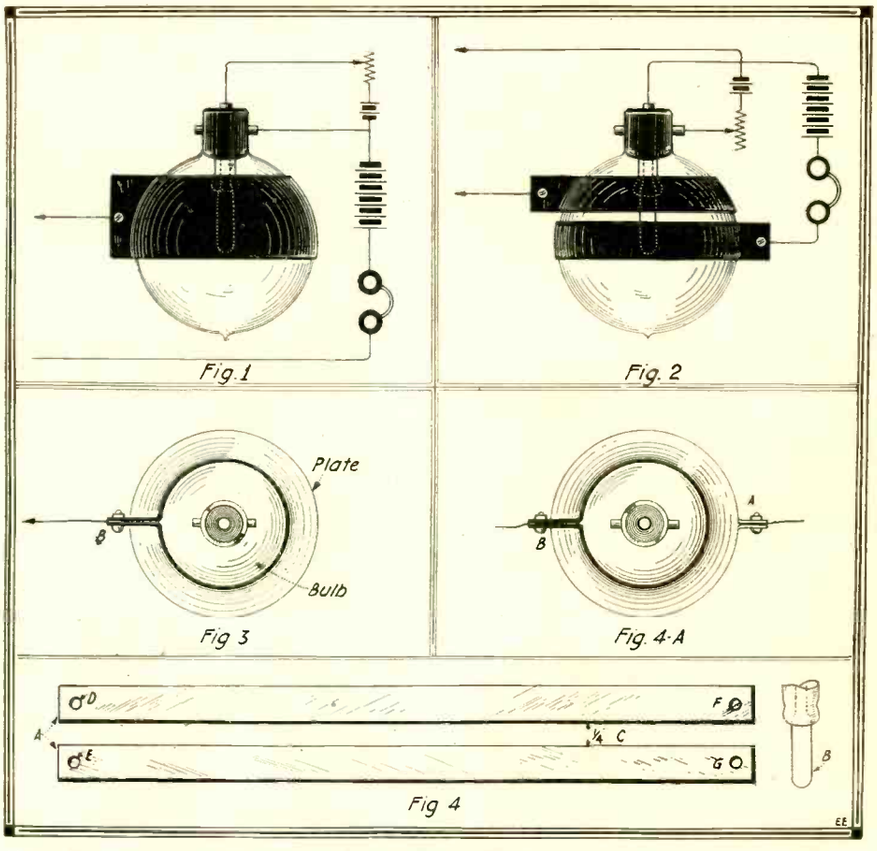
The valve is now ready for use and is connected up as shown in Fig. 1. Adjust the filament to a very high brilliancy, being careful not to burn it out. Do not touch the filament adjustment having once adjusted it, but use the "B" battery potential until the incoming signal is heard loudest in the 'phones.

In Fig. 2 is shown a second type of detector. This differs from the one just described in that its plate is divided. A lamp of the same kind used in the above detector is used for this one.

The construction of the plate for this valve is shown in Fig. 4. A thin strip of copper long enough to go completely around the bulb as shown is first cut (A). This plate should be a little wider than the filament (B). Having cut the strip to the right dimensions a piece one-quarter of an inch wide is cut out (C), Fig. 4. The holes D, E, F, G are next drilled. The two plates are then fastened around the lamp and secured to the bolts (A and B), Fig. 4-A. The plate connections are also made to these bolts.

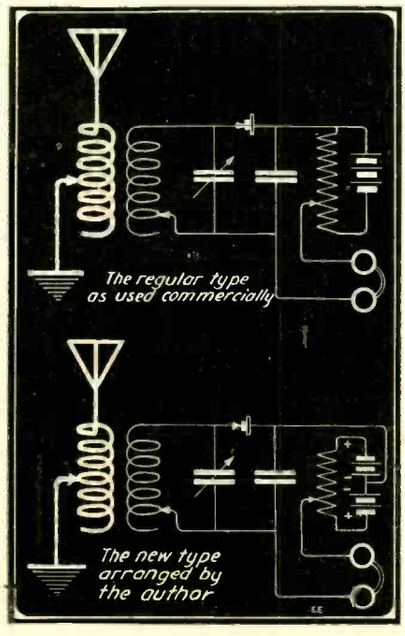
The valve is now completed and is connected as shown in Fig. 2. This valve is adjusted the same as the other one. An "A" battery of six volts and a "B" battery of fifty volts should be used with these valves.

The theory of operation of these valves is: As the glass becomes heated it allows the electrons being discharged from the filament to flow thru it and make connection with the plate on the outside of the lamp. The circuit from the filament to the plate is thus completed. It is therefore advisable to use a lamp containing a carbon filament as it produces more heat than a tungsten filament. The valves described herein are fully protected with patents and must not be manufactured for sale.



Home-Made Audion Designs for Two and Three Electrode Units. Made from Ordinary Single Filament Auto Head Lamps, Purchasable in Any Auto Supply Shop.

The Potentiometer—How to Use It



Above—the Old Way, and Below—the Improved Hook-Up for Obtaining + or — Current from a Potentiometer Circuit Without Switches

There has been very little said in print in regard to the use of this very important and effective instrument as a regulator of battery current which aids some types of crystals decidedly in their functioning.

In the majority of cases upon visiting the ordinary and even the advanced class of Amateur or Experimental stations, I have found that probably one in a hundred made use of this very necessary piece of apparatus. Once used, no one will do without it, owing to the following facts:

1. There is absolutely no carborundum which is not greatly increased in sensitiveness by its aid.

2. I have found upon investigation that there is not a piece of silicon which does not function better, to a greater or lesser degree, according to the kind used, by the aid of minute battery current and a potentiometer for regulation.

Even tho some experimenters do make use of a potentiometer they do not in all cases thoroly understand its operation and correct use in order to derive best results.

As a general rule potentiometers with a critical point of adjustment should be employed. Such a potentiometer would be one wound with fine wire and an over-all high resistance. This affords greater life to the battery shunted across it and allows one to hold point of adjustment at a greater length of time due to the fact that with large wire the battery dies out more rapidly and then it is necessary to readjust the potentiometer to allow the same amount of battery current to flow thru the detector.

A sliding contact potentiometer, if well constructed, should be used instead of the switch contact point arrangement, owing to the fact that it is impossible to arrive at an exact or critical point of adjustment with the latter.

Another point of great interest in connection with this apparatus is that the right polarity must be maintained, and in order to do this with the commercial form of potentiometer, it is necessary to first connect the detector or battery and "adjust"; if no increase in signal strength is found, it is then necessary to transpose either the battery or detector leads. To overcome such annoying procedures as just mentioned the author has arranged the following circuit for the potentiometer, which makes it unnecessary to change the leads of the battery or detector.

The instrument is termed a "duplex polarity potentiometer," and works in the following way: As will be seen from the diagram, the potentiometer is shunted by two batteries opposing each other; therefore no current will flow when the potentiometer slider is in the exact center of the instrument or windings of the same. If it is moved above center one set of polarities is had, and if moved below another set is obtained.

Contributed by E. T. JONES.

Eccentric Antennae

By EUGENE DYNNER

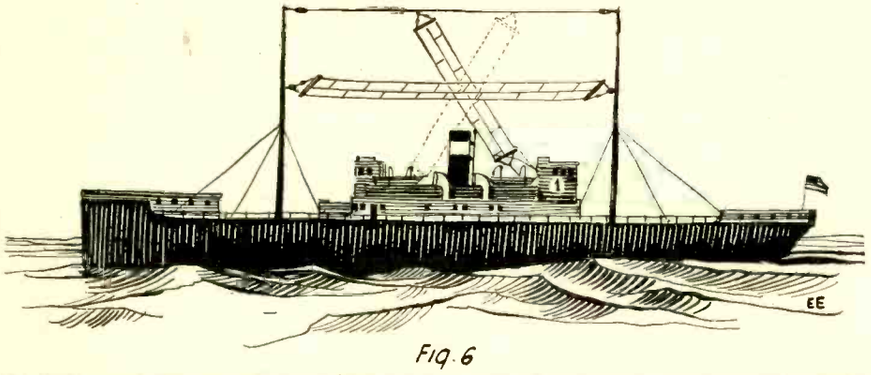


Fig. 6

Novel Form of Eccentric Antenna Tried Out on Ship-Board by the Writer. This Aerial, as May Be Seen, Is of the Cross-Connected Type. With This Form of Antenna, There Was Approximately 50 Per Cent Increase in Strength of Signals Over a 1,500 Mile Range.

SOME time ago experiments were made to develop an antenna which should give the maximum efficiency in reception of radiotelegraphic signals without necessitating the use of expensive apparatus. The first distinctive aërial developed was the one depicted in Fig. 1. This antenna consists of three wires which are connected together at intervals in length twice the width of the spaces between the wires, and measured in such fashion that one of the rectangles formed ends at the center of the adjacent one.

The receiving transformer used was of a special design, consisting of one stationary and three movable coils (Fig. 5). Coil 1 is a primary into which secondary No. 3 may be moved. Coils 2 and 3 also form a primary and secondary which may be brought closer to primary No. 1 or drawn further away. No taps are taken off, there being a double variometer action. A plain galena detector gave excellent results. The entire apparatus was connected as per Fig. 4. Condensers 5 and 6 are of .001 mfd., and condenser No. 7 may be a smaller one.

Using antenna No. 1 with this hook-up, there was an increase in efficiency of about 40 per cent. With coil 2 eliminated and 4 slid inside of 3, a decrease in wavelength resulted and the efficiency was increased about 5 per cent. when an audion was substituted for galena. Efficiency is calculated from results obtained by the use of an ordinary well-built loose-coupler with possibilities for variations by single turns. To test efficiency a device described several years ago in the ELECTRICAL EXPERIMENTER was employed.

With the loose-coupler in circuit and antenna No. 1, it was found that somewhat sharper tuning was accomplisht and signals were louder than those received with the ordinary type antenna.

Antenna No. 2 was found to cause a waste of energy, until the distance between wires 1 and 2, 2 and 3, etc., were separated at least 15 feet. This cage-like contrivance was 150 feet long. Even when this proportion was establisht the increase of efficiency over antenna No. 1 was less than 5 per cent., working under the same conditions.

A composite antenna and "ground" was built, No. 3, which gave excellent results. This arrangement, however, was found most efficient where the capacity of the two bodies was different. Putting the ground above the antenna gave a slight decrease in loudness of signals with broader tuning.

With the antenna depicted in Fig. 6, there was approximately 50 per cent. increase in strength of signals over 1,500 miles away—in direction opposite upper end of vertical antenna—was obtained. Addition of another section of antenna built in direction opposite to first one, gave the same strength in both directions.

In all cases the leads as indicated on diagrams were found most satisfactory. Substitution of single wires for three wire antennae gave practically the same results where the sections were over 300 feet in length, and reception was from stations using wavelengths of over 2,000 meters. For shorter waves the three-wire arrangement was found best.

The United States Navy is using extensively a type of aërial that has been developed in England, and which is used on all her battleships and destroyers. It is termed the "Barrel" type on account of its shape, which is cylindrical. On American battleships, it is anywhere from 75 to 150 feet long. On the smaller type of boat, the aërial must necessarily be much smaller. It consists of six wires arranged in barrel formation and supported every eight feet by three pieces of light bamboo, crost in the shape of a six pointed star. These pieces of bamboo may be of any length, thereby giving the aërial any diameter desired. The diameter is usually determined by the length. On our battleships the diameter of the barrel is anywhere from one to two feet. It may, however, be decreased to six inches for a very small antenna.

For the wire composing the aërial, the United States uses its standard phosphor bronze wire. This wire has been found to be the most efficient in every way. It does not corrode, neither does it rust nor deteriorate in other ways, as the usual kinds of wire do. One big trouble heretofore has been corrosion of the wire in the aërial, due to the action on it of the gases from the smoke stack directly below.

The English government, with whom this type of antenna originated, uses an entirely different kind of wire. They use ordinary copper wire of about No. 12 or 14 B. and S. gage. The bare copper wire is treated with a coat of black enamel, which is made from a specially prepared formula.

The enamel coat does not detract from

(*Continued on page* 470)

This Flat-Type Cross-Connected Aerial Showed an Increase of 40 Per Cent in Efficiency When Used With the Receiving Coupler Described

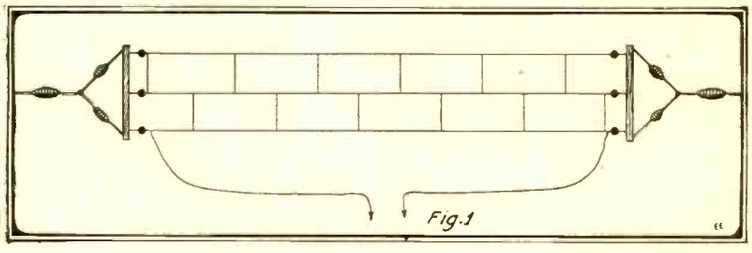


Fig. 1

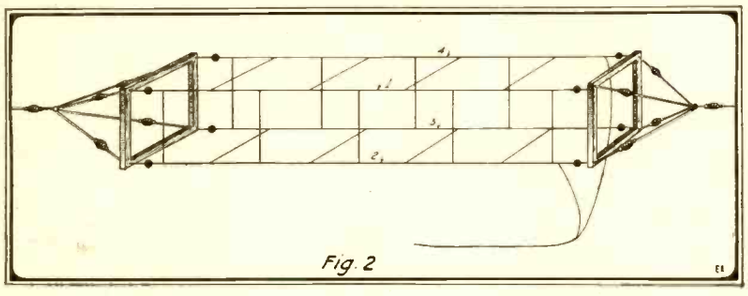


Fig. 2

One Form of Cross-Connected Antenna Tried Out by the Writer With Gratifying Results. The Individual Wires Are of Course Carefully Insulated as Shown.

Novel Composite Antenna and "Ground"—This Design Gave Excellent Results, Says the Author. Placing the "Ground" Above the Antenna Gave Slightly Lower Efficiency.

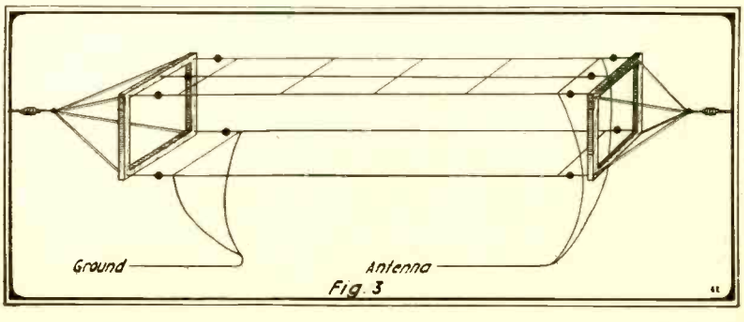
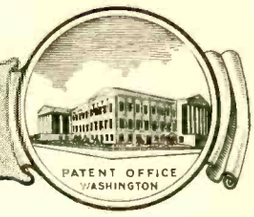


Fig. 3

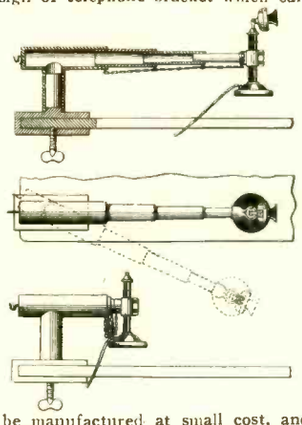
LATEST PATENTS



Telephone Bracket.

(No. 1,288,611, issued to Edward T. Jones.)

This represents a very simple design of telephone bracket which can

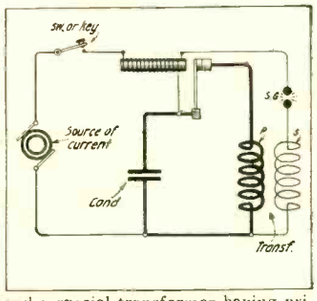


be manufactured at small cost, and still operate with the same efficiency as some of the more expensive and elaborate telephone devices of this character now on the market. The device comprises a series of telescoping metal tubes, which slide into one another when the bracket is to be collapsed, in the manner apparent. A chain is fastened to the successive telescoping sections so that they cannot be put out of alignment or beyond their limit.

Electric Igniter.

(No. 1,307,854, issued to William and Philip Dubilier.)

An electromagnet interrupter is used in conjunction with a condenser

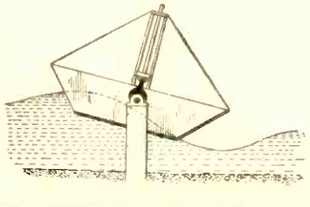


and a special transformer having primary and secondary windings, the primary of which is connected with the interrupter and condenser in such a way that this circuit becomes a tuned oscillator whenever the vibrator is in action. This circuit, in conjunction with a magnetic interrupter, is used to throw a spark across the gap shown, the line current maintaining an arc across the gap.

Wave Motor.

(No. 1,307,095, issued to William Gregersen.)

A surf or wave motor in which the float or body shown is made in the form of a boat pivotally supported, so as to rock with the rise and fall of the wave, and thereby operate a mechanism arranged to rotate a shaft in a continuous circulatory fashion. It is understood that two or more of these wave motor members may be used of course at one location, so as to give a much steadier rotative

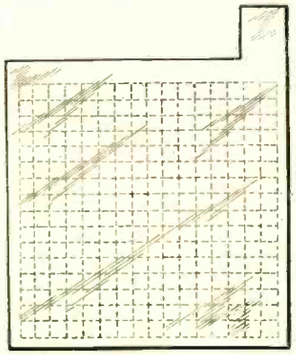


power to the main power shaft, and also to increase the amount of power developed in any instance. The rising and falling float is provided with suitable arms, connected with a set of pawl wheels and ratchets.

Storage Battery.

(No. 1,306,214, issued to Richard J. Crowley.)

A clever scheme providing for a new departure in the manufacture of storage battery plates or grids, having an active agent consisting of lead oxid and aluminum sulfate, and a method of producing a battery plate or grid paste of this compound. One object is to provide a battery element which will permit charging and discharging at a rapid rate without injury to the plates; providing a higher voltage at a heavy discharge and having a greater capacity in ampere-hours than other

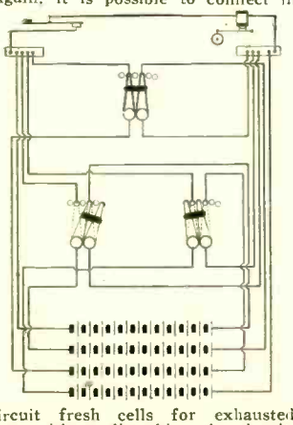


lead cells. Positive elements so made are said not to disintegrate as rapidly as peroxid of lead positives. The electrolyte used may be composed of sulfuric acid and water, but better still it is formed with an acid sulfate of aluminum. This is adaptable for transportation as a solid and only requires the addition of distilled water to form an electrolyte.

Battery Switch.

(No. 1,306,147, issued to Simon B. Hess.)

One of the principal objects of this invention is to provide a battery switching system by means of which large ampere-hour capacity may be obtained for using dry cells. Further, by the switching scheme here provided, it is possible to change the voltage of the battery system at any time without changing the original battery installation in any way. Again, it is possible to connect in

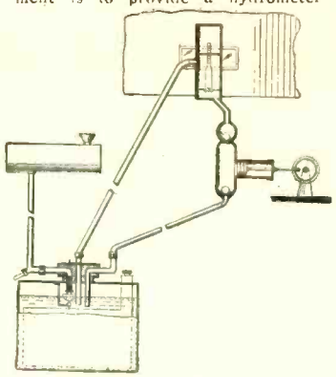


circuit fresh cells for exhausted ones without disturbing the circuit. When the battery system gives out entirely, and becomes no longer possible of manipulation adequate to increase the voltage, anyone not acquainted with the art will be enabled to readily replace old with the necessary new battery cells, and again make the system operative, owing to the simplified connection scheme shown.

Sight Storage Battery Tester.

(No. 1,308,223, issued to Ernest Camp.)

One of the objects of this improvement is to provide a hydrometer

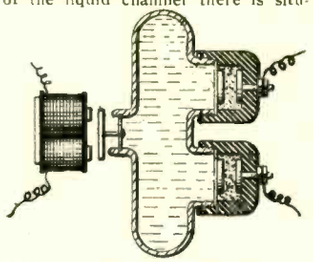


chamber having a connection to the storage battery cell, providing a means whereby the liquid electrolyte may be drawn into the hydrometer chamber, so that the electrolyte may be tested. The testing chamber may be placed upon the dash panel of the car so that the condition of the battery may be examined at any time. A further idea provides a means whereby distilled water may be supplied in small amounts from time to time.

Water Telephone Relay.

(No. 1,306,248, issued to Edward E. Clement.)

At one side of the liquid chamber shown there is placed a diafram actuated by a telephone receiver electromagnet system. At the other side of the liquid chamber there is situ-

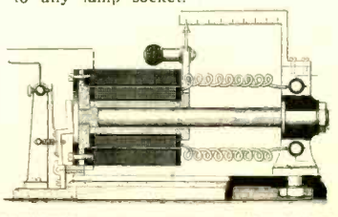


ated one or more microphones. When an incoming sound current passes thru the receiver, it actuates the diafram and corresponding vibrations are transmitted thru the liquid, which may be water.

Induction Coil.

(No. 1,307,093, issued to Benjamin Fulton Gardner.)

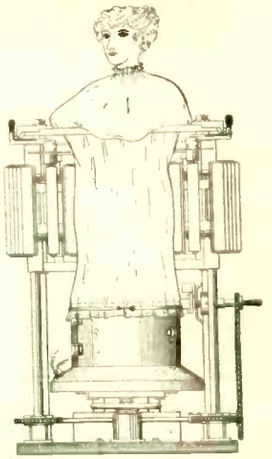
A reversible transformer for the purpose of stepping down or up either alternating current or direct current. There are two coils wound about an iron core and fitted with a vibrator. The outer coil is wound with fine wire and the inner coil is wound with coarse wire, the inner coil being movable along the iron core. A scale is provided so that the strength of the current may be watched as the regulating coil is moved along the core. The device can be connected to any lamp socket.



Electrical Reduction Apparatus.

(No. 1,305,439, issued to William E. Brennan.)

Those having a corpulent form, whether male or female, will be interested in this reducing apparatus invented by Mr. Brennan. One of the principal features of this apparatus lies in the use of an electric heating cell at the base of the structure, in order to give the person

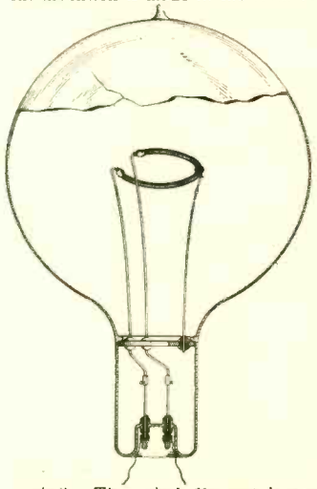


under treatment a considerable rise in temperature while applying the massaging action by means of rotating wooden bars, shown in the illustration. As the inventor points out, any treatment of this nature for reducing the size or weight of a person is much more effective, and the results are more quickly and easily obtained, where the body is heated as well as massaged.

Improved Tungsten Lamp.

(No. 1,306,259, issued to Frederick G. Keyes.)

An improved design for tungsten lamps of high candlepower and suitable for operation on low voltage and high ampereage, in contradistinction to the usual form of high-voltage lamp. One of the features of this lamp resides in the mode of securing proper sealing of the lead wires and the anchors supporting the tungsten filament, which in the present invention is made in the form of



a spiral. The spiral filament is attached at its end to two lead wires made of copper sheathed with iron, the copper being utilized for its good conducting qualities, and the iron being employed for its rigidity, to prevent bending or distortion of the copper wire under the influence of the high temperature developed within the globe.

WITH the AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

The Editors desire to call to the attention of all owners of "Electrical and Chemical Laboratories" the fact that hereafter the MONTHLY PRIZE WILL BE $5.00 CASH, instead of $3.00. ALSO $2.00 CASH WILL BE PAID TO EACH "HONORABLE MENTION" ENTRY PUBLISHT. We have not received any "Laboratory Photographs" of late. So "go to it" and send us your photo, together with that of your laboratory. If they are particularly good we may list some new and bigger prizes. So get busy, Boys!!! It's up to you. Here's a way to earn some greatly wanted laboratory apparatus at no cost whatever. Don't be afraid to send in too many photos, Boys.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER— STANLEY C. REED

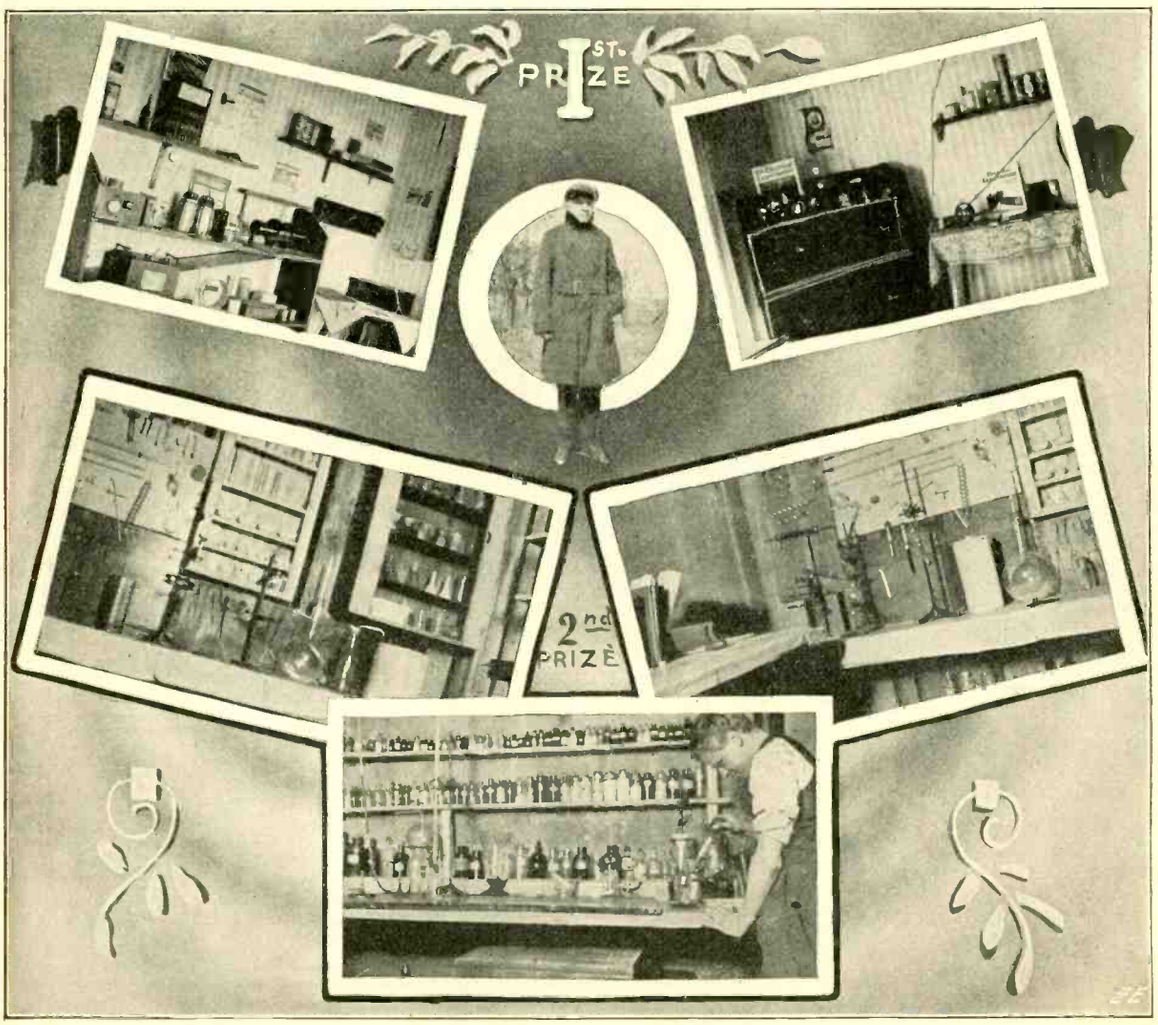
HEREWITH are three photographs of my electrical laboratory. I am sixteen years of age and have had my laboratory two years. I have a 6-volt storage battery, two Tesla coils, spark coils, a dynamo and a number of small motors.

I have a fairly complete wireless "Demonstrating Set" with seven-foot aërials, about ten feet apart. The receiving set consists of a coherer outfit and a detector set with a 75 ohm receiver.

I find the study of magnetism very interesting. I have made many magnets, compasses, galvanoscopes, galvanometers and similar instruments. Also my laboratory contains a chemical department in which I test soils, water, and perform other interesting experiments. In my experimental work I am guided by a library of thirty-five scientific books and the ELECTRICAL EXPERIMENTER.—Stanley C. Reed, Lennon, Mich.

HONORABLE MENTION—THEODORE FREDRICK $2.00 PRIZE PAID EACH "HONORABLE MENTION"

HEREWITH I present four pictures of my chemical laboratory, which is very complete, containing all apparatus used in general chemistry. I spend a great deal of my time in qualitative analysis including analysis of foodstuffs, and most everything else. My laboratory contains an electrical rectifier which I have constructed from an article publisht in the ELECTRICAL EXPERIMENTER. I use this in working experiments in electrolysis, such as making potassium chlorat, sodium hydroxid, etc. I have constructed an electric furnace with which I perform experiments in making alloys and castings. My chemicals number about two hundred and fifty, including salts of most of the metals, and I have about one hundred and seventy-five pieces of apparatus. I have also constructed a large Oudin coil, the top of which can be seen under one of the tables. I have performed a great many interesting experiments in high frequency such as described in this magazine.—Theodore Fredrick, 924 Chicago Avenue, Evanston, Ill.



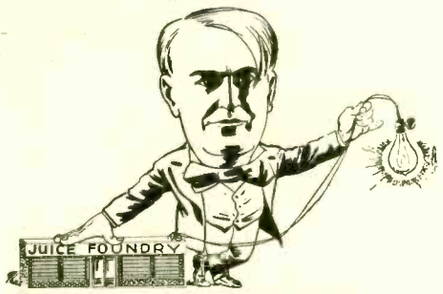
Science in Slang

By EMERSON EASTERLING

"I'M sure glad that station is up and going," remarked Stokes as we motored in from the power plant site.

"I saw a bunch of stuff in the cement houses," put in Punk, "but I'll be flopped if I can make it all out."

"It's more or less a long story," returned Jazz Stokes, "but I'll make it short as possible and still get you birds out of the dark on the subject.



We All Know that Tommy Edison Lost a Lot of Sleep Fiddling Around Over a New Kind of Illumination—the Electric Light. We Used Direct Current then But Nick Tesla Stept in and Gave us "Altering"—Excuse us —Alternating Current.

"We all know that Tommy Edison lost a lot of sleep fiddling around over a new kind of illumination—the electric light—back some years ago. Well, the next thing to do was to make it possible for the neighbors to have the product of his perspiration and inspiration, so he sticks up the primitive central station in the Knickerbocker Burg. The result is that one thing leads to another and now we have 'em all over the sphere.

"Back in the old days they used direct current. Then it was that Nick Tesla steps in and gets disgusted with the layout, kicks out the old stuff and pulls a new one on us. The stunt takes the form of *alternating current*. Nick gets his visionation working and pictures to himself—O, well, anyway he constructs a generator that fools the polarity indicator, and makes it possible for the generator to be farther away from the consumer and yet not have to strain itself to get the juice to the destination."

"How is all this?" asked Bender.

"It's this way," said Stokes, "this alternating current stuff was a new one on the public. The armature in the generator passes thru consecutively opposite magnetic fields and the current therefore goes shooting one way, croaks, and goes flopping back the other way. The speed and number of poles has to do with the frequency of the current.

"Here we put Mike Faraday's induction stuff to some real use. Mike found that if a current be made to pass thru (or over, which way he had it) a wire and another wire be placed parallel, a sort of sympathetic flow will present itself in the second wire; in the other direction. By winding many layers of wire around an iron core—for the iron core makes an easier path for the magnetic flux; the inductive flow is resultant from the induced magnetic field set up by the primary current—of both wires the result is found to be better than to lay the wires stretched out straight. It can be easily seen that the more concentrated flux would act more efficiently than the sparse flux that would course around the extended wires.

"It was found also that if the secondary be wound with smaller wire—more wire being used to make up the mass—that the voltage would be higher in the secondary. If the secondary be wound with larger wire the effect was found to be opposite. All this stuff worked out mathematically to a jot."

The Altering of the Alternating Current

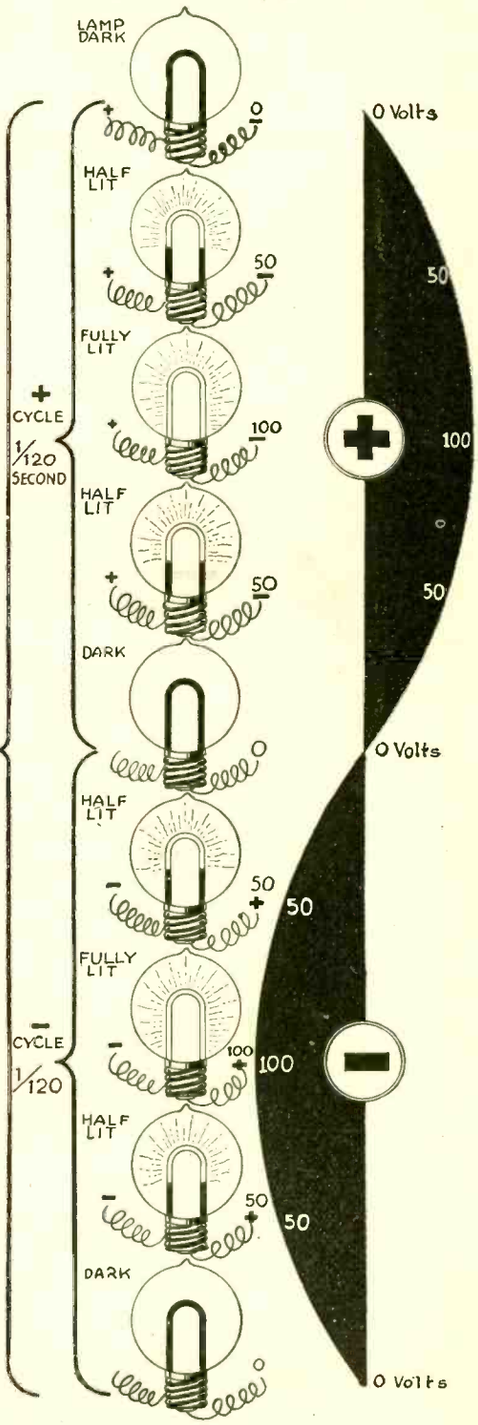
"That all sounds like real spiel," sang out Bender. "But how is it that if the alternating current flops back and forth from positive to negative so many times a second, as you say it does, that we do not perceive any flicker in the incandescent gas bottles, better known as incandescent lamps?"

"Well, as I was going to say," continued Stokes, "several important things happen in producing radiant light from an incandescent lamp after the manner of Tommy Edison's invention. Probably the best way to understand just what happens in the incandescent lamp and why you do not see the flicker when the current pulsation does a one-step, and changes from positive to negative in the twinkling of an eye, is best shown by a drawing." Stokes then took a pencil and pad from his pocket and continued: "Here on the right we have an undulating line known as a *sine wave curve,* and which represents the rise and fall of a single phase alternating current thru two alternations, *or one cycle.* The current at a given instant starts from zero and rises to 50 volts, then 100 volts or 110, whatever it may be, maximum positive value; immediately afterward the positive current impulse starts down hill toward zero again, doing it very smoothly, yet with great speed. The juice makes a complete rise and fall thru *one alternation* or one-half cycle, in 1/120th of a second. Then it passes thru the *dead* or no-current point, also called the zero point, and starts to increase in strength, but in the *negative* (opposite) direction. These negative current pulses, running thru 1/120th second, pass thru the successive rise and fall potentials as you will see, reaching the end once more—this is called *one* cycle by electricians. A cycle comprises two alternations, or a complete reversal from positive to negative. By drawing the various degrees of illumination in the incandescent lamp at different stages thru the cycle, you will at once see how the filament rises from a *dark* condition at the start of a given cycle, increases in temperature and luminosity as the voltage increases thru the *positive* alternation, and finally becomes *dark* again as the current passes thru the first zero point. As the *negative* alternation starts to increase in potential in the next 1/120th second, the filament temperature again rises to a maximum with a consequent full luminosity, and then falls thru successive stages of brilliance until it becomes *dark* once more, as the current passes thru the second zero point at the end of a cycle. This action keeps up repeatedly."

"Yes, that is all very fine," interrupted Bender, "but I don't understand yet, why it is that we do not see the lamp passing thru the dark periods in the cycles. One one-hundred twentieth second is not very fast, and the human eye is supposed to be one of the most wonderful high speed mechanisms in all Nature."

"I was coming to that," bawled Stokes, "if you would have allowed me another minute to catch my breath. Apparently you have forgotten some of your physics, Bender, and on second thought you undoubtedly will agree with me, if you will stop to remember that due to the *retention* of the 'image' on the rod and cone layer of the light sensitive portion of the eye, there is a peculiar action which takes place, causing the image thrown on this element of the eye to be retained for a short but quite appreciable period. Thus it is that

(*Continued on page 444*)



How an Incandescent Lamp Lights Up and Passes Thru the Half Cycle "Dark" Periods When Supplied with "Alternating Current." The "Dark" Periods Are so Short in Time "Duration" that the Eye Does Not Notice Any Flicker.

THE ORACLE

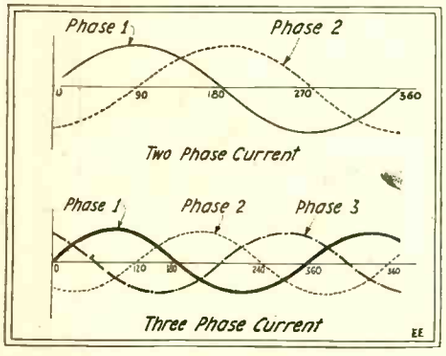
The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

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 address 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.

WHAT IS A POLYPHASE CURRENT?

(1020) Paul W. Meradith, Delavan, Ill., asks:—

Q. 1. What is a polyphase current?



Graphic Curves Showing Difference Between Two and Three Phase Currents. A Polyphase Current is One Comprising three or More Alternating Currents, Spaced Apart on the Time Axis in a Regular and Definite Ratio, Such as Here Illustrated.

A. 1. We must say that this is a very broad subject. You will do very well to consult your library and look up some good works on A.C. current. A very simple explanation, and one which you can readily understand is given in the book entitled, "Alternating Currents—Theory, Practice and Diagrams," by Horstmann & Tousley; also another very excellent work is that entitled "Alternating Currents," by Branch.

We give you herewith illustration showing the relation of the three distinct currents making up a three-phase polyphase system. The three-phase current may be transmitted by six wires or three wires, this system being the usual one in everyday practise. A polyphase current is one composed of two or more distinct, single-phase currents co-acting in a circuit in a certain particular relation to each other. In a two-phase system there are two alternating currents generated in two distinct windings in the alternating-current dynamo; one of these currents is 90 degrees ahead of the other. In a three-phase system there are, as the graph herewith shows, three separate alternating currents generated in three distinct windings on the rotor or stator, as the case may be, of the alternator, and each of these currents is 120 degrees ahead of the other. When one of these polyphase currents enters the windings of an A.C. motor, it sets up a rotating magnetic field of constantly changing polarity, as may readily be imagined, and this drags around the rotor, due to the fact that north and south magnet poles are induced in the iron poles of the rotor, which are repelled and attracted by the suddenly changing north and south magnetic poles of the stator in exactly the same manner as in a direct-current motor.

Your understanding on the subject of D.C. motors most probably makes clear the fact that if it were not for the commutator and brushes connected with the armature or rotor circuit of the D.C. motor, that it could never rotate, and the sole function of the commutator and brushes on such a machine is to suddenly change the polarity of the magnetic poles or fields surrounding the armature, as these poles approach the respective north and south poles of the stationary field.

ONE-INCH SPARK COIL.

(1021) D—— Brothers, East Lynn, Mass., writes:—

Q. 1. Asking for data on spark coil and underground antennae.

A. 1. Regarding data which you request on underground wireless, we would refer you to the June 1919 issue of the ELECTRICAL EXPERIMENTER wherein you will find a special article by H. W. Secor.

For size of coil which you wish to use with four cells of dry battery, we recommend the following:—

Core about 8 inches long, 1 inch in diameter, properly insulated with a fibre tube having about two to three layers of No. 14 D.C.C. magnet wire wound on same. Over these two or three layers of empire cloth and another insulating tube on top of this, wind about No. 38 S.C.C. magnet wire so as to make the coil about 4 inches in diameter when complete. The coil when operated will give about 1 inch spark.

For information on the construction of spark coils, we would recommend a very excellent book, namely: "Design and Construction of Induction Coils," by Collins, $3.25 prepaid.

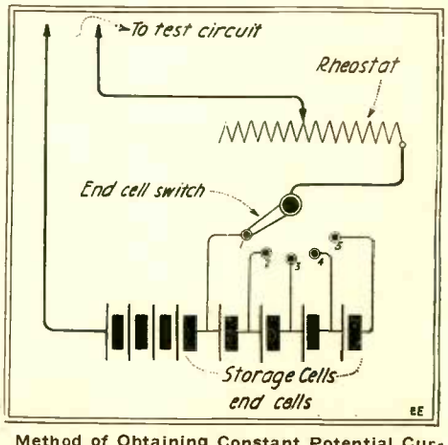
CONSTANT POTENTIAL TESTING CURRENT

(1022)) Oliver V. Austin, Ellisville, Miss., wants to know:—

Q. 1. How can I obtain an absolutely constant testing current from a storage battery?

A. 1. Would say that there is no ordinary method available, to our best knowledge, for maintaining a constant potential from such a source, except by means of a rheostat in the circuit, and also by the provision of a so-called *end-cell switch.*

An end-cell switch is a multi-point switch, connected at the end of the series of cells, and so arranged that as the voltage falls from the battery that other cells one by one can be switched in the circuit, and then the final graduations of potential are compensated for by means of a finely adjustable rheostat connected in series with the battery, as here illustrated.



Method of Obtaining Constant Potential Current from a Storage Battery by Means of an End Cell Switch.

Experimental Mechanics

By Samuel D. Cohen

(Continued from page 423)

favor with all users of reamers. The eccentrically relieved reamer is purely a finishing reamer, and cannot be used with advantage to remove any considerable amount of metal. When hand reamers are used merely for the purpose of removing stock, or simply for enlarging holes, the flat relief will undoubtedly prove to be superior to the eccentric. The primary use of straight hand reamers, however, is for producing holes true to size and smoothly finished, removing meanwhile but a small amount of stock. For this purpose nothing excels the eccentric relief. That there are a number of different classes of reliefs required, according to the use to be made of the reamer, is best proved by the fact that while some manufacturers of tools relieve their reamers eccentrically, intending them to be used as finishing reamers, some of their customers place them in a grinding machine and replace the eccentric relief with a flat one, because they find this relief better for their purpose, viz., simply enlarging holes irrespective of the highest requirements of accuracy and smoothness.

A regular cutter and reamer grinder is often used for grinding reamer teeth. See Fig. 5. Another method is to utilize an electric grinder held in the tool post of a lathe, while the reamer is held between the lathe centers. The most economical and best results are obtained when using a grinding machine, made for this purpose. The sharpening or backing off of reamers in a lathe is unsatisfactory and should never be resorted to unless no other means are at hand. Sometimes it happens that a large reamer must be sharpened, the diameter of which is either too long or too short for the capacity of a grinder. In such a case the electric grinder used in a lathe will prove satisfactory. Of course, from the experimenter's point of view, the only means at hand for him to grind his reamers will be the lathe and electric grinder.

The amount of clearance that a reamer tooth should have depends largely upon the class of reamer and its size. A suitable clearance for reamer teeth, exprest in degrees (the face of the tooth being radial), is not a fixt number, but varies for different diameters, and the smaller the reamer the greater the angle of clearance should be. Hence, if the cutter and reamer grinder are set to grind the right amount of clearance on a large reamer, a smaller reamer would not have a suitable clearance at that setting.

(To be continued)

How the R-34 Crost the Atlantic

(Continued from page 404)

fying audion and sending outfit he has been able to send and receive a distance of 1,200 miles by actual test, he being off the coast of the Azores at the time, communicating with the British Air Ministry at London. The auxiliary outfit is capable of sending 800 miles. In addition to this there is an ordinary spark coil outfit, utilizing but a small amount of current, which has covered a range of 300 miles. This seems rather unique, inasmuch as it is seldom that small spark coil outfits ever cover such a great distance. But according to Lieut. Durrant, it is a fact, and is recorded in the ship's "log." In addition to these outfits there is a "Wireless Telephone" instrument device, which can be connected to the auxiliary wireless outfit, and when so connected, forms a part of this auxiliary outfit, by means of which wireless telephonic communications have been sent and received while in flight.

In back of the Radio Room is the engine room of the forward gondola. This, like the other gondolas, contains a high-powered gasoline engine, which, however, is greatly geared down, the power of each motor being about 275 H.P. An oiler and a mechanic are in charge of these engines constantly, both day and night. Amidships are two gondolas, each of them containing an engine and its respective propeller. The rear gondola has two such engines geared to a single propeller so that either one or both may be operated at the same time. Energy for electric lights is derived by special dynamos each connected to an engine; these dynamos furnish the light for the respective gondolas, and are connected in such a way as to allow any one of them to furnish the electric current thruout the entire ship if necessary. The energy for the wireless station is derived from the main engine. From each gondola there is an aluminum ladder enclosed in a fabric, which leads up into the interior of the blimp. These ladders connect into a passageway so that men aboard the airship may pass from one gondola into another. In the center of the airship there is a large room 20 feet long by 8 feet wide, in which the crew eat, their meals being cooked over the exhaust pipe of the engines. Strange as it may seem the men had bacon and eggs for breakfast on the first day out, cooked as above mentioned on the exhaust pipes of the engine. This shows the terrific amount of heat that these engines, because of their combustion, furnish. Hence each engine has connected with it a very elaborate system of radiators in order to cool it. These radiators are placed above the gondolas as shown in the illustrations.

In the center of the ship there is a runway covered with linoleum, as already mentioned, stretching almost thru the entire length of the keel, i. e., about 600 feet long, and only 9 or 10 inches wide, which the crew use for exercising and for passing from one gondola to another. Should one member attempt to pass the other, either one of them must lean against the aluminum frame-work of the dirigible, so as to allow the other to pass. Should they fail to do this, a drop of about 8,000 feet into the briny deep would result. There is plenty of room to walk upright, the roofs of the gas bags above being about 12 feet from the runway. The gas bags are divided into eighteen separate envelopes, which are inflated with hydrogen, nine of these being equipt with automatic valves so that expanding gases due to changes in temperature may escape. All the bags are incidentally equipt with gages, which register the pressure of gas and are inspected hourly. The hydrogen bags are made of calves' intestines (goldbeater's skin). There are sixteen gasoline tanks attached to the frame-work on either side of the runway, each with a capacity of about 70 gallons, forming a total weight when filled of about 500 lbs. There are forty-nine of these tanks aboard the gondolas and thirty-two in the ship, making a total of eighty-one, more than half of which can be thrown overboard to lighten the craft in case of emergency, which is absolutely necessary inasmuch as there is no way of refilling the

(Continued on page 440)

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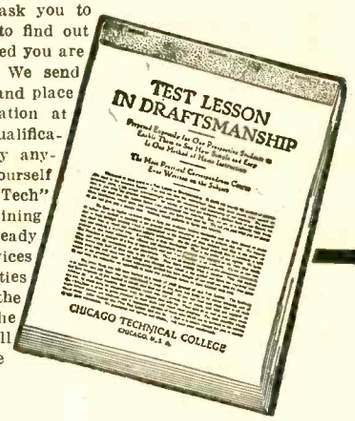

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READ THE CLASSIFIED ADS. ON PAGES 484-486

How the R-34 Crost the Atlantic

(*Continued from page* 438)

bags with hydrogen while at sea. There are three immense drinking water tanks and several water ballast tanks which may be opened to lighten the airship. Everything inside the ship is balanced to perfection, tank for tank, hammock for hammock, and parachutes and life belts for parachutes and life belts on either side. The men eat and sleep in shifts. They sleep in hammocks made of Italian hemp, which are strung from one aluminum strut to another; there are ropes to tie oneself in with. There are ten of these hammocks, three forward, three aft, and two on each side amidships. Two aluminum ladders are connected with the forward and rear gondolas leading between the hydrogen balloonets to the top of the dirigible, where a cockpit opens to the external atmosphere by means of which the observer, taking care not to attempt to stand on the roof while the ship is in motion, takes a "shot" at the sun.

No leather shoes are worn by any of the men around the vessel in order to avoid jarring. Nor are matches allowed inside the envelope at all, everyone using flashlights equipt with miniature electric storage batteries. Inside the ship are found some of the comforts of home, the crew having brought two phonographs to America with them and returning with a third, presented by Mr. Thomas A. Edison. By jabbing a needle into Caruso, they heard him yell all night. In other words, these phonographs were kept going constantly. Lieutenant Durrant asked us not to forget to mention the mascot, a small maltese cat named "Jazz," which he is sure brought them luck on both the journey to America and back home again.

THE AIRSHIP IN MOTION.

The ship is 672 feet long and 150 feet beam at its maximum diameter. The ladders leading to the top are approximately 80 feet high. In order to start the vessel, its moorings are loosened, after which the ship swiftly drifts upward to about 8,000 or 9,000 feet. At this level an equilibrium is establisht and the engines are then started, when the ship proceeds on its course. The speed of the vessel is approximately 49 knots per hour when under full swing with no unfavorable winds, and the men on duty remain at their posts for about four hours, after which they are relieved by another section. For every thousand feet that the dirigible ascends, it loses 1/30th of its volume of gas, and in very heavy foggy weather naturally its normal position would be much nearer to the earth's surface, due to the fact that with a heavier atmosphere it would not be as buoyant.

The ocean viewed from this wonderful craft appears to be a vast blue stretch of prairie, beautifully streaked with green, which is visible thru the rifts in the clouds; every now and then a long white streak forms and rolls along rapidly. Wave motion is not visible at all, but the foam turned up by the wave as it breaks is distinctly noted as the white line of which we have just spoken. On preparing to land, the hydrogen is not allowed to escape, as so many think. The blimp's propellers are kept in constant motion and its rudder is tilted so as to make a nose dive at about a 45 degree angle. Sweeping around the field several times and preparing for a landing place, the vessel comes nearer and nearer to the ground. When all is ready a heavy cable is thrown out from the forward gondola which willing hands immediately grasp, and in addition to this some water ballast is thrown out, giving the landing crew a nice ducking.

While at Mineola, Long Island, the airship was anchored to huge concrete blocks, but because of the terrific resistance such a large body offers to a gust of wind, it broke loose from its moorings, a large hole being torn in its outside envelope. This was repaired in short order, and after that the balloon was held under control by a number of United States soldiers who swung the balloon like a weather vane, so that it continually presented a streamline effect and never broadside to the wind. In this way it was handled for the rest of its stay with no mishap.

An American army portable electric generating station furnished electric current for the searchlights scattered thruout the field, and current for operating the electric gasoline pumps to fill the tanks in the R-34. This outfit represents the latest army type of portable generator, giving about 110 volts and 125 amperes direct current.

Sir William Crookes' Psychical Researches

By Hereward Carrington, Ph. D.

(*Continued from page* 407)

with electricity, and of such a height that it would just fit under the table (see illustrations). Writing of these experiments, Sir William says:

"Mr. Home took the accordion between the thumb and middle finger on one hand at the opposite end to the keys. . . . Having previously opened the brass key myself, and the cage being drawn out from under the table so as just to allow the accordion to be pushed in with its keys downwards, it was pushed back as close as Mr. Home's arm would permit, but without hiding his hand from those next to him. Very soon the accordion was seen by those on each side to be waving about in a somewhat curious manner: then sounds came from it, and finally several notes were played in succession. Whilst this was going on, my assistant looked under the table, and reported that the accordion was expanding and contracting, and at the same time it was seen that the hand of Mr. Home, by which it was held, was quite still—his other hand resting on the table.

"Presently the accordion was seen by those on either side of Mr. Home to move about, oscillating and going round and round the cage, and playing at the same time. Dr. A. B. now looked under the table, and said that Mr. Home's hand appeared quite still, whilst the accordion was moving about, emitting distinct sounds. . . . But the sequel was still more surprising, for the medium then removed his hand altogether from the accordion, taking it quite out of the cage, and placed it in the hand of the person next to him. The instrument then continued to play, no person touching it and no hand being near it."

When Home had hold of one end of the accordion, Sir William Crookes took hold of one of the medium's wrists, and found that *he was not moving a muscle.*

The next experiments were those with a "spring balance." A mahogany board, 36 inches long, was suspended at one end to a balance, supported by a firm tripod stand. See illustration herewith. Any downward pressure upon the board was therefore registered by the spring balance. The other end of the board rested upon a knife-edge fulcrum on a solid table, and directly over the center of the fulcrum was placed a large glass bowl filled with water. Over this, in

(*Continued on page* 442)

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(*Continued from page* 440)

turn, but quite detached from it, being separately supported, was a metal cup, perforated, so as to allow the entrance of the water. The board, thus suspended, weighed six pounds.

It will be observed that by placing the fingers in the metal bowl no added weight was imparted to the board, since this would serve only to displace a small amount of water, which would be registered equally on both sides of the fulcrum.

Mr. Home was asked to place his fingers in the metal bowl, in the water, without touching anything, and requested to *will* the emission from his fingers of the "psychic force," in order to register a depression of the opposite end of the board near the spring balance. He did so, his hands and feet being carefuly guarded (all these experiments being in good light). *A pull of about* 5,000 *grains was registered!* In a number of subsequent experiments, even stronger pressures were measured, which results were permanently recorded by means of a needle, making a graphic tracing of the various depressions and oscillations of the board. The manifestation of some kind of "psychic force" thus seemed to be establisht.

These, however, were but the simple, initial experiments undertaken by Sir William Crookes, which proved to him the reality of "psychic phenomena." His subsequent researches were most striking, including such manifestations as the *levitation or floating in space of the medium's body; the elongation of his body; the movements of objects without contact; playing upon musical instruments without any human hand being near him; the handling of red-hot coals without injury to the medium, and finally (with the medium Florence Cook) full-form materializations, which were seen and photographed by Sir William Crookes, and proved by him to be independent beings, separate from the body of the medium.* Sir William thus enumerates the phenomena witnest by himself:

The movement of heavy objects without contact; raps; the alteration of weight of bodies; movements of heavy substances at a distance from the medium; levitations of tables and chairs, without contact; the levitation of human beings; luminous appearances (lights); the appearance of hands; direct writing; phantom forms and faces; various phenomena indicating intelligence other than that of the medium.

Regarding, for instance, *levitation,* Sir William Crookes says:

"On one occasion I witnest a chair, with a lady sitting on it, rise several inches from the ground. On another occasion, to avoid the suspicion of this being in some way performed by herself, the lady knelt on the chair in such manner that its four feet were visible to us. It then rose about three inches, remained suspended for about ten seconds, and then slowly descended. . . . The most striking cases of levitation which I have witnest have been with Mr. Home. On three separate occasions have I seen him raised completely from the floor of the room. Once sitting in an easy chair, once kneeling on his chair, and once standing up. On each occasion I had full opportunity of watching the occurrence as it was taking place. . . . There are at least a hundred recorded instances of Mr. Home's rising from the ground, in the presence of as many separate persons, and I have heard from the lips of the three witnesses to the most striking occurrence of this kind—the Earl of Dunraven, Lord Lindsay and Captain C. Wynne—their own most minute accounts of what took place. To reject the recorded evidence on this subject is to reject all human testimony whatever, for no fact in sacred or profane history is supported by a stronger array of proofs.

"The accumulated testimony establishing Mr. Home's levitations is overwhelming. It is greatly to be desired that some person, whose evidence would be accepted as conclusive by the scientific world—if, indeed, there lives a person whose testimony *in favor* of such phenomena would be unequivocally taken—would seriously and patiently examine these alleged facts. Most of the eye-witnesses to these levitations are now living (at that time), and would, doubtless, be willing to give their evidence. But in a few years such direct evidence will be difficult, if not impossible, to be obtained. . . ."

Other phenomena recorded by Sir William Crookes regarding the mediumship of Home are still more wonderful. For instance, on a number of occasions, *Home took live coals from the fire, held them in his bare hands, and blew on them until the flames licked between his fingers, and the coal could be seen burning with a fierce heat in his hands.* On several occasions Home asked one of his sitters to touch the coal to assure himself it was hot; he did so, with the result that a large blister was at once raised on the hand. On other occasions, however, Home would apparently communicate his "preternatural incombustibility" to one of the sitters. He would say, "*Now,* touch the coal!" and they would be enabled to do so with the same impunity as Home himself. These phenomena—incredible as they may appear—were vouched for by many witnesses, including Sir William himself, and seem to be among the best-attested of Home's phenomena. The only analogy we have is the so-called "fire walking ceremony" performed in India, Japan, the Fiji Islands, etc.—if we leave out of consideration the historic case of Shadrach, Meshach and Abednego!

Doubtless the most striking tests undertaken by Sir William Crookes, however, were those made with the medium, Florence Cook. These manifestations took place in Sir William's own home—usually in his laboratory—and were of the order of *full form materialization.* Florence Cook, the medium, would enter the cabinet, and apparently go into a state of deep trance. The room being in complete darkness, a white-robed spirit form, claiming the name of "Katie King," would emerge from the cabinet and be seen by the sitters—at times carrying on a conversation with them. Naturally, the question at once comes into the mind: Was fraud possible in this case? Was a confederate employed, or could the medium herself have played the part of the materialized spirit?

It may be taken as certain that no confederate was employed. The tests were conducted, as stated, in Sir William Crookes' own laboratory, and the doors were securely locked before the séance began. No; if any fraud was possible at these times, the medium herself was responsible for it. Could the medium have played the part of "Katie King"?

Writing of this, Sir William says:

". . . Katie is half a head taller than Miss Cook, and looks a big woman in comparison with her. In the breadth of her face she differs essentially in size from her medium, and the photographs show several other points of difference. . . .

"I have the most absolute certainty that

(*Continued on page* 444)

Sir William Crookes' Psychical Researches

By Hereward Carrington, Ph. D.

(*Continued from page* 442)

Miss Cook and Katie are two separate individuals, so far as their bodies are concerned. Several little marks on Miss Cook's face are absent on Katie's. Miss Cook's hair is so dark a brown as almost to appear black; a lock of Katie's, which is now before me, and which she allowed me to cut from her luxuriant tresses, having first traced it up to the scalp and satisfied myself that it actually grew there, is a rich golden auburn. . . .

"One evening I timed Katie's pulse. It beat steadily at 75, whilst Miss Cook's pulse a little time after was going at its usual rate of 90. On applying my ear to Katie's chest, I could hear a heart beating rhythmically inside, and pulsating even more steadily than did Miss Cook's heart when she allowed me to try a similar experiment after the séance. Tested in the same way, Katie's lungs were found to be sounder than the medium's, for at the time I tried my experiment Miss Cook was under medical treatment for a severe cough. . . . ."

Sir William Crookes also took a number of flashlight photographs of Katie—one showing her standing beside him, and one showing Miss Cook, entranced, in the cabinet, with Katie, the materialized spirit, beside her. These phenomena, incredible as they may appear, were nevertheless seen and testified to by a large number of responsible people, and were observed by Crookes himself for many weeks consecutively, and tested in every way possible. These phenomena are among the most extraordinary in the whole history of spiritualism—the most incredible, *and the best attested!* What are we to think of them? That is the question which has been asked for the past half century, and which still remains unanswered! They are the most startling manifestations which Sir William Crookes reported, and will remain forever associated with his name.

In the next issue, "Apparatus Used in Exposing Fake Spiritualists." Another interesting discussion by Dr. Carrington.

Science in Slang

By Emerson Easterling

(*Continued from page* 435)

the eye tends to retain an impression of the filament at full or nearly full luminosity, while the current passes thru zero and the temperature of the filament proper decreases rapidly toward zero. Hence, before the image of the illuminated filament thrown on the eye is lost, insofar as its effect on the optic nerve is concerned, the current and filament temperature has past safely thru the zero point of the style, and started to rise again on the reversed current pulse of the cycle, as I showed you previously.

"As high voltage currents transmit with more efficiency and low voltage currents are more conducive to longevity when placed within reach of the uninitiated consumer, it was found that alternating current would have to neither be partial to the transmission nor the consumer, so the juice peddlers stick in the A. C. generators and hang pots (transformers) to step up the juice for better transmission, and then step her down for the consumers' better health, disregarding the undertakers' scowls."

"That is a pot," Bender said, pointing to a cast iron object on an electric light pole, and looking over at Jazz to see if he was going to censure the statement.

"Yes," replied Punk, "I have noticed them on a number of telegraph poles."

"There is a funny thing," laughed Stokes, "to the general public a pole is a pole—whether telephone, telegraph, light, or power. There is as much difference as there is in nigger, chink, white, or Eskimo. One of the most apparent differences would be found out if you should happen to try to tap in on a high tension transmission line to get the Tia Juana results."

"How is the stuff worked?" asked "Bonehead" Florey. "How is the juice sent from the station where the stuff is manufactured to the kitchen range or cigar lighter?"

"The stuff is first stept up, as I said, then it is stept down somewhat by a substation, generally in the outskirts of the village that the juice is being pumped into. The idea is that 4,000 volts is less likely to cause a massacre if the lines blow down than 66,000, 33,000, 20,000, or the like; so they step it down. Four thousand will transmit the distances from most substations with more efficiency than would the higher voltages—they figure that the line loss is more desirable than the life loss. Some companies step the voltage down to 2,300 again, or direct from the sub-station. Laws, ideas, and convenience have to do with the voltage.

"Then again, the *three phase* effect that the A. C. made possible has put that form of service over the direct current way in practically all power work. The three phase motors have first place in efficiency, you know."

"What is three phase?" asked Bender.

"In alternating currents we have *single phase* currents. The working of the current is generally described on paper by drawing a straight horizontal line representing zero—no current. All above the line is current in one direction, say positive. All below the line negative. The vertical distance from the line represents the height of the voltage. The voltage in a single phase current under ideal conditions would describe a continuous reversed curve, a semi-circle above the line and a semi-circle below the line. It will be seen then that the potential raises from zero to the maximum and to zero, thence to maximum in the other direction. You see the effective voltage is not the maximum voltage, for part of the time there is no flow in the circuit, and part of the time there is more than is recorded on the voltmeter. I guess that explains the single phase.

"Then in actual practise we have *two* and ***three phase*** alternating currents. In the two phase when one circuit is dead, the other is making an impression on the line. In the three phase each wave comes up just as the other is dying and keeps up the 'racket' in a much better manner than is possible for the intermittent single phase, or the two phase."

"And a volt is the pressure on the circuit. An ampere is the rate of flow. The volts times the amperes equals the watts. One thousand watts equals one kilowatt," rambled on Punk. Then turning to Stokes, "Isn't that right?"

"Right," responded Jazz, "and the juice peddlers stick you up so much per kilowatt——"

"Yes," interrupted Bender, "too much."

Speeding Up the Airship

(*Continued from page 397*)

equally light gas, which we do not know of as yet.

On its first visit to the United States, the R-34 proved beyond controversy that the natural element of the dirigible is the air. As long as an airship remains from 300 to 500 feet above the surface of the earth it is comparatively safe, and at this level it will be possible for it to ride out any storm. The airship in this instance is not any different from the steamship, which can ride out any storm, as long as it is in the open ocean. What the steamship fears is the proximity of land or reefs, which usually spell its doom.

The future airship will not land its passengers by coming down to earth, any more than the steamship lands its passengers by climbing upon dry land. The airship will be fastened to earth by means of long thin steel cables from 200 to 500 feet long, and only one or two of these cables are needed; they will probably be attached to either the center or the nose of the airship. The passengers will then be landed by means of a landing passenger and freight elevator built into the airship, as described in our article in the July issue. This idea is also depicted in the above illustration, which shows the portable elevator built into the airship.

Making a Machine for Telegraphing Pictures

By Leroy J. Leishman

(*Continued from page 421*)

of its shaft by about 4 inches. The width of the base should be 8 or 9 inches. It is inadvisable to make these bases from metal, as short-circuits are too liable to occur. Wood is good enough.

Five holes are to be bored in each base as indicated in Fig. 2. A and B are for binding posts. C should be a small hole to accommodate a piece of annunciator or magnet wire. D and E should be large enough for two flexible cords such as that used for light drops. Do not bore E until the machine is practically completed for reason that will be apparent later.

The uprights A (Fig. 1) that support the cylinders must be made of metal. They can be triangular shaped, and should have half an inch of the lower edge turned up to a right angle for affixing to the base (see B, Fig. 1). From this angle to the hole which is to be bored at the top for the cylinder shaft the distance must be at least a half inch more than the radius of the cylinder. The holes in these *must be bored exactly the same distance from the bottom, so that the cylinder will be supported absolutely level.*

The cylinder should be mounted close to the opposite edge of the base to that near which the holes were bored for the binding posts. The binding posts are at the back of the machine, and the cylinder at the front. Mount the cylinder and shaft so that the cylinder comes about 3 inches from the end of the base, leaving about 1 inch between the end of the rod and the other end of the base. One support should be placed against the cylinder and the other about 1 inch from the end of the shaft (see F and G, Fig. 2). Screw the supports in place so that the cylinder is parallel to the edges of the base, and then place the cylinder rod thru the holes provided for the purpose. If Meccano or Erector material is used, collars can be obtained for keeping the cylinder and other parts in place.

Now get a cold-rolled steel rod about 3 inches longer than the cylinder and about ¼ inch in diameter. Have this threaded within a half inch of one end and an inch of the other. No particular pitch is essential, as the progress of the carriage can be governed by other means. The unthreaded ends must now be turned down to the same size as the cylinder rod, so that the same make of gears or pulleys will fit. Then secure a rod about a half inch shorter than the threaded shaft. This rod can be of the same diameter and material as the cylinder shaft.

The height of the supports for these will vary with the material at your disposal for the carriages, which can be made from ordinary telegraph sounders by soldering an extra piece on the end of the arm where the spring is attached. This piece can be the same width and thickness as the original arm of the sounder, but must be at least 3/16 inch square. The length will be dependent upon the diameter of your cylinder and the way the sounder is mounted on its own base. Hold the sounder level and at the same height as the cylinder rod, keeping the end of the sounder with which we are concerned toward the cylinder and the base of the sounder at least ½ inch behind the cylinder. The addition to the arm must be long enough to extend about ⅛ inch beyond an imaginary line perpendicular to the base of the whole machine and extending thru the center of the cylinder when the carriage is held in this position. The phonograph needle, to be placed in the end of this extension arm, will then touch the cylinder right at the top. Drill a hole the size of a steel graphophone needle down thru this extension arm about ¼ inch from the end, when measured from the top, and slightly less than 3/16 when measured from the bottom, so that the needle will set at an angle of thirty or forty degrees. As the needles must be changed, a thumb screw (H, Fig. 2) should be placed in the right side of this arm to hold the needle in place. A Victor or Columbia graphophone thumb screw is satisfactory, and most phonograph repair shops have taps to thread holes to fit.

If you do not have two sounders—one for each machine—the essentials for making the carriage are merely the needle arm, the fulcrum, a pair of electro-magnets, a bar for the magnets to attract, a coiled spring, and a stop to prevent the arm from moving too far up or down.

Under the front of the carriage, near each side, some sort of threaded half-nut arrangement must be provided. It is satisfactory to use a couple of pieces of tin with the edges turned down and slotted approximately to fit the screw or threaded shaft. Place one at each side. Under the back of the carriage two screw eyes can be used for the guide rod to pass thru.

The height of the uprights or supports C (Fig. 1) for the guide rod D and threaded shaft E can now be determined. They should hold these rods at a height which will support the carriage so that the end of the phonograph needle in the end of the arm will touch the cylinder when the arm is in its downward position. These supports can be made of metal, like those for the cylinders, or else from wood. Separate supports can be made for the screw and rod, or else double supports with two holes. *The screw and rod must be absolutely parallel, otherwise the carriage will catch or bind.* They must also be parallel to the cylinder, but not necessarily in the same plane. This means that great care must be taken in boring the holes in the uprights so that the screw and rod will be not only the proper distance from each other, but absolutely the same distance from the base thruout. Be sure, therefore,

(*Continued on page 448*)

Making a Machine for Telegraphing Pictures

By Leroy J. Leishman

(*Continued from page 446*)

that the rod and threaded shaft are straight. Mount these so that the rods extend the same distance beyond each end of the cylinder, and so that the front of the mounted carriage comes about ¼ inch behind the cylinder with the needle at the top of the cylinder directly above its center.

The only place in the whole set of machines where pulleys can be used instead of gears is in connecting the threaded shaft and the cylinder. The pulley I (Fig. 2) for the screw must be larger than the one on the cylinder rod, the exact size depending on the pitch of the threads and how dark or light you may desire the telegraphed pictures to be. The cylinder should make from 60 to 120 turns while the carriage travels 1 inch. After the pulleys are placed on the rods and lined up, put on a cord, elastic band or spiral spring for a belt.

It is essential that the cylinders of both machines turn as true as possible. If they do not do this, bend the rods till they are as perfect as you can make them.

Hole E (Fig. 2) should now be bored about a half inch behind the guide rod D (Fig. 1) and J (Fig. 2), and midway between its two ends.

After both machines are this far completed, they may be wired. Get a piece of flexible fixture cord and cut two pieces about 2 feet long. Peel the ends and scrape the strands of wire till they shine. Inasmuch as it is difficult to tell which one of the wires you want after they are drawn thru the base, it is best to twist both ends of one of the wires in such a way that it will be recognized from the other. Put a pair of these wires thru hole E in the base of one machine, and use the other pair in like manner for the other instrument. Attach one wire to the terminal of the magnet windings on the carriage, and also ground it so that it is electrically connected to the metal arm bearing the phonograph needle. Connect the other end of the same wire to one of the binding posts. The other wire should be connected to the other side of the carriage magnet windings, so that a current in both wires will energize the magnets and lift up the needle. The remaining unconnected end of these wires should be drawn thru hole D (Fig. 2), where it is to be connected to the right side of a two-way battery switch G (Fig. 1). The slack in this wire should be pulled above the base to give the carriage plenty of play. A piece of magnet or annunciator wire should lead from the left contact of this switch thru hole C, and be grounded to the support of the cylinder rod. The main terminal of the battery switch must be connected to the other binding post at the back of the base. Both machines must be connected the same way.

Now suppose we examine these circuits. First turn the battery switch to the contact at the left—the position used when "sending." The current now comes from the binding post to the switch, thru the right contact to the upright and thru the rod to the cylinder, thence thru the needle down one of the flexible wires to the other binding post. When the switch is thrown to the right or "receiving" position, the current passes to the carriage magnets.

Excepting for the gear connections, the machines themselves are now completed, but as no picture can be transmitted unless the cylinders run in *synchronism*, I shall presently explain three ways to synchronize them before showing how to prepare and transmit a picture.

(*Part II will appear in the October issue*)

Popular Astronomy

By Isabel M. Lewis

(*Continued from page 400.*)

his weight would be zero. Continuing from the center to the surface thru the same shaft the weight would increase progressively until the surface value of 150 lbs. was restored.

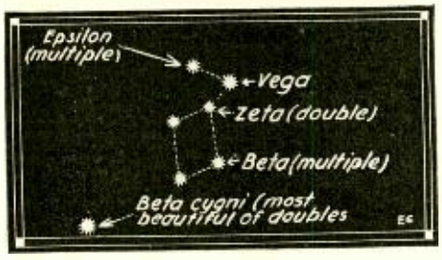
WEIGHT ABOVE SURFACE OF EARTH.

If, on the other hand, it were possible for a man to ascend above the earth's atmosphere he would still be subject to the attraction of the earth (see diagram IV), but the force would *decrease* inversely as the square of his distance from the earth's center, so at a distance of two radii, or 8,000 miles from the earth's center, a man weighing 150 lbs. at the surface would weigh only one-fourth as much as at the surface of the earth, or 37½ lbs. At a distance of six radii, or 24,000 miles, from the earth's center, he would weigh 4⅙ lbs., and at a distance of about 12¼ radii, or 50,000 miles, his weight would be only one pound. If the distance should be increased to four times this amount, or 200,000 miles, his weight would be decreased to one-sixteenth of his weight (at 50,000 miles)—or one ounce.

ASTRONOMICAL QUESTIONS AND ANSWERS.

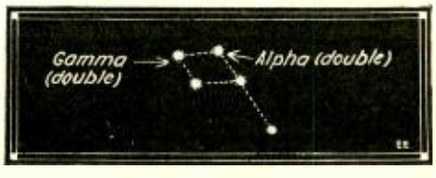
Question 1. What is the sidereal system and sidereal time?

Answer 1. (a) The terms sidereal system, stellar system, and sidereal universe, are all synonymous and refer to the organized system of the stars in which our solar system is a single unit. The stars do not move in a haphazard manner but are governed by some definite law and purpose



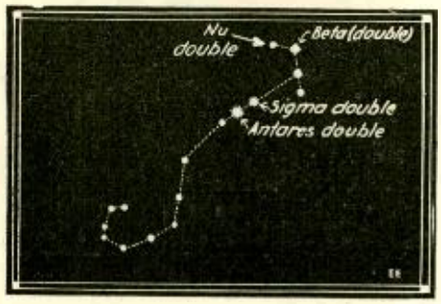
and organized into some great system. To this system belongs the Milky Way as well as practically all the stars, both visual and telescopic, the great irregular gaseous nebulae, the globular star clusters and loosely formed moving star clusters, such as the Hyades and Pleiades groups. It is not yet known whether the spiral nebulae are subordinate units in the sidereal system to which our sun and his satellites belong, or whether they are external systems or external universes independent of our own sidereal system and units along with it in some vaster system.

Answer 1. (b) Sidereal time is "star" time as distinguished from solar time or "sun" time. A sidereal day is the interval between two successive passages of the meridian across the same star. The sidereal time of any place on the earth is zero when the meridian of that place crosses the vernal equinox (point of intersection of the celestial equator and the ecliptic), which is chosen instead of a star as the point of reference for sidereal time. A "solar" day is the interval between two successive passages of the same meridian across the center



of the sun. As the sun appears to move eastward among the stars about one degree a day the solar day is longer than the sidereal day by about four minutes, the time that is required for the meridian of the place to turn thru an angle of one degree and "overtake" the sun. Since the sidereal day is four minutes shorter than the solar day the stars appear to rise four minutes earlier and to come to the meridian four minutes earlier each successive evening.

Question 2. Please name and locate a few double and multiple stars.



Answer 2. An interesting multiple star is Epsilon Lyrae, now visible in the constellation Lyra about 2° N. E. of Vega (on the meridian 9 p. m. Aug. 30). The two wider components are 207 seconds of arc apart and can be distinguished as separate objects by persons with exceptionally fine eyesight. Each of these components is itself a double star and can be separated with a three-inch telescope. Beta Lyrae, about 6° S. E. of Vega, is not only an interesting multiple star but also a remarkable variable with a period of nearly thirteen days and a range of one magnitude.

There are several interesting doubles in addition in this constellation, which is a fine field for a three-inch telescope.

Beta Cygni, about fifteen degrees to the southeast at bottom of Northern Cross is a most beautiful double.

In the constellation Delphinus, known as Job's Coffin, are two fine doubles, Gamma and Alpha. This constellation is a small diamond-shaped group of stars about 30° to the southeast of Lyra.

In the constellation Scorpio (in southern skies in August west of meridian in the early evening) are three interesting doubles, Sigma, Beta and Nu. Sigma is the star just north of Antares, the brilliant red star in this constellation. Antares also has a greenish companion, but it takes a four-inch telescope to separate it. Nu and Beta are about ten degrees northwest of Antares.

200,000 Horse-power in One Hour

(Continued from page 409)

will go out of its way or take a round-about course. However, it notifies the system operator; subsequently these warnings either discontinue, or the rapidity of the signals increases as the storm approaches or dies out. With this storm, however, it was different; it approached with hurricane velocity, and when about one-half to one hour away the bell strikes every minute.

This now became a positive signal that the storm was about to break, and that within a very short time. The fires in the boiler room, which have been banked up to the present time, are now let loose and coaled up. Within a short time "steam is up" in the boilers. The system operator now, by means of telephone or other forms of annunciators, directs the starting of the gigantic reserve generators, so that everything will be in readiness should the storm break. Now the auxiliaries are started. The system operator is warned by the bell ringing continuously, and the device, which

has finished its overtime work, is now short-circuited. There is no further need of warning. The city becomes enveloped in darkness equal to that of night. Suddenly the storm breaks and together with a downpour of rain comes the click of so many light sockets and the pull of so many chains, and we think no more of it. The "juice" is there and we have light.

We never realize how those fellows up at Waterside station have to work in order to supply this demand. There is the crashing of many huge switches, as extra feeders are put into operation, and finally as a last resort powerful storage batteries are thrown into the circuit so as to supply the city with its increasing demand for electricity—and this has been done with no inconvenience and without bravado. Thanks to the Edison service, New Yorkers were able to work at their offices as late as desired, while the house and theater lights blazed forth by the hundred thousand.

Electric Cookery—A Snap!

By Grace T. Hadley

(*Continued from page* 412)

oven switches on *High* for fifteen minutes in advance. Bake paste fifteen or twenty minutes on *High* heat.

Quick Coffee Cake.—Turn oven switches to *High* before preparing cake. Sift together twice one pint of flour with one-third cup of sugar, three heaping teaspoons of baking powder, one-half teaspoon each of salt and cinnamon. Mix to a soft dough with one cup of milk stirred into a well-beaten egg. Add four tablespoons of melted butter and spread in a buttered shallow pan. Sprinkle over with granulated sugar mixed with cinnamon. Bake on lower grate from twenty to twenty-five minutes, turning switches to *Medium* for last ten minutes of baking.

Date Muffins.—Cream three tablespoons of butter with three of sugar and add two well-beaten yolks of eggs, then three-fourths of a cup of milk and two cups of pastry flour sifted with three scant teaspoons of baking powder. Beat well and add the stiffly beaten whites of the eggs and a cup of dates cut into small pieces. Turn oven switches to *High* twenty minutes in advance and muffins should bake in from twelve to fifteen minutes with switches left on *High*.

Advantages of Electric Ranges.

The modern electric range is really a triumph in beauty of design and workmanship. Clear white enamel walls and oven door panel, bright nickel trimmings make this type of range a source of pride and joy to the particular housewife. There is so much labor saved. There are no black bottomed pans and pots to be washed, hence there is a great saving in the matter of cleaning up after the cookery process. The easy control and perfect regulation of the heat establishes dependable temperature conditions. Best of all is the satisfaction of doing good cookery in the most modern way.

"I would not be without my electric range for anything," is the verdict of Mrs. Modern Housewife.

A Dinner Prepared in Automatic Electric Range.

Chicken, 3 lb.; pudding, 1 quart; baked potatoes, six. Place in upper oven; current on thirty-five minutes. Wattage should be 875.

Carrots, spinach, turnips, in three-cluster utensil. Current on fifteen minutes. Wattage 213.

Food cooks in both ovens one and a half hours.

Make coffee in electric percolator, four cups; 167 watts.

Princess Pudding.—Two-third cup butter, one cup sugar, one large cup flour, three eggs, one-half teaspoon baking powder, small glass cider. Rub to smooth cream butter and sugar, add eggs one at a time, beating few minutes after each addition; add flour sifted with baking powder and cider; put into mold well buttered, set in sauce pan in some boiling water; steam thus one and a half hours; turn out on dish carefully; serve with lemon sauce.

Tapioca and Cocoanut Pudding.—One cup tapioca soaked overnight, one quart milk, yolks four eggs, whites of two, one cup sugar, two tablespoons grated cocoanut; bake one-half hour. Make frosting of whites of two eggs, three tablespoons sugar, two tablespoons grated cocoanut; spread over pudding when baked. Set in oven until light brown.

DINNER
Asparagus Soup
Pseudo Roast Chicken
Carrots Espagnole
Baked Tomatoes or Potatoes
Salad
Fruit Tarts Whipt Cream
Demitasse

Pseudo Roast Chicken.—To avoid cold storage chicken and yet have it tender, try the "pseudo roast." Take the cleaned fowl, place it in kettle of water already heated to boiling. Simmer gently in boiler oven, current low, until chicken meat becomes tender; twenty minutes before mealtime baste chicken with butter and place in oven, current on *High* until golden brown.

Carrots Espagnole.—Boil and mash thru a colander two or three bunches of carrots; beat into them melted butter, pepper, salt and cayenne or paprika; add two eggs well beaten and grated cheese to taste; bake in mold and serve turned out on a hot dish; garnish with parsley. It should be as light as a souffle. Cook carrots in boiler oven. Bake tarts, tomatoes or potatoes, chicken and carrots espagnole in large oven.

Electric luncheon to Northwestern Electric Equipment Co. by Edison Electric Appliance Co., Hotpoint Division, January 10, 1919. Menu for forty-five guests:

Celery Olives
Chicken Soup Wafers
Roast Beef, Meat Sauce
Potatoes and Peas in Cream
Sweet Corn in Ramekins
Raisin Bread Sweet Rolls
Head Lettuce Salad
Plum Pudding, Hard Sauce
Coffee Cheese Straws
Van Dyke Cigars

Prepared on electric range by Miss Bell, of the Minn. Gen. Elec. Co.

10 cans soup	469	watts
18 lbs. roast beef	2,325	"
1½ pks. potatoes	1,188	"
2 cans peas, 5 cans corn	300	"
6 loaves bread	1,000	"
5 doz. rolls	700	"
50 portions pudding	1,275	"
70 cups coffee	525	"

At 4 cents per kilowatt-hour, this generous repast was prepared entirely at a cost of 31 cents per person. The operation was in charge of Miss Bell, of the Minn. Gen. Elec. Co., with one assistant, and not only were they on the job only ninety minutes, but the task found them just as sweet and clean as tho they had never seen a kitchen.

Total wattage was 7,782, or 172.9 per person. How was it done? By utilization of one great essential in successful range operation—stored oven heat. Of four surface burners only three were used to a current consumption of 2,682 watts.

$200,000 RADIUM INSTITUTE TO TREAT CANCER.

The establishing of a splendid Radium Institute for Cancer Treatment is being built at Los Angeles, Calif., by King C. Gillette, of safety razor fame. The institute is being established for the study and treatment of neoplastic (tumor and cancer growth) diseases. It will be the only one of its kind in the West, and will employ upwards of $150,000 worth of radium. Mr. Gillette is to be president of the institution, and Dr. Rex Duncan will act as medical director.

In his announcement recently Dr. Duncan, who has just returned from the East, where he studied the use of radium at Johns Hopkins, Harvard and Cornell cancer research institutes, stated that the Los Angeles institute will use more radium and radium therapathic equipment than can be found in all the other territory west of the Atlantic Coast. The building "L" will cover an area 65x38 and 50x36 feet. In addition to its offices and elaborately-equipt laboratories, it will have a large number of beds for patients who find it necessary to remain at the institute for a time.

"The purpose of this institution," said Dr. Duncan, "is to provide unexcelled facilities for radium therapy, and the study and treatment of neoplastic disease. The benefits to be derived will be available to all requiring such treatment, and a fee consistent with the financial condition of the patient will be charged. Any profits earned above those required for the proper maintenance and equipment of the institution will be devoted to scientific and research work."

WORLD'S BIGGEST TURBINE DYNAMO—100,000 H. P.

(*Continued from page* 401)

chine is combined with the flexibility and reliability of three regular independent units.

The entire control of this turbine, together with all the others in the power house, is centered at an electric switchboard located in a room in the upper part of the power house. Here, by merely operating a few dozen small keys, resembling telegraph keys, the operator starts and stops the turbines in accordance with the demands of the transportation system, directs the current into various circuits as required, makes special connections to meet emergencies, and in other ways keeps New York constantly on the move. The responsibilities connected with this work can hardly be over-estimated, since a single error might tie up half of the city's elevated, subway, and surface lines.

In addition to this human control, a system of governors has been devised for the large turbine that automatically takes care of almost every possible contingency. In consequence, the machine practically runs itself and one of the things that strikes a visitor is the fact that workmen are rarely seen on the power house floor.

For the technical reader the following details will be of interest. Superheated steam enters the *high pressure* element at 205 lbs. pressure and dividing into two portions is exhausted into the *low pressure* elements at 15 lbs. pressure. From the low pressure elements it goes into the *condensers* in which a 29-inch vacuum is maintained; 826,000 lbs. of steam are used per hour for the maximum load, and the water rate is below 11 pounds of steam per kilowatt-hour. The generators are each rated at 20,000 KW continuously and 23,500 KW for two hours. Three-phase, 25-cycle current at 11,000 volts is delivered to the substations. The floor space occupied by the entire turbine is only 52x50 feet and its height is about 20 feet.

Photos Courtesy Westinghouse Elec. & Mfg. Co.

Under-Water Surveying by Reflected Sound Waves

By H. Winfield Secor

(*Continued from page* 405)

to the greater sound conducting properties here presented, the velocity of sound wave propagation thru water being about 4,700 feet per second, or somewhat over four times the velocity of sound traveling thru air. Otherwise the sound waves in water behave much the same as they do in air, giving all the echo, reflection and diffraction effects and other well-known phenomena with which we are all familiar.

AUDIBLE AND INAUDIBLE SOUND WAVES.

Mr. Ries has spent a great deal of time on research in the physics of sound wave propagation and reception, and one of his startling statements was the fact that in time of war or for certain other reasons (where multiplex or selective communication might be required in a constricted body of water), it then becomes possible to apply his sound surveying and detecting system by means of *inaudible* sound waves, i.e., sound waves pitched either above or below the normal register of the human ear. The human ear normally does not detect the presence of sound waves at below eight vibrations per second nor higher than sixteen to seventeen thousand per second, altho among radio operators it is common to "hear" at a higher limit of audibility—30,000 vibrations per second. The buzz of the beetle's wings is in the neighborhood of 16,000 to 17,000 vibrations per second, and this is about as high a sound as the average ear will note, unless specially trained. This particular detail is unusually interesting to us, for if audible sound waves have to be relied on to detect an enemy submarine for instance in war time, then the enemy might hear the sound waves.

By means of specially sensitive apparatus well known to engineers and physicists, it is possible by several distinct means to thus utilize for the purpose of solving the location of a distant object under water, by sound wave triangulation *sounds above the audibility of the ordinary ear.* Mr. Ries has devised apparatus which will not only detect such sound waves at two points on the base of a triangle, but also record them.

As Mr. Ries pointed out, it is a simple yet not commonly known fact of everyday physics that a sound that is inaudible to one person may be audible to another person, all depending upon the structure of the outer ear and the thinness and elasticity of the diafram in every case. It has been proven by scientists that there are a perfect multitude of sounds surrounding us all the time of which we have no cognizance, simply because our ears do not ordinarily respond to these abnormal frequency sounds. For example, there are certain insects which make sounds inaudible to ordinary persons, and thus it is believed that they carry on communication between one another. Furthermore, simply because we do not hear a sound, such as produced by Mr. Ries's 20,000 to 30,000 cycle surveyors, while listening at the receiver connected to a submerged microphone, is not a reason why our ears would not under proper conditions pick up and interpret that sound to the brain. If the form of the outer ear, i.e., the shell of the ear, were properly formed with regard to its length and angle, quite possibly the diaframs of our ears would respond. Therefore, it becomes apparent that to hear a certain sound is certainly a case of ultra-mechanics, or building a sufficiently sensitive apparatus to hear a certain sound or range of sounds.

(*Continued on page* 457)

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

Developing an Idea*

By Nelson Hall

NEARLY every one at some time gets an idea that he would like to develop if he knew it was worth while. That is if the field is not already covered or paralleled. It is always a burning question with inventors to know what has or is being done along the line of his idea. In these days when improvements are being made so fast that the patent office issues over a hundred patents a day, it is not uncommon to find, much to the inventor's distress, that some one has covered his cherished idea with a patent or come near enough to be an interference. Realizing the time and money spent in developing, the litigation involved in interference or overlapping of claims, and the disappointment that comes from an invention which has little or no market value, the following information is being offered to those who are developing ideas.

When an idea occurs give it some time and attention. Lay it out in the mind as much as possible, make rough sketches until a clear mental picture is formed. Building models or samples is always very instructive and aids much in producing a working article. At any rate think it out so it can be drawn or some one can be directed to draw it or build it if it is a construction, or go thru the sequence of operations if it is compounding or manipulating drugs or chemicals.

When the conception is developed sufficiently that it can be seen thru all the operations and the parts are in fair proportions, make a complete assembly drawing showing very clearly the new parts, improvements and the novelty. Also write a brief concise but lucid description to accompany the drawing, and take these before a notary public and have one or more of your friends who understand the drawing and description sufficiently to identify them sign as witnesses. If a model has been made photographs of it should accompany the drawing and description. This is much stronger evidence, because it shows that work has actually been done in developing. By these papers and the date affixed by the notary public a record is made that will be taken in court should it ever be needed. Very often the date of conception is of the utmost importance in establishing the priority of claims.

Do not conclude that such documents make it unnecessary to take out a patent, for such is not the case. Should any one secure a patent on the same idea, tho your conception antedated his, it would cost a lawsuit to establish your claims. If too much time had elapsed from the time of the witnessing *the court would consider yours an abandoned idea* unless you could produce evidence of your developing. One should not delay taking out a patent. He should file his application as soon as he knows the idea will work, can be manufactured and marketed. But before one decides how well his idea will work, how suitable it will be for manufacturing and how well the buying public will receive it, some very careful thinking technically and painstaking sounding among manufacturers, prospective users, and salesmen are required.

Every one meets people in several walks of life during each twenty-four hours of the day, and some of these may have just the information desired. By a little artful juggling of words the conversation can usually be shifted to the desired topic and run something like this if, let us say, a tire iron is the idea under consideration:

"I just saw (in mind or the mental picture which was worked out in getting the idea into a working form) a man repairing a tire with a very unique tool. The way he rolled that four and a quarter over the rim beat anything I ever saw, and when it came to replacing it was just as easy."

"What kind of tool was it? I have seen several and have a very good one with my car."

"It was about eighteen inches long with a peculiar shaped hook at one end that slipt under the tire and hooked on the rim, giving an unusual amount of leverage. I understand that it is new and is going to be put on the market soon."

By carrying the conversation further an opinion can be formed whether or not this man who is a user of a car and a prospec-

* Owing to the fact that this special article by Mr. Hall is running this month, the usual "Patent Advice" Questions and Answers will appear next month.

tive buyer feels the need of a new tire iron. Sounding out several such men gives a fair idea of how keenly the public feel the want. This is very essential, from a financial point of view. It is possible for an invention to work perfectly, be a good manufacturing proposition and still not be received favorably by the public.

Often the original patents have expired before the public realized the merits of the invention. This was the case with the typewriter. Offices needed the typewriter, but there were no operators, and it was only after a long and tedious delay of developing operators, educating the public, and perfecting the machines that they became universally adopted in practice. Many of the original experimenters were dead before typewriters found their way from the inventor's shop.

Parallel with this is the modern steam turbine. Mr. Parsons' original patents expired before the turbine was considered seriously as a prime mover by the engineering profession. Mr. Parsons received his returns not from his patents but from his advanced knowledge gleaned from the experimental work which became a priceless asset in his later engineering practice. All this goes to show how important it is for the inventor to realize the condition of the public's wants. Many an inventor has been obliged to abandon an improvement because he could not stay in the game until the public realized its merits. Financial backers are liable to lose interest and withdraw their support if they have "come in" expecting a quick turnover, and it takes several seasons instead. Inventors are prone to be too optimistic about the public's receptivity of their invention and to paint such glowing pictures of success that their organization is sorely disappointed with the volume of business and the financial headway made in a given time.

If one meets a salesman he can adjust the conversation to get an idea of the selling capacity of the article. Will the article be *bought* or *sold?* It has been said there are no life insurance policies bought—they are all sold, and sold by personal solicitation of salesmen. One can describe the article and the plan he has for selling as if he were considering taking an agency himself and ask the salesman for his opinion. "Knights of the Grip" are always ready to pass an opinion, pick up a side line, or while the time away in conversation, so he will tell of any similar article that he may have seen and how it was marketed. If he is favorably imprest, remember him for the future selling force. He may cite to you several ways of marketing this from cases that have come under his observation. It is a very good plan for the inventor to have a feasible selling plan worked out before trying to interest capital.

From a manufacturer one can get some idea of the probable cost of production, necessary equipment, etc. The cost of manufacture is always more or less a stumbling block, but it is one of the three great questions that investors always ask. These are: What does it cost to manufacture, what does it sell for, and how long will it take to get it going? One can, if he likes, submit the whole article to a manufacturer and have him bid on it. But it is preferable to see what the cost of standard parts will be from a trade catalog, get bids on the other parts from screw machine works, stamping concerns, or others specializing in making parts. They will bid on the part in any quantity named from a blue print.

There is a type of man that one is bound to find in his travels, namely, the man with a lot of ideas. He will quickly commence: "I'll tell you what I would like to see and what I would buy if I could find it. I believe it can be done. It's a wonder to me some one has not done it already."

Such a man is often wide awake—he sees

(*Continued on page 473*)

Under-Water Surveying by Reflected Sound Waves

By H. Winfield Secor

(*Continued from page* 454)

We remember one scientific investigator who could hear sounds as high as 38,000 cycles per second.

As Mr. Ries demonstrated, it is very remarkable how accurately a sound can be located, such as a blast from a whistle, if two short curved horns about one and one-half or two feet long are held tightly against the two ears, as shown in one of the accompanying illustrations. Should someone sound a whistle quite a distance away and you then swing your head from side to side, you will quickly ascertain that there is one certain position which will be found to be at right angles to the direction from which the sound emanated, in which a *maximum response* will be heard. It is possible that this method could be used to make a simple *range-finder* for military or other requirements. A very beautiful principle of pure physics was further mentioned at this juncture, and one that probably not one person in ten thousand ever thinks about. It deals with *sight* instead of sound, and the principle of triangulation is clearly illustrated thereby. Mr. Ries said: "Show me a good artist or draftsman and I will show you *the man who possesses abnormally separated eye-balls.*" This does not mean the eye-balls are divergent or convergent as in stigmatism, but that two normally straight eyeballs, having the most accurate observation possibilities, of extreme importance in all perspective drawing and painting, was here enhanced by the fact that the possessor of such a pair of eyes had a *longer base* for his triangulation of sight on a given object than the average man, or one whose eye-balls were spaced abnormally close. This fact is brought out pointedly by referring to the accompanying illustrations. If you are familiar with the laws of simple geometry and trigonometry, or else with the operation of the range finders now in use by the Army and Navy gunners, you will see that the reasoning is correct, and of momentous import indeed.

Mr. Ries's Under-Water Sound Detector.

There are two general methods by which Mr. Ries's highly perfected system of surveying may be carried out by means of sound waves. In the first method it may be applied in charting or surveying a given body of water and ascertaining the formation and character of bottom. In this case it is only necessary to provide at the receiving or measuring station a beam of known length on the extreme ends of which are placed two of the improved sub-aqueous microphones with balanced diaframs, perfected by the inventor. A sound projecting horn is sounded at pre-arranged intervals, and readings are taken as the apparatus is moved from point to point. In order to measure the range quickly, the two pivoted microphones are connected by means of gearing or rods with a calibrated dial placed in the center of the beam supporting the microphone sound detector. This dial moves proportionately to the movement of the microphone, and always gives the appropriate reading for identical angular positions of the microphones. The diaframs of Mr. Ries's subsea microphones are accurately balanced against the water pressure by comprest air, the pressure of which is automatically varied to a nicety in proportion to the pressure of the water, which, of course, increases as the depth of submergence is increased. The horns fitted on to the front of the microphones may also be attuned to a certain frequency.

Where it is not possible to utilize a distant direct source of sound, as in measuring the distance of an iceberg, etc., then *reflected sound signals are used*. As afore-mentioned, a powerful siren or bell is now placed midway between the two microphones, and this is operated in the following manner: By means of an automatic *double contact switch* when the siren or submarine bell is sounded, to send out the *originating* sound signal, the circuits of the receiving microphones are automatically disconnected so that the powerful sounds being transmitted are not picked up, which would prove confusing, if for no other reason. After the signal has been sent out for a few seconds, the switch is thrown to "receiving," and the microphone circuits are re-connected. By this time the sound has died away at the transmitting station, and is being propagated toward the distant point from which the reflection is sought. After a few seconds, and during which time the pivoted beam supporting the two microphones is swung back and forth continually, a sound will be heard which is the echo, if there has been a reflection of the sound, and of course, if there is no reflection or echo, then no sound will be heard. The distance which the echo has traveled can be checked by a stop watch or other chronometer, dividing the time elapsed in seconds before the echo is heard, by two, and then multiplying this value by 4,700, which gives the range in feet. This is not necessary, however, as the automatic range reading scale connected to the two pivoted microphones is calibrated to give both the distance and position directly, once the beam has been swung so as to be at right angles to the point of the original sound, or in the present case the point from which the echo was reflected.

One of the accompanying views shows a diagram of Mr. Ries's *differential sound receiver* for this purpose, and its operation is very ingenious indeed. A differentially wound telephone receiver is used, provided with two windings or coils, one of the receiver coils connecting thru an induction coil as shown to one microphone, while the second receiver connects thru another induction coil and shunt circuit to the second microphone. What happens when a sound is received, is interesting. No sound is heard at all in the receiver, for the following reason:—When the microphones have been properly focust and the sounds localized and picked up in each microphone unit are equal in strength, then the currents passing thru the induction coil circuit to the two differential windings in the telephone receiver are arranged so that they neutralize one another, and as a consequence no sound is given forth by the receiver diafram.

An exceedingly important and timely application of Mr. Ries' invention is that brought about by the World War that is now happily ended, namely, the location and recovery of many of the numerous and costly warships and merchant vessels sunk by submarines, mines, etc., amounting, according to recent estimates,* to more than 18,000,000 tons out of a total world tonnage in 1914 of 42,000,000 tons. Among the original purposes which Mr. Ries had in view in devising his apparatus was the location and salvage of vessels and the preliminary study and charting of their position and condition, *from the surface*, by means of the reflected sound waves which were brought to a focus upon and caused to travel in exploration along the entire exposed part of the vessel, and also over the ground on which she lay. In this manner not only the exact depth and position of the ship is ascertained without the use of a diver, but every part of the ship is plotted as the survey proceeds. A three-funneled steamship, for example, with the widely separated sound receiver horns brought to *a spot focus* upon it, will give

* See article in "Sci. Amer.", July 19, 1919.

three characteristic echoes as the pivoted exploring arm is moved.

Ries Balanced-Flame Sound Detector.

In this case two manometric flames, as shown in the accompanying illustration, are separated by an opaque partition inside of a ventilated glass bell or other cover. The two flames are adjusted to burn with equal brilliancy, and pneumatic comprest air tubes provided with appropriate needle tips are placed at the side of either flame. These two pneumatic tube systems, which are used to cause either of the flames to vary or quiver, are suitably connected to the two receiving microphone-telephones. While the microphones in this case are being focust, there will be a fluctuation of the flames until the beam is accurately focust and the sounds of the telephones are of equal strength, when the flames will become balanced, and each will burn with equal brilliancy and shape.

An interesting experiment, which the reader may like to conduct, is that of causing a focust sound wave to be propagated across a room, and then listening for the focust ray. This will demonstrate one of the principles on which Mr. Ries's invention works. To perform this experiment, all you need is a common garden variety of watch, such as a dollar Ingersoll, which gives a good healthy tick, and this may be placed in a parabolic or other reflector, or even a china oatmeal bowl.

Experimental Under-Water Signaling System.

All that is required for making this experiment is a water-tight tin box, in which is mounted a small buzzer. This buzzer may be soldered to the inside of the metal box, which may be a cocoa tin. The two wires carrying battery current to the buzzer are carried out thru the top of the container thru a piece of small rubber tubing. Where the rubber tube enters the box the joint may be tightly sealed by the liberal application of hot sealing wax. The lid of the box may be sealed tight by thoroly waxing with paraffin.

The receiver is of the microphone type, and any electrical experimenter will be able to make this device very easily with a little ingenuity. There are several ways in which it may be done. The first requisite is a sensitive carbon microphone. A Skinderviken microphone button, which is complete in itself, may be used, attaching it firmly to a ferrotype (iron) diafram about 2¾ inches in diameter. It is best to place solder over the nut on the water side of the diafram to keep the inner chamber of the receptor thoroly water-tight. The receptor may be mounted on a piece of pipe or a metal rod, so as to be suspended over the stern of a rowboat or launch, and provided with a handle so that the microphone and its attached metal horn can be swung in different directions. One side of the circuit may be completed thru the metal suspension of the microphone apparatus, and the other side of the circuit thru an insulated wire leading up above the water thru a rubber tube. All joints around the microphone should, of course, be made water-tight, but this is not very much trouble where a simple experimental apparatus is under consideration. The microphone diafram should be fitted with substantial rubber gaskets on front and back, and then the base of the horn and the rear casing of the microphone thoroly bolted together to form a compact whole by means of a number of small stove bolts or machine screws and nuts placed around the perifery of the chamber, as shown in the drawing. This is due to Christian Berger.

An ordinary 75-ohm telephone receiver, or a pair of them, are connected up with a dry cell or two in circuit with the microphone at the receiving station. All is then ready to try out the transmission of sound signals thru water.

"Audions on A. C." Correction

In the article entitled "Operate Your Audions on A. C.," by Elliott A. White, published in the July issue of the ELECTRICAL EXPERIMENTER, page 234, an error occurred in the statement of the formula in the center column of page 234. The multiplying factor in the numerator of the equation should have read 6.25 instead of .625. Also the second line at the top of column three should have read 1 ampere instead of 0.5 ampere.

We are pleased to add the following information contributed by Mr. White since the publication of the original article, and which we believe our Radio friends will be very glad to procure, especially in view of the high technical standing of the author, who was formerly Radio instructor at the *Carnegie Institute of Technology*. The additional information follows:

"If the tubes of the rectifier are of the high internal impedance type, they must pass at least as much current as is required by the plate circuit of the receiving tubes; and if the tubes of the rectifier are of the low internal impedance type (such as the G. E. Co.'s *Tungar* tube), a current-limiting resistance should be inserted in the lead from the middle of the transformer windings T3 T4, to protect the tubes. As the filaments of these tubes require only 2 volts, but a correspondingly heavy current, the transformer windings T5 T6 would have to be wound for 2 volts with heavy wire. There is another simple way of connecting the rectifier to the transformer, whereby all the windings are in series and the plates in parallel, but to avoid confusion this method is not given. Any connection or design adopted by the experimenter is satisfactory, so long as it is adapted to the kind of tubes used, whether they are transmitter tubes, receiver tubes, commercial tubes, or home-made ones."

TRENCH USE OF TELEPHONE WIRE.

Telephone wire is the *sine qua non* of the trenches. It is used to hang pictures on the walls of the dugouts, to mend cots and to make them. Men who have been "over there" have said that frequently soldiers have stopt in their pursuit of the Hun to gather bits of telephone wire lying along the blood-soaked fields of No Man's Land.

De Forest Defends His Three-Electrode Audion

(*Continued from page* 428)

gave off torrents of negative electricity. This discovery was made before anything was known of electrons, but Dr. Fleming had persisted in his efforts, directed towards rectifying alternating high frequency currents, and eventually by an exceedingly pretty contrivance, was able so to control and study the current as to suppress all the oscillations in one direction by the Fleming valve. This was improved on later by Mr. Marconi, and the present three-electrode valve, with its contrivances for audio-magnification, three times repeated, was finally evolved. Two currents being coupled and exalting each other made an exceedingly sensitive detector, and the lecturer remarked that this might be tested by placing the receiver and the transmitter of a telephone together, when all the little noises in the room were picked up and a whistling sound produced. Thus, with the modulation of the waves to the human voice, the problem of radio-telephony was solved, and great developments were to be expected.

"Conversation with ships would be practicable, as man to man in the same room, and also Trans-Atlantic telephony. The Premiers of the Dominions would, he anticipated, be able to take part in a cabinet meeting in London by vocal intercourse, tho their bodies were thousands of miles away."

The protest of Dr. de Forest is contained in the following letter:

Editor of *Morning Post*,
London, England.

Sir:

I have just read the paragraph in your issue of February 25th entitled "The Future Telephone," a resume of a Cantor lecture by Prof. Fleming. Prof. Fleming's lectures have usually been so clear and instructive that I am astonished to see him now quoted as having made statements widely at variance with well known facts. In the recent testimony before Mr. Justice Spencer in the unsuccessful attempt before his court by the Marconi Company experts to prolong the "Fleming valve" patent it was admitted by the Marconi experts (Prof. Fleming himself being present at the trial) that the Fleming valve did not amplify, that it only rectified the weak currents received in wireless signalling.

As a matter of fact, well known to radio engineers, the true Fleming valve has itself been of exceedingly small value in the modern wireless art. And Fleming did not improve it. It is a three-electrode vacuum tube, called by myself, shortly after its invention, the "Audion," which, if I may say it in all modesty, has brought about all those wonderful advances in radio signalling.

The Audion and not the Valve made possible the trancontinental wire telephony —the Audion and not the Fleming Valve, used as an oscillator at the transmitter, and as detector, and then amplifier at the receiver stations made possible transoceanic radio telephone in 1915, and again this year between New Brunswick, N. J., and the S. S. *"George Washington"* in Brest Harbor.

I cannot believe that a scientist of Prof. Fleming's standing would knowingly lend his name to any deliberate attempt to mislead the public in stating, or artfully inferring that Marconi improved the Fleming valve and produced the three-electrode device. Neither do I believe that a paper of the standing of the *London Morning Post* would knowingly lend its columns to any unfairness or pettiness in withholding the credit due an American inventor, altho there always has been and there still is plenty of evidence to show such an unfair and petty attitude on the part of certain British interests, especially in the United States. Marconi had no more to do with inventing a three-electrode device or Audion than the Kaiser, altho both have made good use of it, since an American produced it and demonstrated its limitless possibilities.

In the interest of fair play and scientific fact, I ask you to publish this communication. (Signed) LEE DE FOREST.

CORRECTION NOTICE.

Courtesy for the photographs used in illustrating article entitled "Airplane Antenna Reels" on page 324 of the August issue, should have been given to Emil J. Simon, Inc.

The "Fog Warning" Radio Telephone

(*Continued from page* 426)

third repetition the warning, "You are getting closer, keep off!" is sent out with a limit of range of about two miles. These signals are sent out during fog, mist, rain, and falling snow.

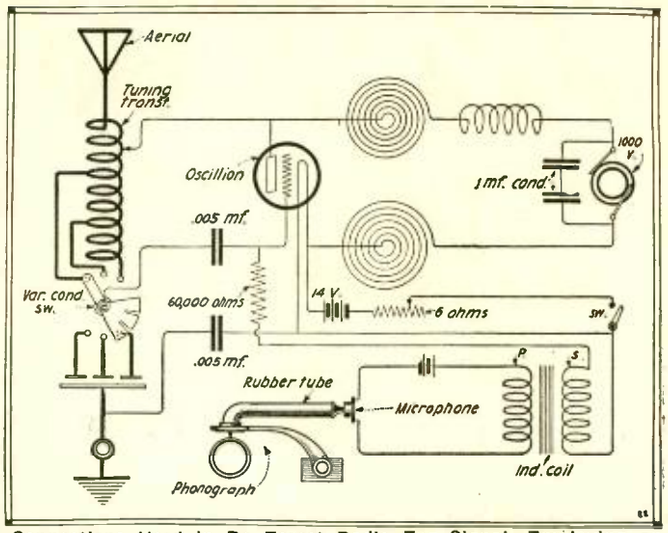
When sent out by *radio* the signals can be heard with any suitable or well-known wireless telegraphic telephonic receiving apparatus which may be employed to receive, detect, or reproduce the emitted or radiated signals. Crystal detectors may be used. The signals are sent out now on a first wave length of 600 meters.

If the transmitting and receiving apparatus is equipt for graduated strength musical note signals, these will be received by a ship at sea; for instance, suppose the ship receives the note corresponding to the Middle "C"; then it will be known that the lighthouse is four miles away.

If both the middle "C" and the "E" and "G," are detected at the receiving station, the distance is two miles, and if all four notes are heard, then the distance away is one mile or less, and so on for any other pre-arrangement and adjustment of the sounding apparatus.

This invention is bound to be a great help to all mariners and the system is a direct innovation over any that have heretofore been tried. Doubtless many disasters and wrecks will be avoided and in general to make navigation safer.

Every important lighthouse and lightship on the U. S. coasts will be fitted with this new Radiophone "fog signal."



Connections Used in De Forest Radio Fog Signal, Employing an Oscillion Bulb to Generate the Transmitting Oscillatory Current.

EMIL J. SIMON WINS CANADIAN LAWSUIT.

The Marconi Wireless Telegraph Company of Canada, Limited, the plaintiff in a Canadian radio patent suit, recently released and discharged the American Wireless firm of Emil J. Simon from and against all claims and demands set forth in the Statement of Claims, and further stated in their disclaimer that it will not institute any other proceedings against the defendant, Emil J. Simon, in respect thereof. This notice was dated Montreal, June 7th, 1919.

A competent English authority says that English central station managers realize that lighting is fast becoming the small end of the electric central station's income, and power and appliances are to be the main sources of revenue in the future.

The How & Why of Radio Apparatus

By H. Winfield Secor

(*Continued from page* 431)

comprising a four-wire inverted "L" aërial, the wires being spaced about 2½ feet apart.

However, where long distances are wanted, it becomes necessary to use longer aërials.* The reason for this is that, to gain the highest maximum results in any radio transmitting or receiving circuit, the antennae oscillatory circuit down to earth should be able to vibrate at a frequency approximating its natural period. Hence, it is seen that for this reason, it is necessary to use a long aërial, having in consequence a long wave *natural period* in order to pick up efficiently such wave lengths as 12,000 or 15,000 meters. This is not the whole story, either, for another important factor is that the longer the aërial, the more energy will be picked up from the rapidly moving etheric wave front, as it passes across the antenna wires. This may be compared for analogy to the electromagnetic field. In a dynamo or motor you will recollect that the longer the wire, the more magnetic flux it will intercept in its rotation in the field, with a consequent greater potential produced in the moving conductor. In the case of radio transmission, the conductor is stationary, while the electrostatic field moves and thus cuts the wire, inducing an electric current in the wire. It is this induced current which operates the detector in the receiving set.

*See "Calculation and Measurement of Inductance"—in the September, 1917, issue of this journal.

As a guide to the young radio designer, the accompanying graph chart is given, which shows the natural wave lengths of four-wire antennae of various heights and lengths. These values were computed from data given by Dr. Louis Cohen. A common rule for calculating approximately the wave length in meters of a simple antenna system, without any coils or other apparatus connected with it, is to multiply the length of the flat-top, plus the length of lead-in wire to earth, in meters by 4.5. This rule applies to inverted "L" type aërials. It is also applicable to "T" type antennae, but here the length of wire considered in meters is the lead-in length to earth, plus *one-half the length of the flat-top.* The factor 4.5 varies under different conditions, as, for instance, where metal roofs may change the natural capacity of the antenna. But it serves very well for approximation, and has been very extensively used.

Mathematical Calculation of Antennae Wave Lengths.

In a previous paper the writer had the following to say in regard to the wave length of radio antenna and the value of tuning inductances in the aërial oscillatory circuit.

Having theroly discust the methods of both calculating and measuring the inductance of coils, we are now in a position to continue with the design of the most im-

(*Continued on page* 464)

The How & Why of Radio Apparatus

By H. Winfield Secor

(Continued from page 462)

portant type of inductance coils used in radio work. We will confine ourselves to the types of coil which are mostly used, namely—loading inductances, loose couplers, variometers and transmitting oscillation transformers.

Before we delve into the actual design of these coils, however, let us first consider the fundamental facts necessary for the design. Since the inductance is employed in building up the proper oscillating condition of the circuit and consequently the wave length, we can express this relation by the following formulæ:

We have first the formula expressing the wave length, *W.L.*, of the open (antennae) oscillatory circuit, thru the primary, L_o, of a loose coupler, loading or tuning coil.

$$W.L. = A\sqrt{L \times C}\ ; \qquad (1)$$

where:—

A = a variable, ranging from 38.15 to 59.6 for short wave length. (See curves for various values of *"A"* in article cited below in February, 1917, issue.)

L = total inductance in centimeters of aërial, including lead-in and loose coupler, tuning coil or loading coil.

C = capacity in micro-farads of aërial, including lead-in.

Those interested in this subject should refer to the excellent article on "The Design of Large Radio Receiving Transformers," by C. S. Ballantine, in the February, 1917, issue of this journal, page 732. The variable factor, 59.6, appearing in the usual wave length formulæ was there discust at length, with a graph giving the different values of this function for various wave lengths and aërial inductance to localized inductance ratios.

Considering long wave lengths (10,000 meters and higher) and the design of large loose couplers we are safe in using the expression:

$$W.L. = 59.6\ \sqrt{L \times C}\ ;$$

where:—

L = inductance of loose coupler primary and loading coil (if used); the inductance of the antennae being neglected, owing to its small value compared to the inductance of the loose coupler (or loading coil).

C = Capacity of antennæ, including lead-in.

For designing short wave apparatus we shall call L_o the value of the loose coupler (or tuning coil) primary inductance. Then we have:

$$L_o = \frac{\lambda^2}{3552 \times C} - L\ ; \qquad (2)$$

here:—

L_o = inductance of load (loose coupler, tuner, etc.), in centimeters.

λ = maximum wave length to be tuned to.

L = inductance of antenna and lead-in in centimeters.

C = capacity of antenna and lead-in in micro-farads. (See tables herewith for these values.)

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

$$L_o = \frac{\lambda^2}{3552 \times C}\ ; \qquad (3)$$

with all values the same as in formula No. 2.

The following tables will be found useful in applying the above equations to the design of loose couplers, etc.:

TABLE "A"

Cap. in M.F., Including Lead-in, of 4 Wire Inverted "L" Aerials. Wires Spaced 3 Ft. Apart

Height	Length of Flat-top in Feet			
	60	80	100	120
40....	.00033	.00042	.00051	.00060
50....	.00035	.00043	.00050	.00058
60....	.00036	.00044	.00051	.00059
70....	.00037	.00045	.00052	.00059
80....	.00039	.00046	.00053	.00060
90....	.00040	.00048	.00055	.00061
100....	.00042	.00049	.00056	.00062

TABLE "B"

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

Height	Length of Flat-top in Feet			
	60	80	100	120
40....	35,000	41,100	47,200	53,310
60....	48,800	55,460	62,090	68,700
80....	62,400	69,320	76,300	83,300
100....	76,260	83,500	90,750	98,020

It is possible to determine approximately the inductance required to produce a desired wave length when the capacity of the total oscillating system is known. When using any of the above formulæ, it should be remembered that they include the *total value* of the unit. Thus, the capacity factor includes the antenna, and condenser capacity, each of which must be determined separately and the capacity of the antenna must be obtained by actual calculation, formula for deriving this quantity having been given on page 732 of the February, 1917, issue of this journal, as well as a table of the capacities of a four wire antennæ of different lengths and heights.

The first step in the design of an inductive tuner (having determined the wave length) is the actual size of the instrument, and from this to find the approximate dimensions of the winding tubes to be used. Having these on hand, and knowing the maximum inductance of the primary by equations (2 or 3), we can immediately determine the number of turns that the primary coil will require to obtain the wave length sought, by solving equation (3) of (Part 1, March, 1917, issue) for *N*.

The inductance of the secondary winding should be such that its wave length should correspond very nearly to the antenna circuit, and that of the primary. If this condition is to be obtained, then we have an ideal condition of maximum efficiency and great care must be exercised in bringing about this ideal condition. The value of the secondary inductance must therefore be in the neighborhood of the primary (unless it is to be shunted by a variable capacity), but in practise it is made somewhat larger than that of the primary. It is customary in coupler design to allow one-half inch difference in size of diameters between the primary and secondary tubes and therefore the diameter of the secondary can readily be determined The number of turns required is deduced from equation given in the September, 1917, issue.

Details of Aërial Construction.

When it comes to discussing details of amateur aërial construction, one could almost write an encyclopedia of several volumes, for in traveling about the country, it is amazing to note the many different ideas followed in building antennæ. This is so for many reasons, not simply because one Radio Amateur wishes to have something different from his fellow Amateur across the street, but in a great majority of cases his pocketbook controls the design. And so it is that instead of using beautifully molded ten-inch Electrose insulators on his aërial, you may perchance bunk into one of the greatest freaks of modern times, a real dyed-in-the-wool Amateur antenna—constructed from about six kinds of wire, including some good old iron hay-baling wire, and a variety of insulators that would win first prize in any freak photo contest, made from miscellaneous odds and ends,

including beer—excuse us, *near-beer*—bottles, porcelain cleats, waxed wooden rods, pieces of crockery and other choice bits of "backyard junk."

So it is seen that there is a wide latitude in ideas, and good ones, too, in many cases, let it be said, for building an experimental wireless antenna of fair efficiency. Your average Radio Amateur does not care so much about the "looks" of his antenna as he does about the fact as to whether or not he can sit down in his little coop with his apparatus about 10 P. M. and hear "Carnarvon" calling one of his Britannic Majesty's cruisers lying off the Canadian coast! That's the life that cheers.

Figs. 5 and 6 show several practical and approved developments in aërial design, which are not only efficient, but simple as well, in their application. Fig. 5 shows a typical elevated aërial spreader, which may consist of a length of stout bamboo, or a very good spreader is composed of cypress or oak sparring, about two inches square. The best shape for the spar is to make it about four inches broad at the center, so as to give it greater strength against bending. For ordinary work the Amateur usually winds several turns of wire around the spreader, and then fastens his insulators to it. A good construction, however, is afforded at very small cost by having a blacksmith (or else you can make them yourself) bend up a few eye-bolts, as shown in Fig. 5. These may be made from ⅜ inch round, wrought-iron bar, threaded at one end and provided with a washer and a nut or two. The iron and wood work on the aërial should be thoroly painted, of course, before erection, so as to withstand the weather. A heavy red or white lead paint is advised. If the antenna is to be used for "Receiving" only, four insulators are placed at both ends of the flat-top at the spreaders. Where the very highest efficiency is desired, extra insulators may be placed in the suspension ropes holding the spreader, as shown at X. This is the standard of aërial construction, but a much simpler form which has been extensively used in commercial practice, on ship stations particularly, is that shown in Fig. 6. Here no insulators are used in the flat-top part of the aërial proper, but they are placed in the main suspension ropes, as shown at X. This insulating scheme effectually insulates the aërial, of course, and a piece of brass or iron pipe may very well serve as a spreader, connecting the wires of the flat-top to the pipe, by winding the ends of the wires around it. It is the best practice to run a jumper wire across the strands, soldering this thoroly at the joints. This applies to the free end of the antenna; no jumper wire being required at the opposite end, where the lead-in rattails are led off. In any case all joints in the aërial circuit thru which radio frequency energy has to pass, *should be carefully soldered*, or else a very good design of clamp should be used, packing the cleaned wire joint with tin-foil before tightening the clamp. The jumper and rattail connections for inverted "L" and "T" type aërials are clearly shown in Figs. 1 and 2.

Kind of Wire to Use in Aërials.

"What kind of wire should I use for constructing my aërial?" "How many feet long?" and "What altitude?" are questions frequently repeated, and these are not simple ones, either. However, the Radio Experimental fraternity may count itself lucky in the respect that the size of wire for the antenna is pretty well standardized. For Amateur antennæ, it is common to use a wire corresponding in size to No. 14 B. & S. gage solid conductor. Where stranded cable is used, and which possesses a much lower *high frequency* resistance than a solid conductor of equal diameter (owing to its greater surface area, which

is the only part of the conductor traversed by the radio frequency currents), then a seven-strand cable is commonly employed. Seven strands of No. 22 or 24 wire constitute a common size of cable for experimental work, while a heavier cable is used in building commercial and Government stations. There are several kinds of wire in use for aërial construction. Aluminum wire was used previously, but it is very difficult to make a good soldered joint with aluminum wire, and for several other reasons it has not been used very much in latter-day practice. A very good wire for amateur work is a plain solid copper conductor, No. 14 B. & S. gage, or heavier, which may or may not be tinned. A good stranded cable for this work is one comprising seven strands of tinned copper wire. Another standard cable is a seven-strand one composed of phosphor bronze stock, which is of course very strong and suitable for the extra long spans. Still another form of wire in use for experimental aërial construction is copper-clad steel wire, which possesses greater tensile strength than any other equal size electrical conductor. The radio-frequency currents pass thru the outer copper jacket. Plain iron wire alone has been used, but is not very satisfactory.

Grounding Connections.

The matter of grounding antennæ, especially of the elevated type, is very important, markedly so in the case of *thunder-storms*. Also the *Fire Underwriters'* rules have to be carefully heeded in this respect, which apply to every building on which *fire insurance* is carried. The safest method to follow in any event, for your own protection, as well as keeping in conformity with the Fire Underwriters' rules, covers the following recommendations for the *grounding of radio antennæ*.

These regulations call for a ground wire connected to a first-class ground plate or pipe running down to damp earth, or to the street side of water mains in cities, this ground wire being composed of No. 4 B. & S. gage solid copper conductor. The ground wire connects to a grounding switch rated at 600 volts and 100 amperes. The regulations do not specify what size of lead-in conductors should be used, but it is apparent and obvious that if you intend to conduct a heavy static surge or induced charge from a thunder-storm down to earth thru this massive switch and ground wire, that you certainly would not make a lead-in of No. 14 gage wire, like so many amateurs have been wont to do in past years. The right way to do this is to construct the lead-in wire of No. 4 B. & S. gage solid copper conductor or its equivalent in cross-sectional area, such as by employing two or more wires of smaller size stranded together. Good Radio Engineering practice calls for rattail leads brought down from each strand of the aërial to be of equal cross-sectional area to the aërial strands proper, and then bunching these rattail leads into the lead-in joint at the bottom of the fan-tail construction. All of these joints, as aforementioned, should be SOLDERED. The rattail leads should be brought into an aërial connector of some kind before being soldered, so as not to depend upon the solder alone for mechanical strength or electrical conduction.

The *Fire Underwriters'* rules further stipulate that this lightning ground and switch should be placed on the exterior of the building in all cases, and furthermore, that this *ground* which has just been described in detail, should be separate from the station ground. It is the usual practice in experimental radio stations to place the aërial grounding switch either on the window-sill or on the side of the window, and, of course, it should be covered with a metal or other box, so as to protect it from rain

and snow. In running the ground wire down the side of a building, it need not be insulated and bare copper wire is generally employed. Fig. 4 shows one form of efficient ground for lightning protection or for the regular station grounding purposes. This ground is composed of a piece of galvanized chicken wire buried from three to five feet in the earth between two layers of charcoal. The depth to which the ground plate is buried will depend upon how dry the top soil is. *The ground plate must be placed in wet earth*, no matter if it has to be buried twenty feet deep, unless some provision is made to keep the earth in this vicinity moist, such as by daily watering, or else by allowing a waste pipe from some water system to empty over the spot.

Types of Masts.

When it comes to masts or towers for supporting the elevated type of antenna, there are many different styles. One of the latest events in radio is the "Tree Aërial," as devised by Maj.-Gen. George O. Squier, which was described in detail, with special drawings, in the July, 1919, issue of the ELECTRICAL EXPERIMENTER.

This represents one form of natural elevation for supporting aërials or aërial conductors at a considerable altitude, and another one is the balloon or box kite. The average Radio Amateur does not care so much about details on the construction of radio masts, for in practically all cases he will follow his own intuition in making use of whatever material and facilities he may happen to have on hand. For example, some antenna masts used in the past have been of the latticed wood form of construction, while others of the iron pipe type have been erected to considerable heights. We remember one mast of iron pipe construction in the vicinity of New York City which rose to a height of 110 feet. For safety's sake, such a mast should not be constructed with too small a pipe at the base, and for altitudes of 75 to 100 feet, the first and second base sections of the mast should comprise standard heavy wrought iron pipe not less than 3 to 3½ inches in diameter. Needless to say, the iron pipe should be either galvanized or else thoroly painted before erection, and very carefully guyed by stranded steel cables attached ⅓, 2/3 the altitude and at the top. Long guy wires should be split up into sections not exceeding 20 feet, by means of strain insulators.

Aërial Insulators.

Various forms of commercial and home-made aërial insulators are shown in Figs. 7 and 8. Fig. 7 illustrates the commercial, fluted type of molded Electrose insulator, as well as the Electrose ball insulator. Where greater efficiency is desired, several of these insulators are connected in series to give a high resistance. Porcelain cleats are often used in constructing small experimental antennæ, and serve the purpose quite well. Another detail shown in Fig. 7 is an aërial insulator made from a piece of hard rubber, polished or unpolished (Bakelite is best), the two ends of which have threaded screw eyes as indicated. A tin or galvanized iron water shield is made to clamp at one end of this hard rubber insulator in order to ward off rain, and thus keep the insulator in a better working condition during inclement weather. It is absolutely impossible to obtain any long distance results for *transmitting* or *receiving* with rain pouring down on the insulators; for a considerable amount of the energy induced in the aërial conductors will leak to earth thru the water covering the insulators. The commercial radio companies have overcome this difficulty by placing cable shields on the antenna insulators in this fashion in a great many instances, and undoubtedly will use more of them as this fact is better appre-

ciated. Figs. 7 and 8 show novel ideas for constructing antenna insulators from porcelain tubes. Of course, the small tubes are not of much use, generally speaking, but the large size tubes, measuring about 12 inches long by 1½ inches in diameter, are cheaply purchased, and make very good insulators. Of course, the main question here is "How can the screw-eyes be securely anchored?" and several suggestions are given in the drawing herewith. In one case the screw-eyes have their lower ends twisted spirally with the largest diameter at the base, so as to hold firmly in molten sulfur; or the screw-eye may be held by slotted wooden blocks cut so as to expand and wedge against one another inside the tube. Fig. 8 shows a detail drawing for making a pair of brass or iron clamps which will make a very substantial aërial insulator from any stout porcelain tube.

THE HOW AND WHY OF RADIO APPARATUS.

Series to Date.

No. 1. *The Induction Coil, Page* 493, *November,* 1916.

No. 2. *The Transformer, Page* 656, *January,* 1917.

No. 3. *Condensers, Page* 735, *February,* 1917.

No. 4. *Spark Gap, Page* 113, *June,* 1917.

No. 5. *Radio Transmitting Inductances, Page* 537, *December,* 1917.

No. 6. *Radio Receiving Tuners, Page* 685, *February,* 1918.

No. 7. *Radio Receiving Condensers, Page* 766, *March,* 1918.

No. 8. *Detectors, Page* 30, *May,* 1918.

No. 9. *Telephone Receivers, Page* 176, *July,* 1918.

No. 10. *Radio Amplifiers, Page* 472, *November,* 1918.

No. 11. *How to Make and Use a Direct-Reading Wave Meter and Decremeter, Page* 874, *April,* 1919.

Radio men everywhere will undoubtedly like to obtain the complete set of these specially prepared papers on the "How and Why of Radio Apparatus." Also the following three important and timely papers on the "Calculation and Measurement of Inductance," by Mr. Secor and Samuel D. Cohen.

Nos. 1, 2 *and* 3 *"Calculation and Measurement of Inductance," appearing in the March, April and September,* 1917, *issues.*

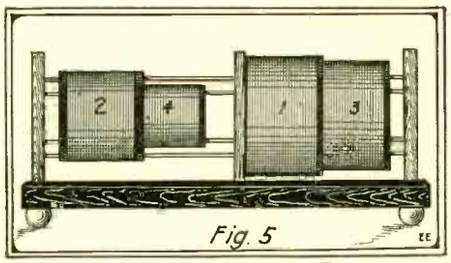
Those interested in these valuable papers can obtain prices of individual back numbers containing them by writing to the "Circulation Department."

In closing, it may be said that the Amateur Radio man will learn much by close observation and the application of common sense and everyday electrical technique to his antenna structures. Don's use faulty lead-in insulators to bring the aërial current into your radio shack—buy a good one, even tho it costs a few dollars. An excellent one is that made of molded Electrose, with threaded tightening flanges. A hole drilled thru the center of a piece of glass, hard rubber or bakelite sheet, at least one foot square, makes a very excellent lead-in insulator. Don't tie your aërial so tight that in a wind-storm it will break at the first swing; suspend one end by a counterbalance weight, or else by springs, so that the flat-top can expand at least 5 to 10 feet in a 100- to 150-foot span. Watch your aërial's behavior in your first wind-storm and you will learn more than by reading several books on the subjects.

Eccentric Antennae

(*Continued from page* 432)

the general efficiency of the aërial, but serves to protect it from corrosion. As to the relative merits of the two kinds of wire, there seems to be some doubt. The operaters using each kind declare their own particular kind the best.

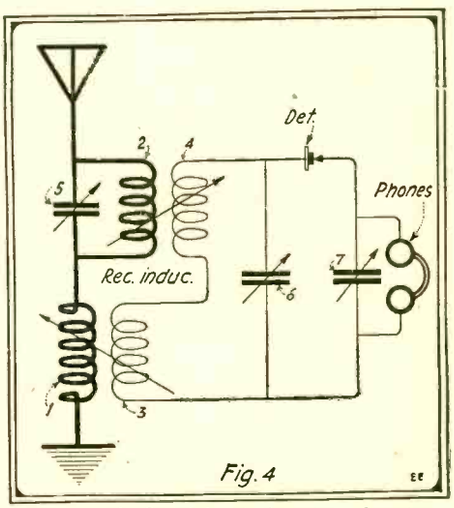


Side View of Special Receiving Transformer Having Four Coils. 1 and 2 Are Primaries, While 3 and 4 Represent Secondaries. This Affords Very Fine Tuning.

There has also been some discussion as to the relative merits of the two forms of aërial—i.e., the *flat-top* and *barrel* types. There is no doubt, however, that the barrel type has far more capacity for the same length than the other. But it also, apparently, would help to increase the static in the phones.

The United States Government has evidently found some very excellent advantages in it tho, for it has adopted the barrel type for use on all its battleships, and has practically abandoned the use of the flat-top aërial on them. It was first tried out by our battleships that were working in conjunction with the Allied fleet in the North Sea.

No doubt the up-to-date Amateur will be glad to give these different antennae a try-out.



Hook-up of Special Variometer Coupler, Provided With Four Coils, Two in the Primary and Two in the Secondary.

NEW HONOR FOR SIR OLIVER J. LODGE.

On June 6th at Clarence House, the Duke of Connaught presented to Sir Oliver Lodge the Albert Medal of the Royal Society of Arts, which was awarded to the famous scientist "in recognition of his work as the pioneer of wireless telegraphy."

BARGAINS IN RADIO MASTS.

What with the great epidemic of underground antennæ now sweeping Amateur Radiodom, we should shortly see radio masts given away for the asking. What?

New 1 K. W. Quenched Gap Transmitter

(*Continued from page 427*)

switch has been named a "Tone Clearer" because poorer tone conditions due to changed operation in the gaps may be compensated for by rotating the handle at the left of the holder as shown in Fig. 3. Precaution is urged never to use the power changer or gap changer with the current on, as the shaft and handle are "alive."

Each gap unit consists of two brass discs which are bolted together thru their centers. A silver ring electrode is riveted to one side of each disc. Two fish paper gaskets, one placed underneath the bolt head and the other between the interior face of the discs. Upon close scrutiny these gaskets will be observed in the gap in the photos herewith presented.

Proper cooling of the gap is afforded by the two sheet metal parallel flanges, which are placed integrally with each gap disc. These flanges join each other at two edges only, the other two edges being left open, forming a flue.

The resonance inductance which is furnished with this set is of the iron-clad type. It has two windings, one being for full power operation, the second, which is larger inductance, is for low-power operation. Actual operating tests show that the natural period of the A. C. armature, resonance, inductance and transformer primary is 425 cycles. The operating frequency ranges from 450 to 550 cycles.

One of the most unique parts of this set is the combination flame-proof Morse key and antenna switch. The key is made with larger contacts for carrying audio-frequency currents at low potential. It is encased in a gas-tight housing of black Japanned sheet brass, this housing making the "live" parts of the key free from all electrical contact with the power circuit. The connection between the key and the panel is made by two lengths of flexible cable, each five feet long. By means of the antenna switch, both the generator armature circuit and also the generator field circuit are broken when the switch is in receiving position.

The thermo ammeter is used in connection with the Weston shunt-block, one end being grounded to the panel frame. It reads from 0 to 15 amperes.

The wave changing device that is used in connection with this set, is built for durability as well as the highest efficiency. It consists of a fixt primary coil and movable secondary coil. They are designed to have corresponding turns as tuning points, and make simultaneous contact with two selector arms. At the left of the upper panel will be seen the handle which varies the wave length. At the left of this handle will be seen three openings, the center one being encircled by a white ring. The correct wave-length of the set is read from this point, the other two openings being for various calculations of wave length. The right-hand handle on the panel is used in connection with the loading inductance. Designated wave lengths of this set when operated on a Navy standard are 600, 752, 952 and 1,905 meters. This set under laboratory tests with a dummy antenna, the same as would be used on a ship, has radiated as high as 18 to 19 amperes antenna current. It has a daylight sending range from actual tests of over 1,000 miles.

This set is at the present time being used by the Navy and is installed on a great many of the merchant vessels, and has proven one of the most efficient sets ever designed.—*Photos courtesy, Emil J. Simon.*

Developing An Idea

By Nelson Hall

(*Continued from page* 456)

much, gathers up a large amount of information in his travels which he is ready to impart to any one who will give him an attentive ear. By pulling him to your line you can get what he knows and all he has heard. In time he will make a good advertising medium if he is given "the dope."

Then one can inquire in stores handling such a line for the article. They will show the nearest thing in stock and tell if they have seen anything like it. Also it is good to write to mail order houses, for they are posted on a large variety of manufactured commodities.

Trade journals and magazines have special articles describing new inventions as they come out and later advertise them. One can find these articles by consulting such as *Pool's Index, Reader's Guide to Periodical Literature* and *The Industrial Arts Index,* which can be found in public libraries. Often librarians will look up references and sort out the articles if you will write or telephone your request in time. But usually it is best for one to go over the references himself, for while the articles may not directly pertain to the subject they may suggest something worth while considering. Strange as it may seem, the best part of some papers is in the advertising section. By taking papers going to the class of people interested in your article you can see what is being offered. It is well to look over several different papers, because advertisers do not confine themselves very closely and often try the dailies as well as trade journals. A good paper for general interest is the *Saturday Evening Post;* for office supplies, *System;* for household supplies, *The Ladies Home Companion;* for agricultural implements, *The Farm Journal* or *The Country Gentleman;* for tools, *Machinery;* for marine supplies, *The Marine Engineer;* for power plant equipment, *The Electrical World,* and the ELECTRICAL EXPERIMENTER, for what the electrical experimenter and "bug" will want. Nearly every public library has all of these and many more along the same lines on its files. But if one desires most of them can be obtained from newsstands.

From the advertisers many circulars, catalogs and leaflets can be had for the asking. In some libraries there is a file of trade catalogs in the industrial department that may be profitably consulted.

Sometimes going to all of this trouble will not bring to light the fact that some one has taken out a patent on this very article and has not put it on the market—yet. Hence it behooves one to make a patent search or have one made. Patent attorneys will make the search from a drawing, model, or description if it is clear to them, for a nominal fee. But it is usually more satisfactory for one to make the search himself; then he can see what has been done and the looking about may suggest something new. The *Patent Office Gazette* is on file in public libraries and in offices of many patent attorneys. One can go thru the indexes of these, get the numbers and read the short description given in the Gazette, and if it interests him send for a copy of the original patent. These can be obtained from the Commissioner of Patents, Washington, D. C., for five cents each in coin or money order (no stamps accepted). If one decides to have the search made, be very certain that the attorney has the idea right, understands how it works, and sees the novelty of it. He should be furnished with an assembly drawing, lettered so it can be described, clearly showing how it works, and laying special stress on the novelty. A copy of the one taken to the notary public is all right.

Some may think this is carrying the research too far, but after an inventor has developed an idea or two with much laborious study and a fair amount of money on experimental work he will then realize the importance of looking ahead and finding out what has been done by other inventors *and not do the same thing over.* Looking ahead will save the inventor much annoyance and his company from financial distress. Many Teslas and Edisons are turned into insignificant positions because they blundered in their first attempt and lost heart.

The Mystery of Atmospheric Electricity

By Rogers D. Rusk, M. A.

(*Continued from page* 416)

particles the water vapor has condensed as a liquid, forming the large ions, while about others it has only condensed as a dense atmosphere, forming the intermediate ions. When the vapor pressure in the air increases, the dense atmosphere on the intermediate ions may change to a liquid, as in Fig. II, and thus the *intermediate* ions become *large* ions in a fraction of time. This theory is not at all conclusive but it fits in with the observed facts better than any other, and is the only one which explains how the intermediate ions may suddenly become larger and more slowly moving. As water vapor only condenses in this peculiar way on rigid surfaces under certain conditions, we must assume that the centers of the intermediate and larger ions are different from the smaller ones usually found in gases and that they contain some small, rigid dust-like particle. This would also explain why they are not found in dust-free gases even tho the small ions are present, and why they are commonly found in the air.

HOW ATMOSPHERIC PARTICLES ARE ELECTRIFIED.

How these particles become *electrified* is another and vital question. There are many possible ways in which the phenomena may be accounted for. The ultra-violet light from the sun is a very powerful ionizing agent, having the power to detach electrons from the molecules of the air, as it passes thru the air. This ultra-violet light is particularly strong in the upper and thinner layers of the atmosphere, and tho the air absorbs a great many of these waves on account of their shortness, still a large number reach the lower levels of the air. Some more visionary theorists claim that ions and electrified particles are actually carried in huge streams from the sun to the earth, and there is some striking evidence that this may be true during periods of the sun's greatest activity. Friction is a great producer of electric charges, as is evidenced by the action of the well known friction *static machine,* and it is highly probable that friction of the air and dust particles in the air may be one of the potent causes of the electrification of the air. Again it may be due in part to radio-active substances in the earth's surface which constantly give off electrified particles into the air.

The mystery of the electricity in the air is a double one and if we could discover just how the ions are produced we could more easily ascertain just what they consist of. When these two questions are solved we may be in a position to harness the "electricity of the air" to our own use.

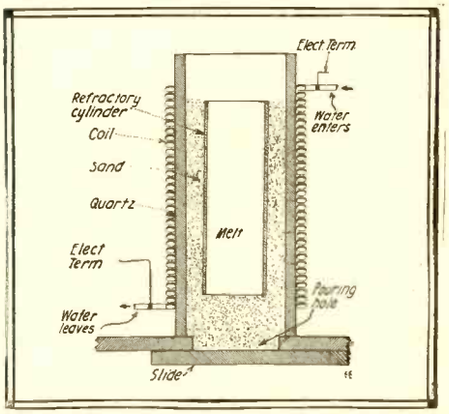
Possibilities of High Frequency Currents

(*Continued from page* 410)

could hardly be called power transmission, for only a very small portion of the original energy eventually reaches its destination in any case.

Very few investigators have given any thought to the utilization of these currents, for great power distribution.

Very new and strange phenomena are apparent when these currents are working. For instance, currents can be induced efficiently in circuits *without iron* as a magnetic medicine. Hysteresis losses are practically eliminated. Without iron in a transformer, it would be lighter for a given power than the present 60 cycle ones. It would be more compact, thereby reducing magnetic leakage. There is no saturation point to consider because of an air core. The reactive effect of a few turns of wire



The Special Type of "High Frequency" Induction Furnace Required for Enabling the "Carbon Free" Melts Is Here Illustrated. The Tremendous Concentration of Energy Produced by Inductive Action in a Comparatively Small Volume Makes It Necessary to Maintain the Inductor Coil Cool by Artificial Means. To Accomplish This Cooling in a Simple and Effective Manner, the Material Used for Winding the Inductor Coil Is a Thin Walled Flattened Copper Tubing. It Is Flattened and Wound Edgewise to Obtain the Maximum Possible Number of Turns to the Inch. A Small Flow of Water Thru This Tubular Coil Maintains It Always at the Temperature of the Tap Water Used. The Melt, Which Is Located Within the Inductor Coil and Which May be Only ½ to 1 Inch Less in Diameter than the Inside diameter of the Coil, May be Raised to a Temperature of 2500° or 2800° C., the Coil Remaining Under 20° C.

is very great; but a small condenser will cause resonance. Therefore the power factor can be easily made unity.

Among the few original engineers in this field of high frequency A. C. power transmission is Prof. Dr. E. F. Northrup, who was assisted by the writer at the Palmer Physical Laboratory, Princeton University, in extensive research along these lines. With these currents, it was possible to get results never before obtained by any other investigator.

Advantages of High Frequency Transformers

With an *air core* transformer, having a resistance load, more efficient results were noticed than could be procured with transformers having iron for a core. The losses were mostly due to the resistance of the conductors; but they were very small, as the circuits were of large cross-section. The hysteresis was negligible, due to the absence of iron. Magnetic leakage was reduced to a minimum because the coupling between primary and secondary was close. The capacity was 10 kilowatts, with three turns primary, insulated for 7,200 volts, and one turn secondary, reducing to 2,400 volts. The circuit was *resonant; therefore the power factor was unity*, or numerically 1.

It remained for Prof. E. F. Northrup to critically study these currents at *low voltage*. He found they could be confined in a mass of metal, thereby producing a terrific heat in a very simple and efficient manner.

The present day development in wireless has been to *raise* the voltage and frequency, because under these conditions maximum radiation of energy is brought about.

After several years of careful experimentation, a *high frequency, electric induction furnace* was produced that was applicable for the production of heat in either a *conductor* or *non-conductor*. Its extreme simplicity, owing to the absence of iron and a few turns in the inductor coil, leads one to believe that along these lines lay perfection in electrical mechanics.

At present there is in actual operation under industrial conditions a 20 K.W. furnace of this type. It is used for studying glass at high temperature in *vacuum or under pressure.*

A few years ago applications of this sort were purely imaginary.

There is now under test a 50 K.W. unit. Most all tests were carried on with the damped oscillations of condenser discharges up to 50 K.W., but the undamped oscillations of the high frequently alternator will be used for greater capacity.

With the spark method for producing these currents, a two phase field was used, no doubt for the first time. Altho nothing other than a half revolution of a circular conductor on an axis in this field was noticed, the writer is firmly convinced that, with proper apparatus and research, an induction motor could be made utilizing these currents. *A motor of this sort would be* WITHOUT IRON as a magnetic medium and therefore extremely light. Proper design would undoubtedly make it efficient.

High frequency lighting has already given promise to be eventually the means whereby the much heralded "cold light" may be produced.

The fundamental principles involved in producing these currents has been firmly establisht in "wireless" and with these methods, slightly changed, it is possible to investigate a brand new field of "endless wonders."

In the last decade there has been marvelous advances in electricity; but these have only paved the way for far greater things.—*Photos courtesy Pyrolectric Instrument Co.*

Practical Chemical Experiments

By Albert W. Wilsdon

(*Continued from page* 418)

soluble glass as it is called. Into most laundry soaps both sodium silicat and sodium carbonat are *crutched,* as a filler to soften hard water and to give additional detergent properties.

Toilet soap is made either by melting raw soap, by perfuming an odorless soap, after cutting in fine shavings and drying, or by making the soap directly by the use of pure materials. In either case the mass is colored by metallic oxids or anilin colors, and is perfumed by the use of essential oils, and is then prest into molds while yet fresh. To make a transparent soap it is necessary to dissolve an ordinary soap in alcohol, allow the insoluble residue to settle out, and distill the alcoholic solution to jelly. This may then be prest into molds and dried. Another method quite frequently utilized is to make a cold process soap, with coloring matter and perfume aded, and then to add to the mass more glycerin, or a strong sugar solution, which renders it still more transparent. Soft soap is made directly by the use of potash lye, or by the use of soda lye and considerable water. The glycerin and the excess of lye, if any, remain in the soft soap. This is used in *fulling* or shrinking cloth and in other manufacturing operations, probably on account of the excess of alkali which it contains. The salt lye which is drawn off

from the kettle in which soap is boiled is used for the manufacture of glycerin. In this process the soluble soap and impurities are taken out by chemical treatment, and mineral salts are separated by evaporation and crystallization. The purified crude residue containing about 80 per cent glycerin is distilled with steam under diminished pressure.

It is false economy to use a cheap soap, on account of the excess of alkali which it usually contains, it injures the fabrics washed, by causing the fibers to disintegrate and readily fall apart. There is a great advantage in using a well dried soap, as it does not so readily become soft in the water and therefore does not wash away so quickly. A laundry soap will lose 25 per cent of water if the bars are piled and allowed to remain for some time where they are freely exposed to the air. Chevreul in his researches on soap said that the cleaning action was because the soap was decomposed, when brought into contact with the water, into fatty acid and alkali. The impurities are set free by the alkali and entangled by the fat acid salts, and thus removed with the lather. Thus it will be seen that vigorous rubbing is not necessary to remove the dirt, tho, quite naturally, it aids the process.

Ordinary soaps are readily soluble in water, but if the water is *hard* from the presence of lime or similar mineral substances, the alkali soap is decomposed and an insoluble lime soap is precipitated, thereby forming a disagreeable scum on the water. Not until all this lime is thrown down by the soap will the lather begin to have a detergent action. On account of the necessity for using hard soap in some localities *washing soda* is used to *break* the water; that is to precipitat the lime so that less soap will be required. In order to make a laundry soap fit for hard water, sodium carbonat is added to it in the crutching.

Experiment No. 1. To make a hard soap, dissolve in a medium-sized beaker 15 grams of caustic soda (in stick form) in 120 cc. of water, and pour one-half of this into a porcelain evaporating dish of at least 500 cc. capacity, add 60 cc. of water and 50 grams of tallow. Boil this solution for three-quarters of an hour, carefully replacing, from time to time, the water that has been lost by evaporation; then add the remainder of the solution of caustic soda and boil for at least an hour more. Water should be added as before, but the volume of the liquid may be allowed to decrease about one-third. Add 20 grams of salt, boil for a few minutes, and allow the liquid to cool. The soap will rise to the top, and the glycerin, excess of lye, and salt will remain in solution.

Experiment No. 2. Slightly acidify the water solution separated from the soap in the above experiment with dilute hydrochloric acid. If any fatty acids or impurities separate out, filter. Pour the solution into a porcelain evaporating dish, and evaporate to dryness on a water bath. Dissolve the residue in strong alcohol, filter or decant from the undissolved crystals of salt, and evaporate the alcohol. The slight residue will be sticky, and give the sweet taste of glycerin.

Experiment No. 3. Cut a good quality of soap into shavings and mix with hot water on a water bath, until well dissolved. Add dilute sulfuric acid until the solution is acid. Note that if the soap is *filled,* the sodium carbonat will cause an effervescence on adding acid. Heat on the water bath for some time or boil slowly, and the fatty acid will separate, forming an oily layer on the top. When clear this may be separated from the water by pouring on a wet filter, and the sulfuric acid removed by washing on the filter with hot water.

Washing soda, is often used, not only to soften hard water, but as a stronger

washing agent than soap. This is a much better material than most of the so-called *washing powders* on the market. It should always be dissolved in a bottle or other vessel, and used as a solution in the quantities necessary. An excess disintegrates the fabrics, or *rots* the goods. Sometimes the washing powders or liquids on the market contain in addition to the washing soda, a little soap or ammonium carbonat or a small per cent of borax, but they are much more expensive than the common washing soda, and no more efficient.

Experiment No. 4. To test a washing powder for sodium carbonat, put a little of it in a test tube and add a few drops of hydrochloric acid. If there is a brisk effervescence it will indicate the presence of a carbonat, and if the gas that is given off colors the Bunsen burner flame yellow, it is an indication of the presence of sodium.

Bluing.

Bluing is the process resorted to in the laundry to overcome the slight yellow color of the clothes, and for the same purpose in the bleacheries where new goods are finished. Indigo was one of the substances most commonly used some years ago. It was known to the ancient Egyptians as a dye and to the Romans as a pigment. The method of using it for bluing, as it is insoluble in water, is to tie up a lump in a cloth, and when soaked in water the finely divided precipitat which is in suspension will give a blue color to the water, and to the clothes, which are to be immersed in it.

Prussian blue (Ferric Ferrocyanid) is also used for bluing. It is insoluble in water and in mineral acids, but is decomposed by alkalies and dissolved by oxalic acid. It is generally used as a solution or *liquid blue,* but this imparts to the goods a greenish-blue color. On account of the ease with which it is decomposed by the alkalies, there is danger that *iron rust* will be deposited on the goods if this form of blue is used.

Experiment No. 5. Make Prussian blue by the action of Ferric Chlorid upon potassium ferrocyanid in the presence of a few drops of hydrochloric acid. Treat this blue precipitat with an excess of sodium hydroxid, and heat to boiling. Notice the reddish brown precipitat of ferric hydrat.

Experiment No. 6. Make some Prussian blue as in the previous experiment, and add to the precipitat, in the test tube, a few crystals of oxalic acid, and warm the mixture. Notice the intense blue solution obtained (liquid Blue).

Ultramarin is an interesting artificial compound which is put upon the market in the shape of small *bluing balls.* It is similar to the native mineral called *Lapis Lazuli,* and is a double silicat of sodium and aluminum containing sulfur. Like indigo, it is insoluble in water and is simply held in suspension in the liquid. There is a difficulty in preventing the formation of blue spots and streaks with the solid blue. This blue is extensively used for coloring wall paper and for *bluing* white sugar.

Experiment No. 7. To show the presence of sulfur in ultramarin place a part of a bluing ball in water in a test tube, and add to it enough hydrochloric acid to make the solution acid. Notice the odor of escaping gas when the solution is warmed, and test it for hydrogen sulfid by holding above the mouth a piece of paper previously dipt in lead acetat solution. The paper will turn black on account of the formation of lead sulfid.

Anilin colors made from coal tar are the basis of most of the liquid blues upon the market at the present time. The soluble blues from this source are very numerous, and they are probably as satisfactory as anything for this purpose.

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What Physicians and Users Say

Trixie Friganza, well known actress says "Cheerfully will I add my praise for Violetta. It's the best 'pain chaser' and 'soother' I've had the good fortune to find. It's WONDERFUL. It cured my brother of neuritis. As for myself I use it for facial treatments and general massage. I cannot say too much for it."

Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Violetta High Frequency Instrument in all cases of neuralgia. Almost instant relief in Facial Neuralgia."

K. L. Allen, D.C., 205 Boone National Building, Boone, Iowa, says: "I have had very good results with the application of High Frequency Current in cases of Paralysis, Rheumatism and Neuritis, and think it a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the VIOLETTA in such cases as Goitre, Bronchitis, Pluerisy, Neuritis, Neuralgia and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."

Experiments in Physics

By John J. Furia, A.M.

(*Continued from page* 417)

the card is turning thru 180 degrees the image remains if the speed of the card is sufficiently high. The image of the reverse side strikes the retina while the image of first side is still on it, and hence BOTH objects appear to be in view. This is the fundamental principle of the *motion picture.*

Figure (4) is another example of an illusion due to persistence of vision. A black star is drawn on a blank card. If the card is placed on the forefinger and spun around, the star will disappear and TWO circles will appear as in B, the inner one *black* and the outer one *gray.* As the card is spun around the image of the points of the star and the image of the white card between the points strike the eye in rapid succession, so that due to persistence of vision, both black and white are seen and the result is the gray circle or mixed shade. Since the center of the star is all black, the center circle is black.

Even tho money is not of much use to many of us now, the following interesting device for "Making Money" provides a fitting conclusion to any performance. A small miniature clothes wringer is brought forth. A piece of paper is cut to the size of a dollar bill. The paper is inserted in the wringer, *the handle is turned and a brand new, crisp dollar bill comes out from the other side!* This may be repeated indefinitely (provided the performer is a multi-millionaire). Figure (5) tells the secret. The two rollers are not two distinct rollers, but are made of a continuous piece of goods wound as in B. Beforehand the performer has wound some dollar bills into one of the rollers and then on performing the "stunt" places the paper in the other roller. *As he winds the paper into one roller, the dollar bill is unwound from the other roller.* If the apparatus is well made and carefully put together, a great deal of fun can be gotten from it without the *modus operandi* of the illusion being discovered.

(*To be continued*)

Diploma Awarded to the Electrical Experimenter by the United States Government To Show Its Appreciation of the Patriotic Service Rendered During the War by America's Greatest Electrical Magazine.

Telephone Solves "Lower Berth" Squabble.

(*Continued from page* 408)

The disadvantages of this system of distribution of cards are numerous, the greatest one being that while one agent may entirely fill his cards, another may not, and thus there will be vacancies in spite of a heavy demand at some other window. Added to this there is a good deal of time wasted while the ticket agent is trying to get in touch with some other agent who has a berth open, not to mention your good time and patience wasted while waiting for him to get the desired information.

But this new system which has been installed in the Grand Central Terminal obviates all this. All the time and energy that were formerly wasted are now saved by the creation of one central telephonic distributing system, which has been installed on the second floor of this railroad terminal and known as the *Pullman Distributing Office*. It is kept open all night long, and in it are maintained all the records and diagrams of every parlor and sleeping car operating out of the terminal.

Altogether this office takes care of the seventeen groups of ticket offices spread over New York City, Weehawken, and Yonkers.

This whole system was built especially to order for this railroad company, the idea being the outcome of a long and exhaustive study of the problem by Mr. Neil Mooney and Mr. Devlin, of New York City.

The equipment proper consists of a distributing board 18 feet long, 3½ feet wide and 2½ feet high. For its whole length this is surmounted by a rack containing pigeonholes which accommodate 190 sets of diagrams. This distributing board is built in three sections, with four operators to a section, each operator being assigned a certain set of trains. On the table in front of her is a set of signal lights, and she is equipt with head 'phones and a mouthpiece as shown in the illustration.

In all of the seventeen groups of ticket offices taken care of a duplicate set of buttons is given to each ticket agent. (See illustration.) He is also furnished with a key showing which operators are taking care of certain trains. By this method the agent in Yonkers or at any of the other stations presses a button, and instantly a light flashes before an operator in the distributing room, who answers "All right", —then the conversation runs like this:

TICKET SELLER:
"25.
"Chicago.
"Thursday, April 10th.
"Lower."
PULLMAN CLERK, at Distributing Board:
"All right."
TICKET SELLER:
"1776" (meaning railroad ticket number).
PULLMAN CLERK:
"Lower 12.
"Car 42.
"25.
"Chicago.
"Thursday, April 10th.
"1776."
TICKET SELLER (repeats):
"Lower 12.
"Car 42.
"25.
"Chicago.
"Thursday, April 10th.
"1776."

Translated into good English language this means that a lower berth is desired on train No. 25, the 20th Century Limited, on Thursday, April 10th, New York to Chicago. This formula reduces conversation to a minimum, and is very strictly adhered to. No girl is given "another chance".

At one side of the room are several desks which take care of nothing but telegraphic requests for reservations. Nearly a thousand requests per day are received, and it is easily seen that this forms no small part of the day's work.

Because of this concentration of distribution space may be sold until two minutes before the train leaves, when the diagrams are sent by special messenger from the distribution office to the conductor of the train.

There is one more feature that deserves mention, and that is the entire absence of all bells. All the signals and calls are made by different colored lights. The only time a bell rings is when one of the different circuits opens, or a fuse blows, in which case an expert electrician is immediately set on the job, and the trouble is fixed up very quickly.

Possibly a word as to the operators themselves would not be amiss. They are all well educated girls, some of them from college, a number of them having husbands in the American Expeditionary Force. The majority of them have been chief operators at some other exchange, and all of them have exceptional "speaking voices." The head of that department, Mr. Devlin, was very careful to make clear the difference between the "speaking" and the "talking" or "telephone" voice. A beginner there is paid $87.50 per month, and the more experienced operators get $125. In return the company demands a most rigid discipline while on duty, but at the same time everything is made as pleasant as possible for the girls. On the floor above is a big rest room fitted up with easy chairs and sofas, where the girls may go whenever they feel sick or faint.

Taken all together, the New York Central Railroad is doing its best to present to the long suffering public a good and efficient method of coping with the Pullman proposition, and they feel that their present method is nearly 100 per cent efficient.—*Photos courtesy New York Central Lines.*

Twin Cell Design of Dry Battery

(*Continued on page* 413)

each consisting of flat zinc strips 15/16 in. wide by 24 in. long, bent in the form of a letter "M." The maker points out that these zinc anodes present to the material contained in the cell a surface of around 90 sq. in., as against 42 sq. in. in a round design. It is therefore claimed that the density of current per square inch is greatly reduced with an increase of life of the cell that is of great practical importance.

The common positive electrode can be used with either negative electrode separately or together by joining the two negative electrodes by a connection. This is the way the battery is furnished. Either half of the battery will give 1½ volts, so that when only one-half the cell is used, the remaining half is kept fresh. The battery measures 1⅛ in. by 3 in. by 6 in., and weighs 2 lbs. 2 oz. The outside case is waterproof and non-conducting. On test it is claimed the battery has shown a voltage of 1.5 to 1.55 and on short circuit a current of 35 amperes.

Sent up by Italian scientists, a balloon carrying recording instruments reached an altitude of 23 miles and found the lowest temperature, 70 below zero, 12 miles from the earth's surface.

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A Tell-tale Submarine Net

(*Continued from page* 406)

holding the net sets in motion the signaling alarm devices provided by the inventor.

The anchoring devices at each end of the net each comprise a buoy in the form of a cylindrical body or tube containing an air chamber and ballast at the lower end. The lower end of the buoy is connected with a number of chains having weights or anchors at their lower extremities, and all of which may be adjusted and set to maintain the net or nets at the usual depths traveled by submarines. A series of nets can be arranged at various levels so as to form an effective barrier wherever required. The buoys remain in their original position, even if the net is detached by the submarine, and can be used for replacing another net.

Each buoy carries a float chamber having a dependent stem extending into a chamber at the upper end of the main buoy and on this stem is placed a spool carrying a cable. When the net is pulled away from the anchoring devices, a set of catches disengage the spools so that the floats rise to the surface of the water and are carried along by the net. The float will thus serve to indicate that the net has been torn away from its anchorage by a submarine enmeshed therein, and moreover indicate the position of the sub-sea raider. At the same time a set of *marker floats* rise from the buoys to indicate their position.

In order to detect a submarine that has enmeshed with the net during the night, the float devices have suitable illuminating means which are easily set into operation by electric current. The float chamber contains a storage battery or other source of current connected in circuit with lamps adapted to be illuminated when the circuit is closed, by a special time-clock device connected with the release mechanism of the buoys. At the same time that the signal lamp circuit is closed in the floats, by means of the time-clock arrangement, an aërial bomb or rocket is projected into the air as shown in the accompanying illustration, this bomb being arranged in a barrel having at its lower end a charge of explosives, which is ignited by a spark plug connected up with an electric battery and spark coil circuit within the float. The bomb is fitted with a fuse which will cause it to be exploded when it reaches a certain height. A red light or flare may be produced on the floats when the bomb is projected. For this purpose a charge of *red light* or other signal powder is arranged in a compartment within the float chamber.

ELECTRIC SHIP WELDING SUPERIOR.

The displacement of riveting by electric welding in ship construction is being considered in English insurance circles, with regard to possible reduction in rates. It is claimed that welded plates stand the impact test as well as riveted plates, but underwriters require further information on the question of the results of stranding and collision. The cost of electric welding is stated to be much below that of riveting, and if similar insurance rates may be secured will undoubtedly supplant riveting to a great extent.

A New Cam Regulator for Auto Dynamos

(*Continued from page* 415)

A number of voltage regulators have been developed, but of these only two—the bucking-winding system and the third-brush system—have been generally used. To these has been recently added a third, the Cam-Regulator System.

This system is very different from the usual systems both in principle and in operating characteristics. Some of the chief advantages claimed for it are as follows: The voltage is held more nearly constant than is the case with the other systems. Ideal battery-charging conditions are provided, since the amount of current delivered to the battery is large when the battery is discharged, and small when the battery is full. The battery is not necessary to the proper operation of regulator. Hence, in an emergency the generator can be operated with the battery disconnected, and in some cases the battery can be dispensed with altogether.

The generator for this system is of the simple *shuntfield* type, and voltage regulation is effected by *inserting resistance in the field circuit.* This principle is the same as that employed in ordinary power-generator service, but the method of application is quite different.

In power service the voltage of a generator is kept constant by increasing or decreasing the *amount* of resistance in series with the shunt field as the voltage tends to rise or fall. With the cam-regulator, however, a fixt amount of resistance is always used but the voltage is regulated by varying the *length of time* during which this resistance is in the field circuit. How this is accomplisht can be best understood by referring to the diagram of the cam-regulator.

This device consists of four main parts—a magnet coil and core, a set of contacts, a cam mounted on the generator shaft, and a resister. The resister is so connected that it is *short-circuited* when the contacts are *closed,* and *in series* with the shunt field of the generator when the contacts are *open.* The arm carrying the lower contact rests on the cam and is moved up and down with every revolution of the generator shaft. The upper contact is mounted on a pivoted arm, and when the generator is not in operation, it is prest against the lower contact by a spring finger.

With the engine running at low speed, as in starting, the contacts are together and the resistance short-circuited. When, however, an increase in the engine speed brings the voltage of the generator up to the operating point (7 volts), then the magnet comes into play.

The coil of this magnet is connected across the brushes of the generator, and when the voltage rises above 7 volts, it has sufficient strength to draw the upper contact away from the lower, thus inserting the resistance in series with the generator field. Immediately the voltage starts to fall, and the magnet drops the upper contact, closing the points and cutting out the resistance. This increases the voltage again, and the magnet picks up the contact, only to drop it immediately afterwards. Since the strength of the magnet's pull depends upon the voltage of the generator, the higher the voltage the longer the upper contact will be held, and the fewer will be the number of closings per minute. This is equivalent to an increase in the amount of resistance.

The operation of opening and closing the contacts takes place so rapidly that the eye can not follow it, nor can the variations in voltage be noted on a voltmeter. In practice the regulator is adjusted to hold the voltage at approximately 7 volts at all operating speeds and under normal loads.

—Photo courtesy Westinghouse Elec. & Mfg. Co.

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Earn $25 Weekly, spare time, writing for newspapers, magazines. Experience unnecessary; details free. Press Syndicate, 566 St. Louis, Mo.

Jacobus Advertising Service

SALES COMPELLING LITERATURE

1073 Sanford Ave. Irvington, N. J.

July 17, 1919

ELECTRICAL EXPERIMENTER,
N. Y. City.

Attention, Mr. DeMott.

Gentlemen:—Herewith two small ads. for next issue of your two magazines. We also expect one along in a day or so from a Cartoon School out in Pennsylvania, but he is making a drawing for same and no doubt this is what is delaying it. As soon as we receive it we will rush it right over to you.

Your magazines are pulling good for us and it all seems to be a good class of trade, which indicates your readers are wide awake and answer ads.

Very truly yours,

H. JACOBUS.

Cameras, Supplies—Photo Developing.

Clean, Neat, Perfect Kodak Finishing at the lowest prices. Work returned the same day received. Send film for sample print and copy of catalogue on developing, printing, enlarging and hand coloring, also copy of Photo Craft Magazine, which will help you make better pictures. Photo Craft Co., Box 69, Ann Arbor, Mich.

For 15c we will develop and furnish prints from one, six or eight exposure film or enlargement 8x10, your favorite negative, 20c to show quality and service. Associated Photo Company, Sta. A 12, Cincinnati, Ohio.

Roll Film Developed, 6c. Prints, 2c up. Send for price list. The Blad Photo System, Wareham, Mass.

Mail us 15c with any size film for development and six velvet prints. Or send six negatives any size and 15c for six prints. Or send 35c for one 8 x 10 mounted enlargement. Prompt, perfect service. Roanoke Photo Finishing Co., 255 Bell Ave., Roanoke, Va.

Exchange Ads.

Exchange, Buy, Sell. Wireless, electrical goods, etc. Large list 6c. State what you have and want. Zehrbach, Box 250, Hiram, O.

Wanted Tribune light car or parts. State lowest cash price and full particulars. Van Deurs, 325 Beta Place, Glendale, L. I.

Photographs wanted of Autolite and Hoyt (Gray-Davis) automobile Ammeters. Also speedometers. Will pay $1.00 each. Write Victor Todd, Rainbow Lake, New York.

Amateurs! Complete Audiotron regenerative cabinet, $18.50. Write for photo and particulars. H. Springfels, 70 E. Utica St., Buffalo, N. Y.

Let's swap! What'ye got? What d'ye want? Free Advertising. Three months, dime. Swap Bulletin, Wayne Congress, Detroit.

Sell—Gilbert's $10 Electrical Set. Tank developing outfit. Fine condition. Write. James Raiford, Route 1, Bessemer, Alabama.

2-$4.00 3-slide tuning Coils, sell for $2.50 each. 1-Murdock Loose Coupler, cost $8.00, sell for $5.00. Instruments used only 2 months. Prepaid. Sidney Kronengold, 5508—5th Ave., Brooklyn, N. Y.

For Sale—DeForest audion on panel, Oscillation Transformer and sending, receiving switch, $8. Also I.C.S. Electric Lighting Course, $20. Stamp for particulars. Eldred Hall, Solvay, N. Y.

Sell; Curtiss 3-ft. Biplane, $8.50. Guaranteed to fly. Complete arc light, $8.00. Send for photos. Merlin F. Harrod, New London, O

5000 Meter Coupler and other instruments for sale. Write quick. Ritchey Hume, University, Mississippi.

For Sale—Transmitting set, including 2" coil, helix, condenser key and gap, $15.00. Also Knapp dynamo-motor, $4.00. H. Hilton, 20 Jewett St., Amsterdam, N. Y.

Amateurs. Write me for list of Radio Apparatus for sale at big bargains. All in good order; closing my station. Wendell Holst, 3619 N. St. Louis Ave., Chicago.

65 Chemical Set, $5.00. Bricktor, $4.00. Lionel Gates, Coalport, Pa.

Sell 1/20 H.P., 110 volt, 60 cycle continuous duty induction motor, $7; 40 watt dynamo, $4.50; 20 watt dynamo, $2.25; volt and ammeter, $1.25. Adolph Gedeon, 3296 W. 50th St., Cleveland, Ohio.

For Sale or Exchange—$40 Hawaiian Guitar outfit, $25. Write. Arthur Ellwein, Wrightsville, Pa.

Chemical Laboratory for Sale. 100 Chemicals—50 pieces of apparatus, cheap. Louis Dotte, 205 West St., West Hoboken, N. J.

Must Sell. Send stamp for list of electrical goods. Earl Cook, Benardston, Mass.

Bargain. 1 K.W. Thordarson transformer, brand new, $21.00. Crawford, 13 Ten Broeck St., Albany, N. Y.

For Sale. Blue prints for connecting A.C. motors. See ad under "Blueprints." Charles Chittenden.

Sell—Valuable electrical Stereopticon. First money order gets it. Thompson, 36 John St., Worcester, Mass.

Exchange! Over 100 "American Boys," also other Magazines for something electrical, letters answered. W. Leslie, Oak Hill, Ohio.

Trade—Moving Picture Camera, 150 ft. capacity; for small lathe. Ora Coppock, Tipton, Ind.

For Sale—Nickel plated; short model Valve Trombone. Ralph D. Kors, Humboldt, Neb.

For Sale—Audion, complete, except bulb, $6.50; Walnut case, no bulb or battery, $3.50; Blitzen, ¼ K. W. transformer, mounted, $10.00; Audion coil, $1; 55 galvanized pole steps, $1.00; Double variometer, $2.50; Telegraph outfit, $1.00; 30 Algier stories, $2.50. Rule D. Egbert, Tiffin, Ohio.

Will Exchange 5 H.P. gasoline engine for shot gun. Schmelzers, 90 St. Marks Place, New York.

Sell—Electrical apparatus. Thompson, 36 John St., Worcester, Mass.

Sale—22 Remington Rifle $5.00. Two telegraph sets $4.00. No. 6 Erector $5.00. Electric Miroscope $4.00. W. Grus, 505 Clinton Ave., Oak Park, Ill.

Electrical Supplies & Appliances.

Battery Charging pays big profits with HB Equipment. Electric Light Generators and Motors can also be furnished on easy payments. Full information free. Hobart Brothers, Troy, Ohio.

Storage Batteries. Make the plates yourself, we will tell you how. Sample plate 40c. Windsor Specialty Co. (not incorporated), 5419 Windsor Ave., Chicago, Ill.

Castings, Blueprints, Engines—Gas and Steam, ⅛ H.P. up. Gears, Pulleys, Pumps, Fittings, Small Boilers. Complete circulars for stamp. Latest models. Universal Gas Motor Co., 364 Monadnock Block, Chicago.

Storage Batteries charged by alternating current. Inexpensive, Simple and Efficient; Instructions and Print $1. K. & S. Engineering, Box 124, Sewickley, Pa.

Magnets: Large Horseshoe Magnets. Will lift 12 lbs. Mail $1, stamps or Money Order. Parcel Post Prepaid to all parts of U. S. or Canada. West Side Novelty Co., Drawer No. 8 Wabash P. O., Pittsburgh, Pa.

Motor Winders. See ad under "Blueprints." Charles Chittenden.

100 induction motor winding diagrams, 1, 2, 3 phase, star delta. 2 to 12 poles inclusive. Postpaid, $5.00. W. Glass, 2108 South Broad St., Philadelphia, Pa.

Electrical Workers and all others who are interested in Electrical Work in the Reconstruction that is taking place. To send us their name and receive descriptive literature of our Modern Blue Print Chart Method of Electrical Wiring. Souvenir information card included. Electrical Wiring Diagram Co., Box C. 173, Altoona, Pa.

Lava Insulation is not molded but individually sawn, lathe turned, milled, drilled, threaded. No limitation on form, only on size. Kilned at two thousand degrees. Hard, strong, accurate, fire, acid proof. Ask for book. American Lava Insulator Company, Chattanooga, Tenn.

Chemicals.

Radioactive and Rare Metal Salts. An opportunity for experimenters to become acquainted with radioactivity and rare metals. Ten salts in neat tubes—Thorium, beryllium, unranium, cerium, and others. Price only $1.75. Radio Chemical Supply Co., 915 Westcott St., Syracuse, N. Y.

Chemicals—We have the best chemicals at the lowest prices. Write for circular. Jos. Simpson, 3880 Windsor Place, St. Louis, Mo.

Experimenters—August list and 10 formulae—5c. Chemicals and laboratory apparatus for analytical and experimental work. Do your reactions ever go wrong? Our chemicals for analytical work are guaranteed c.p. C. C. Frane, Eureka, Ill.

For Advertisers.

Jacobus Ads. Are Business Builders. Booklet Free. Jacobus Advertising Service, 1073 Sanford Ave., Irvington, N. J.

"Quick-Action Advertising—How it is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 West 39th St., New York.

Advertise—24 words in 100 magazines, $1 lists Free. Stanford Co., 308 Hostetter Bldg., Pittsburgh, Pa.

Personal.

Are You Self-Conscious, embarrassed in company, lacking in self-control? These troubles overcome. C. E. Veritas, 1400 Broadway, New York City, N. Y.

Get Vital Strength. Retain youthful vigor. Wonderful results. Intensely interesting booklet free. Winslow H. Chase, Washington, D. C.

The Salesman Wins. Thousands of positions open. We teach traveling salesmanship by mail and guarantee offer of position or refund tuition. For interesting particulars, address Kansas Vocational Bureau, Miltonvale, Kansas.

Novelties

Here Boys! Make a Toy Aeroplane. See our Nifty ad., page 454.

Wanted to Buy

Cash for Old False Teeth. We pay up to $35.00 per set (broken or not). Also buy discarded gold jewelry, gold crowns, bridges, platinum, diamonds, watches and silver. Send now. Cash by return mail. Package held 5 to 10 days for sender's approval of our offer. U. S. Smelting Works, Dept. 73. Chicago, Ill.

Formulas.

Whiskey. I will not sell a million formulas for $1.00. My little book of selected formulas will put you wise. Every formula has been carefully selected and plainly printed. Tells you how to make excellent whiskey or Beer with a good Kick at small cost. A few good formulas are worth a million bad ones. Complete book and formulas $1.00 bill. I'm prompt too. Frank Ward, Box 503, Baltimore, Md. Dept. D.

500 Successful money-making formulas and trade secrets. Postpaid 25c. Charles Dynes, Winchester, Ind.

Motors, Engines & Dynamos.

Small Motors and Generators from bankruptcy and receivers' sales. Motors for all phases of current. Immediate delivery. Less than one-half regular prices. See display ad on page 459. Johnston, West End, Pittsburgh, Pa.

For Men.

Send us your dull razor blades. We re-edge them Good as New, any kind, 2½c each. Prompt service and satisfaction guaranteed. Dealers wanted. Keenedge Company, Inc., 184 Washington St., Chicago, Ill.

Detectives Earn Big Money. Travel. Great demand. Experience unnecessary. We train you. Write for free particulars. American Detective System, 1968 Broadway, N. Y.

Dredge's Necktie Valet removes wrinkles (without ironing) from neckties. Sample 25c. Dept. E, 190 Pilgrim, Highland Park, Mich.

Wireless.

Radio Apparatus of Quality. Manufactured to your own specifications. Radio Engineering Company, Baltimore, Md.

Switch Points. Binding posts, switch levers, and small parts, send 2c. for catalogue describing these and other goods. A. W. Bowman & Co., 23 Church St. (Harvard Square), Cambridge, Mass.

Wireless, improved switch-knob lever, complete, 25c; brass switch points with screws, 25c dozen; Magnet wire, 22-24, 50c, 26-28, 60c half pound, postpaid prices. Amateur parts our specialty. Electro-Novotoy Shop, 2100 Fifth, Charlotte, N. C.

Panel Wireless Sets and Parts. Heavy rubber Knobs. $1.10, post extra. Klaus, Eureka, Ill.

"Bargains"—6000 ¾" Spark coils without vibrators must be sold at once. Send 40c and 12c postage. Also ¾" Spark coils with vibrators, at 85c and postage. A. Dubs, 1534 Pitkin Ave., Brooklyn, N. Y.

10,000 feet strandcd aerial cable, seven strands number 22 pure copper. The need of the hour. 1 cent per foot, $9.00 per thousand. L. A. Bates, 8 Moen St., Worcester, Mass.

For Inventors.

Inventors join National Institute of Inventors, 118 Fulton St., New York City; membership society 1,900 strong; will help protect, develop, finance and market your invention. Absolutely no charge. Write for booklet.

"Sell or Finance Inventions." Read Money Talks Magazine. Send for free sample copy. 70-B Park Place, Newark, New Jersey.

Inventors. Protect yourselves. Record your idea before exposing it to anyone, even to me. Paul E. Klein, M.E., Consulting Engineer, Registered Patent Attorney, 21 Park Row, New York.

600 Mechanical Movements, also illustrations and explanations of 50 perpetual motions. My book, Inventors' Universal Educator, 4th edition, tells how to procure and sell a patent for your new invention. Government and other costs. Covers the matter from A to Z. 140 pages elegantly bound. Contains noted Court decisions on Patent cases. Mechanical Movements greatly assist inventors—suggest new ideas that might prove of great aid in perfecting inventions. Tells how to select an attorney. Has valuable information regarding Patent Sharks, Selling Agents and Brokers. Price $1. Postage free. Fred G. Dieterich, 603 Ouray Bldg., Washington, D. C.

Inventions Wanted. Cash or royalty for ideas. Adam Fisher Mfg. Co., 205 St. Louis, Mo.

Inventors write me about patents. My fees payable monthly. Booklet free. Frank Fuller, Washington, D. C.

Business Opportunities.

Enter a New Business. Earn $3,000 to $6,000 yearly in professional fees making and fitting a foot specialty, openings everywhere with all the trade you can attend to; easily learned by anyone at home in a few weeks at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

500% Profit Monograming Autos. "Perfect" transfers. Irvin J. Wolf, Sta. E, Philadelphia.

$30 a Week. Evenings I made it with a small Mail Order Business; continued my regular job daytime. Free Booklet Tells How, 2c postage. Albert W. Scott, Cohoes, N. Y.

Make $4.00 a Day Silvering Mirrors. Complete instructions, 10c (coin). Lloyd Stultz, Middletown, Maryland.

Build Up an Income in Oil. Others are doing it—Why not you? Today is the opportunity. Join our easy monthly payment plan now—it may mean hundreds in profits. Write for information. National Oil Drilling Co., Dept. K, Houston, Texas.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

Money-Making Farms. 19 States. $10 to $100 acre. Stock, tools, crops, often included to settle quickly. Write for big illustrated catalog. E. A. Strout Farm Agency, 150 E C Nassau St., New York.

Breed Canaries—Profitable pastime—Particulars free—Bird Farm, Lynnhaven, Virginia.

Victory. Mechanical Toy Soldier window attraction. 30 inches high. Salutes, turns head, points with finger, etc., as set. Well made, nicely dressed officers, privates, Uncle Sam, etc. Electrically operated. Does some stunt every half minute or oftener as set and will salute soldier and pay no attention to other if desired. Representative wanted in each city and town. Write for prices. The John M. Biggs Co., Box 324, Chattanooga, Tenn.

Radio Amateurs; Here is an opportunity for you to secure a very efficient amateur radio set complete. Photos and description furnished on receipt of postage. Address Clarence Bornofska, 1322 Lincoln St., Racine, Wis.

Complete Course on compiling and selling names by mail to advertisers. Description free. Globe Publishing Co., 120 Syracuse, N. Y.

"Let's get started once more, fifty complete, guaranteed radio receiving sets, $1.65 each." Eureka Manufacturing Company, Independence, Iowa.

"Quick-Action Advertising—How It Is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publishers. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 W. 39th St., New York.

Start a Profitable Business manufacturing "Puffed Crisp." Delicious confection. Whirlwind money-maker. Machine, Instructions complete $6.50. Samples 10c. Bestever Products Co., 2426-PE-9, Polk St., Chicago.

Blue Prints, 236 A.C. diagrams,contains 54 single phase, 42 two phase, 50 three phase Star, 40 Delta, 12 Star-Delta. Appendix 68 changes of voltage, phases, speed, cycles, etc. 10 samples 25c. Particulars free. Charles L. Chittenden, 811 West 18th Street, Kansas City, Missouri.

Salesmen—New proposition that nets $100 to $200 weekly. Give moving picture shows at schools, colleges, universities, chuches, Y. M. C. A's, clubs, lodges, societies and homes. We furnish complete outfit. Write for particulars. W. H. Wade, Dept. 5, 14 N. Michigan Ave., Chicago.

Make Big Money opening safes and setting combinations. Wayne Strong, P. O. Box 1430, Los Angeles, Cal.

Motion Pictures.

Electric Arc Generator halves expense. Your engine operates. Easy terms. Hobart Brothers, Troy, Ohio.

Earn $1200 A Year in Spare Time writing photoplays. Experience unnecessary. Send for free book, valuable information, special prize offer. Photo Playwright College, Box 278 E-5, Chicago.

Photoplays Wanted. Big prices paid. You can write them. We show you how. Free particulars. Rex Publishers, Box 175, E5, Chicago.

Continued on Page 486

Books.

Dear Reader. If Occult, New-Thought and Scientific books appeal to you, send for my catalog, it's free. I have books on Personal Magnetism, Concentration, Spiritualism, Clairvoyance, Seership, Will, Mind, Hypnotism, Messmerism, Character Reading, Healing, Mysticism Success, Salesmanship, Mechanics, Entertainment, etc. A. W. Martens, J-49, Burlington, Iowa.

World-Romic System. Masterkey to all languages. Six textbooks, $1.44; French chart, 37c.; Spanish, 37c.; aviation dictionary, $1.50; French-English aviation dictionary, 61c. Languages, 143 W. 47th St., New York.

A Magazine Published for Boys by boys. Year, 25c. Single copies 5c. Hoosier Boy, Brazil, Indiana.

"Chicago Mysteries" Illustrated Book, 25c. Catalogue, 2c. Paul Duff, 2713 Mozart, Chicago, Ill.

Nature Laws every married and engaged person should know, 45c (no stamps). Central Company, 599 Ninth Ave., New York.

To Get Better Pictures. Read the amateur photographers' weekly; illustrated; weekly prize competitions; print criticisms; many unique features; $1.50 per year; three months' trial subscription 25c. Abel Publishing Company, 401 Caxton Bldg., Cleveland, O.

Old E. E. Back Numbers. We have some valuable old E. E. back numbers on hand as follows: 1915—Jan., Feb., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec., price each 35c. 1916—Jan., Feb., March, May, June, Nov., Dec., price each 35c. 1917—Jan., April, May, June, Aug., Nov., Dec., each 35c. 1918—March, May, June, July, Aug., Sept., 35c; Oct., Dec., each 20c. 1919—Jan., Feb., Mar., Apr., May, June, July, Aug., 20c. We can fill orders at once upon receipt of your remittance and if you have not these numbers already, now is your chance to get them, as they probably will be snapped up very quickly. Experimenter Publishing Co., 233 Fulton St., New York City.

Tricks, Puzzles and Games.

Tricks, Puzzles, Jokes, toys, games, novelties, doll and cane racks, plays, wigs, stage supplies, escapes and illusions. Large 1917 catalogue free. Oakes Magical Co. Dept. 549, Oshkosh, Wis.

Magic. Entertain at home. Tricks, puzzles, novelties. Big Catalogue A, 25c. Martinka & Co., Inc., Harry Houdini, President, 493 Sixth Avenue, New York City.

Black Art Hindoo experiments. 1919 edition, 25c. Invisible ink. Free trick. Catalogue each order. Lindhorst Magic X Shop, St. Louis.

Magic—Card Tricks. Sensational escapes, jokes, novelties. Everything in the amusement line. Large illustrated catalogue of a thousand tricks free. Write today. Largest amusement goods manufacturers in the world. Heaney Magic Co., Desk 205, Berlin, Wis.

Illusions—Stage Tricks with 500 Illustrations. Catalog 15c. Small catalog free. Hornmann Magic Company, 304 West 34th St., New York.

Ventriloquism taught almost anyone at home. Small cost. Send today 3c stamp for particulars and proof. O. A. Smith, Room R629, 801 Bigelow Street, Peoria, Ill.

Ten Magic Numbers, Hallowe'en Fun, $1.00. Belle Mason, Binghamton, N. Y.

Health.

Cigarette, pipe or chewing habit conquered. Nature's method. Guaranteed. Write for free brochure. Edw. J. Woods, TA-300, Station F, New York.

Tobacco or Snuff Habit Cured or no pay; $1 if cured. Remedy sent on trial. Superba Co., SA, Baltimore, Md.

Tobacco Habit Cured—$1 prepaid. Harrison, 105 Walker, Evansville, Ind.

Instruction

Questions answered. All subjects. Details free. Answerall Information Bureau, 51 Cliff St., N. Y.

Free Advice? No! Our advice is the best. We advise on any subject, no matter how complicated; we have the best experts. We also make translations from any language. Tell us about your problems. Any one can understand us. Our charges are nominal. We invite your correspondence. Phone, Forsyth 1690, if you wish. A trial will convince you. Remember, poor advice is dear at any price. Paragon Technical Bureau, 329 East Fifth St., New York City.

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Telegraphy (both Morse and wireless) and Railway Accounting taught thoroughly and quickly. Big salaries now paid. Great opportunities. Oldest and Largest School—est. 45 years. Catalog free. Dodges Institute, 7th St., Valparaiso, Ind.

Help Wanted.

American Made Toys Wanted. An opportunity for homeworkers on small scale and manufacturers on large scale. Unlimited quantities needed of Toy Soldiers. Army, Navy, Marines, Cannons, Machine Guns, Warships and other Toys and Novelties. Greatest chance for industrious people for independent business. Enormous demand and future in American Made Toys, all over United States, Canada, Mexico and South America with over 50,000 10 cents stores and toy dealers. This new American industry stands out conspicuously. Factories are established, people trained, machineries made. Christmas Sets needed in millions this year. The great hit for 1919 without any competition. We are buyers of these goods all year, paying fixed prices. Attractive prices offered for painted goods. Experience or tools unnecessary. Hundred and more made complete per hour. Casting-form outfits from $3.00 up. If you mean business, send for booklet and information free. Toy Soldier Manufacturing Co., 32 Union Square, New York.

Wanted, Men. Become Auto Experts. $35 Week, Earn while learning. Franklin Institute, Dept. J. 806, Rochester, N. Y.

Men wanted for Detective Work. Write J. Ganor, Former U. S. Government Detective, Danville, Ill.

Secret Service Operatives and Detectives are in demand. Earn Big money. Travel everywhere. Fascinating work. Learn this profession by home study. Particulars free. American School of Criminology, Dept. E., Detroit, Mich.

U. S. Government Wants Clerks. Men—women 18 or over. $1,000-$1,600 year. Permanent clerical positions. List positions free. Write immediately. Franklin Institute, Dept. J. 26, Rochester, N. Y.

Stamps & Coins.

California Gold. Quarter size, 27c.; Half dollar size, 53c.; dollar size, $1.10; large cent, 1820, and catalogue, 10c. Norman Shultz, Kings City, Mo.

Stamps—61 All Different Free. Postage, 3c. Mention paper. Quaker Stamp Co., Toledo, O.

1,000 U. S. and Foreign Stamps, including Mexican Villa Dollar, 25c. C. W. Parker, 77 Kensington Heights, Meriden, Conn.

100 Different Stamps 12c.; 200, 27c. Michaels, 5600 Prairie, Chicago.

Best One Cent Approvals in America. F. P. Hand, 1117 So. 60th St., Philadelphia, Pa.

100 Different Stamps, 10c. 100 U. S., 25c. Buckey, 412 Bowen, Dayton, Ohio.

Stammering.

St-Stu-t-t-tering and Stammering cured at home. Instructive booklet free. Walter McDonnell, 105 Potomac Bank Bldg., Washington, D. C.

For the Hair.

Don't Use Soap. Shampoos containing Soap or Alkalies injure the Hair. "Tricon" Herb Shampoo made from Mexican Amole, and other Roots and Barks contain neither. Cleanses the Scalp, removes Dandruff, stimulates Growth, restores Softness and Gloss. 10 cents postpaid. Agents Wanted. W. L. McDaniel, Box 916, El Paso, Texas.

Do You Want Hair? You can have it by using The Ekdee Hair Cerate. 95% of baldness curable. Thin hair made thick. (Not a dye.) One month's trial sent postpaid for $2.10. The Ekdee Company, 800 Union Ave., North Portland, Oregon.

I Was Bald. Obtained hair growth by an Indian's ointment containing genuine bear oil and rare plant juices. Many others have good hair-growing results. Will send box, postpaid, with recipe, 10c. John Hart Brittain, 150 E. 32nd St., BA-300, New York.

Song Poems Wanted.

Write the Words for a Song. We revise poems, write music and guarantee to secure publication. Submit poems on any subject. Broadway Studios, 197C Fitzgerald Bldg., New York.

Write the Words for a Song. We write music and guarantee publisher's acceptance. Submit poems on war, love or any subject. Chester Music Co., 920 So. Michigan Ave., Room 265, Chicago, Ill.

Only Poems having commercial possibilities accepted. I revise poems, compose, arrange, edit and autograph music for Chicago's best music firms. Irving Ginrich, 646 Belden Ave., Chicago.

Printing.

500, 3 x 6, 2 Color Circulars, neatly printed and sent prepaid for only $1.00. Robinson's Print Shop, Portland, Conn.

500 Two-Color Letterheads, $2.05. Samples Free. Printshop, 1915 S. Kedzie, Chicago.

100 Bond Letterheads and Envelopes, $1.25 Postpaid. Garland Miller, Trimble, Ohio.

1000 Letterheads, Envelopes, Typewriter Letters, $2. Circulars, Labels, $1; samples. M. Lemond, 65 Broadway, Brooklyn, N. Y.

100 Engraved style visiting cards, 50c.; 100 emblem cards, 70c. H. Gregory, Warwick, N. Y.

Attractive Gummed Labels Samples Free! Edward Harrison, "Guaranteed Printing," Baltimore.

Miscellaneous

For Sale. Choice Silver Black breeding foxes. Reid Bros., Bothwell, Ont., Canada.

Steam-No-More for eyeglasses and auto-windshields. Send ten cents for twenty-five cent sample. Gray's Sales Agency, Port Huron, Michigan, Dept. J.

Mansfield's Automatic water and oil finder a proved success, silver medal awarded. Particulars from Edwin A. Mansfield & Co., 94 Victoria Road, New Brighton, England.

Shoes for Everybody at reasonable prices. Save money and send for free descriptive circulars. Central Sales Co., 599 Ninth Ave., New York.

Wanted. Small Gasoline and Steam Engines, Small Lathes, Drill Presses and other light machinery. Will pay high cash prices for good material. Johnston, West End, Pittsburgh, Pa.

Patent Attorneys.

Patents—My fee payable in monthly installments. Send sketch for advice. Booklet free. Frank Fuller, Washington, D. C.

Millions spent annually for ideas! Hundreds now wanted! Patent yours and profit! Write today for free books—tell how to protect yourself, how to invent, ideas wanted, how we help you sell, etc. 212 Patent Dept., American Industries, Inc., Washington, D. C.

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Inventors. Send sketch of your invention for advice regarding patent protection. Twenty years' experience. Handbook on patents sent Free. Talbert & Talbert, Patent Lawyers, 4822 Talbert Bldg., Washington, D. C.

John M. McLachlen, Atty. at Law, Patents, Trade Marks, Copyrights, 410 McLachlen Bldg., Washington, D. C.

M. F. Miller, Ouray Building, Washington, D. C., Patent Attorney, Mechanical and Electrical Expert. Best quality of work and results. Moderate charges. Advice free.

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Patent Your Own Inventions. Save attorney's fees; we prepare applications; furnish full instructions and give satisfaction. Free information. Carl Larsen Co., Park Row Bldg., New York City.

Inventors' Adviser. Sent free on request. Wm. C. Linton, 918 F St., N.W., Washington, D. C., 363 University St, Montreal, Canada.

Patents promptly procured by personal expert service. Information on request. James D. Lyles, Washington, D. C.

Patents. Prompt, personal efficient service by an Attorney-at-law skilled in all branches of Patent practice. Over 12 years' actual experience, full information upon request. B. P. Fishburne, 324 McGill Bldg., Washington, D. C.

Phonographs and Supplies.

Build Your Phonograph. "Perfection" high-quality spring and electric motors, tone arms, reproducers. Wonderful results. Big saving. New catalog and building instructions mailed for ten cents. Indiana Phonograph Supply Co., Indianapolis, Ind.

Build Your Own Phonograph and manufacture them for profit. Drawing instructions, parts, price list, blueprints, etc., complete, sent free upon request. Write today. Associated Phonograph Co., Dept. E-1, Cincinnati, Ohio.

Make Your Own Phonograph. Particulars free. DeSelO-PhonE, P. O. Box 720, Attica, Indiana.