March

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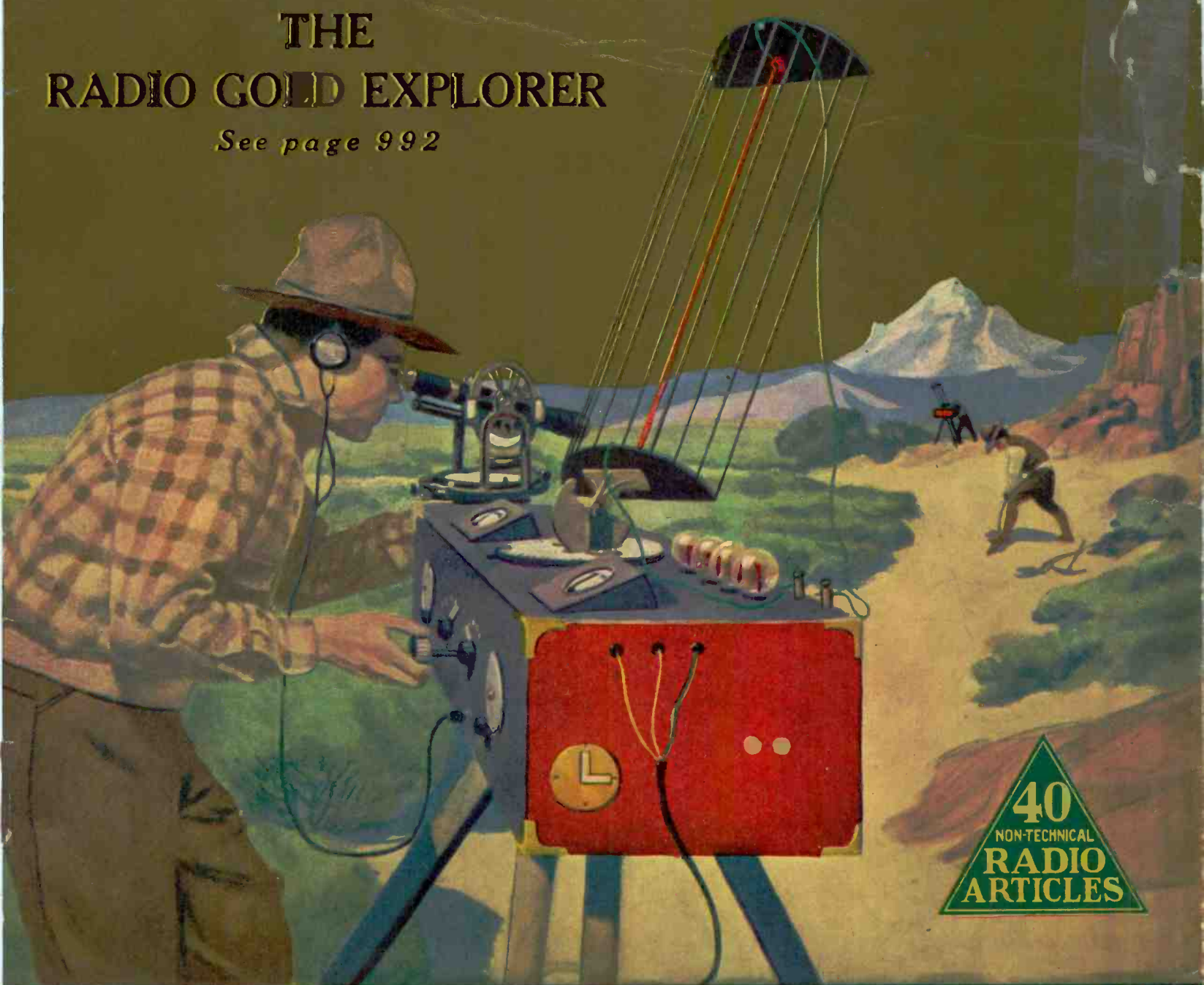
The EXPERIMENTER

THE RADIO GOLD EXPLORER

See page 992



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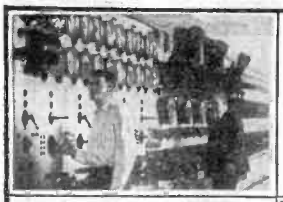

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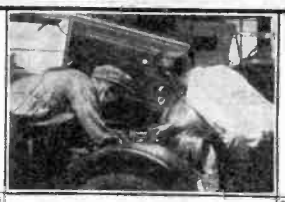

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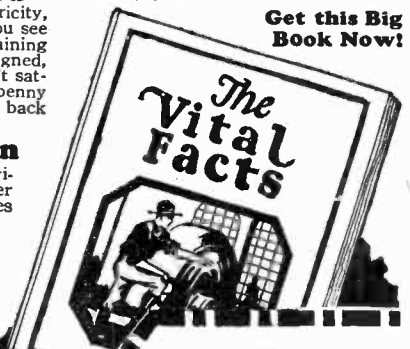

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Vol. XIII.
Whole No. 155

Science and Invention

FORMERLY

ELECTRICAL EXPERIMENTER

COMBINED WITH "THE EXPERIMENTER"

Member Audit Bureau of Circulations

March, 1926
No. 11

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Publishers of SCIENCE & INVENTION, RADIO NEWS and MOTOR CAMPER & TOURIST.

IN OUR NEXT ISSUE

Can We Meet Spirits?

Even if communication with the next world could be established, do you realize what the chances would be for you to meet one particular spirit out of the billions that have passed beyond?

Can Submarine Accidents Be Prevented?

There have been so many disasters of late where submarines have submerged but failed to rise again, that many have turned their thoughts toward rescuing methods for submarinists. A completely illustrated article on this subject will be presented.

Do You Use "Electric" Shoe Soles?

This and other medical frauds will be exposed in a highly interesting and authentic article.

What Is The Cosmic Ray?

A new emanation from space has recently been observed, measured and studied. What it is and all about it will be clearly dealt with.

What Is Reversed Electrolysis?

It is a recently discovered system whereby corroded bronzes and other antique art objects can be restored. It will be described in detail.

Contents for March

HOW TO SUBSCRIBE FOR "SCIENCE AND INVENTION." Send your name, address and remittance to Experimenter Publishing Co., 53 Park Place, New York City. Checks and money orders should be made payable to Experimenter Publishing Co., Inc. Mention the name of the magazine you are ordering, inasmuch as we also publish RADIO NEWS, THE EXPERIMENTER and MOTOR CAMPER & TOURIST. Subscriptions may be made in combination with the other publications just mentioned at special reduced club rates. Send postal for club rate card. Subscriptions start with the current issue unless otherwise ordered.

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Better than any get-rich-quick scheme, is a training in high school subjects. Not too late, no matter how long you have been away from school, to acquire the essentials of a high school education, in your spare time, at home at trifling cost. The most important message of the year for YOU.

It may sound too good to be true, this remarkable way to make your earning capacity TWENTY-THREE TIMES greater than it now is; but it is, nevertheless, a fact.

The earnings of millions of people have been checked up by the U. S. Census Bureau, and the result PROVES beyond question that High School graduates earn 23 TIMES as much as grammar school graduates!

Can any ambitious, sensible man or woman afford to neglect this astonishing advantage?

"Knowledge Is Power"

We all know the truth of that old adage "Knowledge is power."

One active brain can accomplish more than ten thousand pairs of strong hands. Thought harnesses steam, electricity, gasoline and NATURE, and makes them work for humanity.

The ability to THINK has lifted man above the savages. The *difference* in ability to THINK lifts one man above another.

To EARN more you must be able to THINK more.

Every penny you invest in developing your BRAIN will come back to you a hundred or a thousand-fold.

Make Up for Lost Time

Whatever work you may ever do, you are doomed to earn only one twenty-third as much as you COULD earn if you had High School training. Think what a handicap you have been under—and will be under all through your life—without high school training!

You may feel that it is hopeless for you to attempt to "go to school again." But through a wonderfully simplified method you can now make up for lost time—in your own home—in your spare moments—without missing a day's work, and at such a moderate cost as to seem unbelievable!

An Astonishing Method

You can acquire the essentials of a High School Course through the remarkable series of pocket-size Question-and-Answer books.

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These Question and Answer books, if placed in the form of a Correspondence Course would undoubtedly have to be sold for $5 or more per subject. They are, however, so easy to read and understand, that no further instruction is deemed necessary. They are therefore offered at the amazingly low price of only $1.00 each. The subjects treated are as follows—a book on each subject:

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A Problem in Invention Can You Solve It?

This simple test will show whether or not you have inventive ability; thousands have it and do not know it, or *do not develop it.* Yet invention is the easiest way to earn a fortune. No technical or scientific knowledge necessary. Read below a few instances of how little ideas have made millions of dollars for their inventors.

HOW would *you* like to get the royalty paid to the inventor of the tin cap used on millions of bottles? How much money would *you* have now had you thought of the simple idea of putting rubber tips on pencils? Wouldn't you gladly be the inventor of the Gillette Safety Razor, who it is said made as much as TWO AND ONE-HALF MILLION DOLLARS *a year,* or the inventor of the tiny snap-fastener who recently paid an *income tax of* $29,000, or be the man who invented the President Suspenders, now worth $5,000,000? Or would you prefer to be the inventor of the autographic attachment for cameras who sold his patent rights for $300,000.

Ideas Worth Fortunes

One single idea—as simple as any of these—can make you independently wealthy in a short time. Other inventors have made hundreds of thousands of dollars from such common things as the crimped hair-pin, the metal-tip shoe lace, the paper safety match, the ordinary wire paper clip. These are certainly not complicated inventions—they are so simple, in fact, that probably *thousands* of people thought of them but only *one* man DID anything about the idea when it came to him.

You, too, probably have ideas for needed inventions—and the only reason you have not turned your ideas into gold is because, like thousands of other persons, you doubt your own ability. Or like most persons, you believe that every inventor is a genius who invents things as naturally as other people do their work as bookkeepers, mechanics, doctors, or farmers.

Inventions Can Be Learned

But this is not true. What were our great inventors *before* they invented anything. Bell was a teacher. Edison was a telegrapher. Gillette and Waterman were traveling salesmen. Better proof than this is that you can satisfy yourself that invention is not limited to geniuses or that it is merely guesswork, luck or chance. You can prove to yourself that invention—*any* invention, from the collar button to the colossal railroad engine—is the result of the same kind of thought that you use in adding a row of figures.

Think, for a moment, what you do in any example in addition. You *see* a problem—the row of figures. You recognize that a result is wanted—the sum of the figures. From these two facts you go ahead and get the result. And because only one answer can be correct for that particular example, you know your problem is solved when you find that answer.

Raymond F. Yates, who with fourteen other famous inventors, now makes it easy for you to learn how to invent in your spare time at home.

Proof YOU Can Invent

Exactly the same thing is true in invention. This is the proof. At the top right-hand corner of this page is shown a simple problem in invention. What would *you* put on a shaft "A" to force members "B B" to move back at the same time. A little thought will show you the correct answer within a few minutes.

This test of your inventive ability, simple as it is, illustrates the thought behind every invention. Like your arithmetic example you see first, a problem to be "fixed." Then you think of something which will "fix it," something which is the only correct answer to your problem. That is all—that is *everything*—to invention.

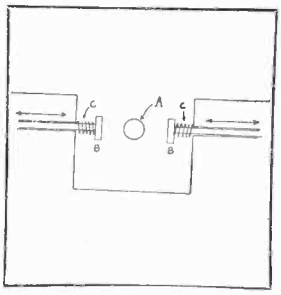
What Edison Says

Could you ask the advice of any greater authority than Thomas A. Edison? He says: "Invention is a Science and should be taught as a profession."

And now for the first time you can profit by Edison's advice. You can actually learn invention as a profession—exactly as other people are learning electricity, mechanics, law, medicine.

The Bureau of Inventive Science offers you the first course in practical invention ever devised. It has written down the easy-to-learn principles of Inventive Science so that everybody can read them and learn to use them. It doesn't matter who you are, or what your present work is—you have the native ability to invent. It was *born* in you. What you need now is to develop this ability so you can use it to produce inventions. All you need, to become succesful, is this easy, fascinating training which will develop your ability so it will be worth real money. Fifteen famous inventors tell you WHAT TO INVENT and HOW TO INVENT.

They tell you the secrets of inventions which every successful inventor knows. They explain how to originate ideas, how to develop and perfect them, how to get patents. But they tell you even more: Thousands of inexperienced inventors have been defrauded of their rewards because they did not know how to protect their patent rights. This great course tells you everything you want to know—how to sell your invention, how to get royalties—how to get the most money for your ideas.



Here is an interesting problem in invention. Its solution will be found very simple, if we really think.

"A" is the end of a shaft. The two members "B B" are free to move in either direction indicated by the arrows. If they are pushed back, the springs "C C" will immediately pull them forward again.

Our problem is to put some kind of an attachment on the revolving shaft "A" so that the members "B B" will be pushed back both at the same instant every time the shaft "A" makes a single revolution. The device on shaft "A" must also allow the two members "B B" to come forward once in every revolution. What would you suggest putting on the shaft "A"?

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—How to develop your ideas.
—How to get the facts you need for inventions.
—How to keep legal records of ideas.
—How to use scientific principles of mechanics.
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A wonderful new book, just printed, tells you more about the Bureau of Inventive Science and its simple new course in invention. It costs nothing, so send the coupon at once. Every day you see things which must be improved. Every day you run into problems which a simple idea can solve. It may be a new toy for your children. The man who invented the Kiddie-Kar, it is reported, made over $5,000,000. It may be a new kind of soap. E. T. Babbitt is worth millions of dollars today. It can even be a new kind of broom to make housework easier for millions of housewives. But no matter what it is—if your idea is practical, if it solves a problem, if it satisfies a need—a fortune may be waiting for you. This bureau is not connected with patent attorneys or manufacturers. Its only purpose is to teach you the principles of practical invention used by every successful inventor. Write for the FREE BOOK now.

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Name ..... Age.....

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They Called Me a "Human Clam"

But I Changed Almost Overnight

AS I passed the President's office I could not help hearing my name. Instinctively I paused to listen. "That human clam," he was saying, "can't represent us. He's a hard worker, but he seems to have no ability to express himself. I had hoped to make him a branch manager this fall, but he seems to withdraw farther and farther into his shell all the time. I've given up hopes of making anything out of him."

So that was it! That was the reason why I had been passed over time and again when promotions were being made! That was why I was just a plodder—a truck horse for our firm, capable of doing a lot of heavy work, but of no use where brilliant performance was required. I was a failure unless I could do what seemed impossible—learn to use words forcefully, effectively and convincingly.

In 15 Minutes a Day

And then suddenly I discovered a new, easy method which made me a powerful speaker almost overnight. I learned how to bend others to my will, how to dominate one man or an audience of thousands. Soon I had won salary increases, promotion, popularity, power. Today I always have a ready flow of speech at my command. I am able to rise to any occasion, to meet any emergency with just the right words. And I accomplished all this by developing the natural power of speech possessed by everyone, but cultivated by so few—by simply spending 15 minutes a day in the privacy of my own home, on this most fascinating subject.

WHAT 15 MINUTES A DAY WILL SHOW YOU

- How to talk before your club or lodge
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- How to propose and respond to toasts
- How to make a political speech
- How to tell entertaining stories
- How to make after-dinner speeches
- How to converse interestingly
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- How to enlarge your vocabulary
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- How to acquire a winning personality
- How to strengthen your will-power and ambition
- How to become a clear, accurate thinker
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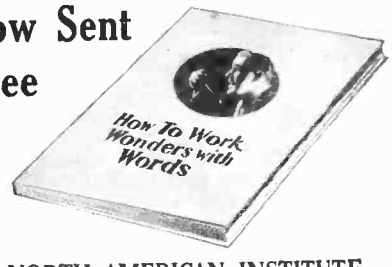

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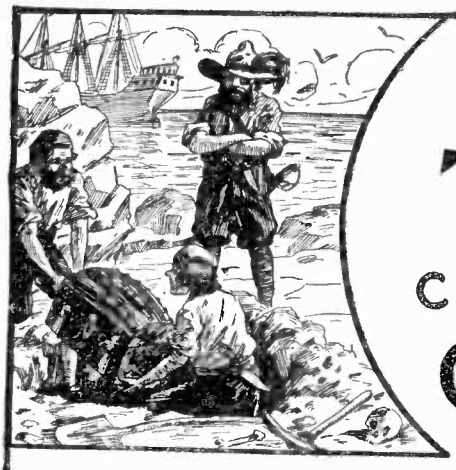

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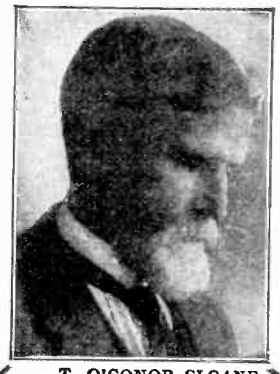

T. O'CONOR SLOANE, A.B., A.M., LL.D., Ph.D.
Noted Instructor, Lecturer and Author. Formerly Treasurer American Chemical Society and a practical chemist with many well known achievements to his credit. Not only has Dr. Sloane taught chemistry for years but he was for many years engaged in commercial chemistry work.

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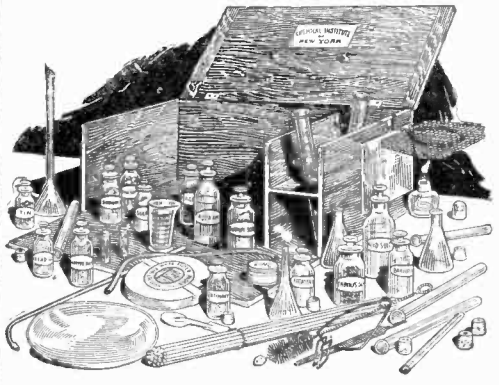

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Science and Invention

March, 1926
No. 11

Editorial and General Offices, - - - 53 Park Place, New York

"Those Who Refuse to Go Beyond Fact Rarely Get As Far As Fact" - - - HUXLEY

WHAT IS THOUGHT?

By HUGO GERNSBACK

WHAT is thought? This is perhaps one of the most difficult questions to answer correctly in popular language, without going into abstruse technicalities. As a matter of fact, psychologists and scientists alike are not at all agreed upon the mechanics and nature of thought and what processes go on in the inside of the human brain in the evolution of a thought.

Although there is a great deal of literature on the subject, very little of it can be understood by the layman. The ideas on the subject which I am presenting here are, for the most part, my own, and are very likely open to criticism; but I believe that from a scientific standpoint they are sufficiently correct for a popular treatment of the subject.

According to William James, the first fact of psychology is —not that mind exists, but that thinking goes on by a sort of phenomenon. The nearest approach to explaining this would be to use the impersonal term "It thinks," in the same way that we say "It rains." This statement, of course, is unsatisfactory in many ways, because it does not go down to the root of the question.

I believe that all thinking must be traced back to what we are pleased to term "animal instinct." From this, ordinary thinking probably evolved in the dark ages long before human speech was known. For instance, many people will say that a dog does not think. I do not share this view, and insist that most dogs do think, although only in a very primitive way. For instance, you have trained your dog to bring your slippers. The process, then, is as follows: You say "Tiger, get the slippers!" This spoken command, through the dog's auditory nerves, forms a picture in his mind that associates itself with slippers, which he knows as a pair of physical things. His entire nervous and muscular system immediately reacts to this and he brings the slippers. This, of necessity, must be a thought complex and can not be called instinct.

Furthermore, I make the assertion that any living being that can dream must of necessity think. And we all know that dogs dream, by actual observation, when they cry out in their sleep, as every dog-lover knows. The same is the case with many other highly-developed animals. Many psychologists today believe that no thinking can go on unless there is a mental picture of whatever is thought about. I do not share this view for the simple reason that I know that blind people who have never seen anything are capable of thinking perhaps just as well as those who see. Even those born blind and deaf, as, for instance, Helen Keller, can be taught to think clearly without a true picture in the mind and without sound associations.

It is probable, however, that the answer to the question lies in the statement that thought is not possible, unless it is based upon outside impressions. Whether these impressions are obtained through any or all of the five senses is immaterial. This, I believe, can be proven by the fact that whatever you think of must be associated with some experience that you have had at one time or another, or with a combination of a sort of "anticipated experiences," if I may use such a term. The inventor uses such a procedure by thinking of a machine that does not as yet exist. In that case he works it out in his mind from past experience impressions, adding to these new subjects, which new subjects may, of course, be old experience subjects, but the entire machine will then be "new."

We do quite a good deal of various thinking that, as a rule, we are not even aware of. For instance, before speaking a sentence it is necessary to think out the sentence in our minds. Most of our thinking is nothing but internal or "mental speech." This means a mental use of words. We can also think music, as every one knows. This is simply repeating an aural impression made some time past, which impression has been retained by the mind and is brought out again by a special mental faculty, our memory, when we think of the music. Thus, a composer, when thinking of a new composition, must work out this composition the same as a child fits blocks together to build his house.

We can even think of a taste without eating at all. We can think of certain smells, and we can think all of the other senses whenever we wish to. The reason here, of course, is that we are simply repeating outside impressions as they were made upon us, the same as if we had a phonograph record disk inside of our mind, which we revolved every time we desired to bring forth any impression at will.

If any proof is wanted that thought must be derived from an impression of an outside experience, the following will make this clear: I can not say that blue is blue, or that red is red, unless I am familiar with the original ideas of blue or red. Some one must have taught me what was blue or red before I could think of such colors.

Speech and thought are so interlaced today that even the psychologist does not know where one begins and the other ends. It can be proved by experiments that you must actually think before you speak, but this process is so rapid that when listening to an orator, for instance, you would not think that such is the case. But, nevertheless, there is a certain time lapse, no matter how quickly he talks, between the thought and the spoken word. It is also true that many sentences can be spoken by experience without a conscious thought. For instance, you say "I feel cold." The outside impression here was that the body feels cold and the expression, "I feel cold," is let loose immediately without any perceptible thinking operation at all.

This is similar to reflexes as, for intance, when you suddenly drop a pencil to the floor. With lightning rapidity you will reach for the falling pencil, all depending upon how quick your reflexes are, without a conscious thought in your brain telling your hand to reach out for the pencil.

This is simply an "experience action" and many sentences and words are experience actions of this sort, where conscious thinking is no longer necessary.

Thought and speech go back into the dark ages, and the first word probably was nothing more than a guttural cry, comparable to the sounds most animals of the higher species now use. For instance, we have the war cry, the hunger cry, food cry, etc. These "word cries" in time became lengthened, as the human being felt the necessity for better communication among themselves, and from this language originated.

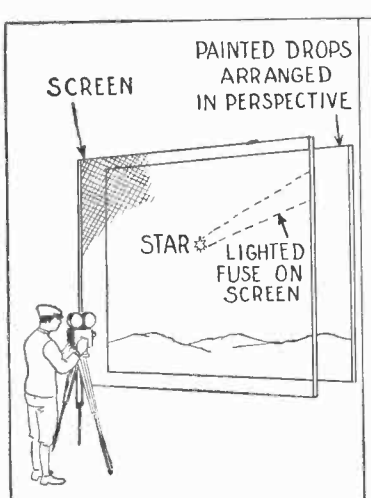
What I have said here of course touches only the highlights of the subject. It does not go into complex thinking as, for instance, logic, concept, imagination, inference, memory, and many others.

Mr. Hugo Gernsback speaks every Monday at 9 P. M. from Station WRNY on various scientific and radio subjects.

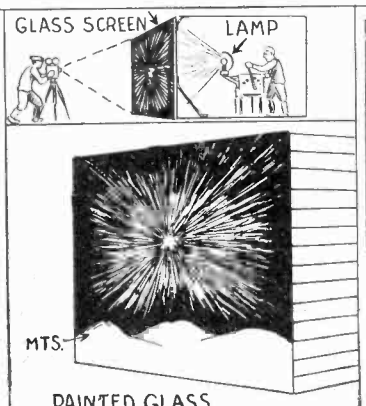
BEN HUR---WONDER MOVIE

Authentic Reproductions of Ancient Buildings and Ships in Full Size and Detail Characterize Film.

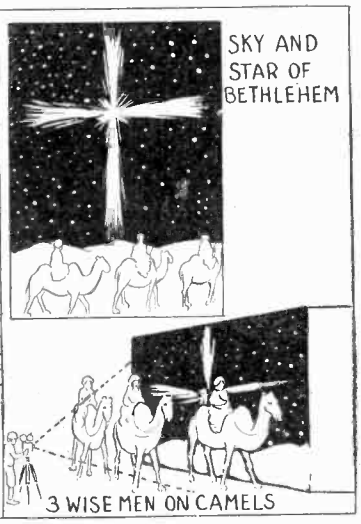
By H. WINFIELD SECOR

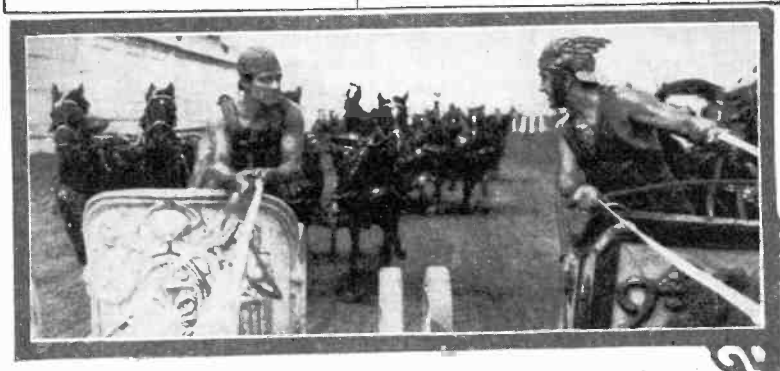


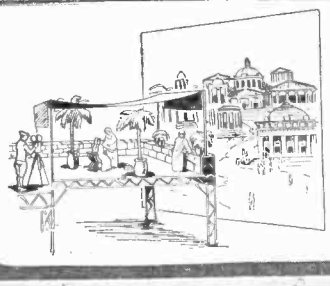
STAR OF BETHLEHEM AS THE PUBLIC SEES IT.



PAINTED GLASS (OPAQUED ON BACK) STAR TRANSLUCENT WITH ELECTRIC LIGHT BEHIND SAME

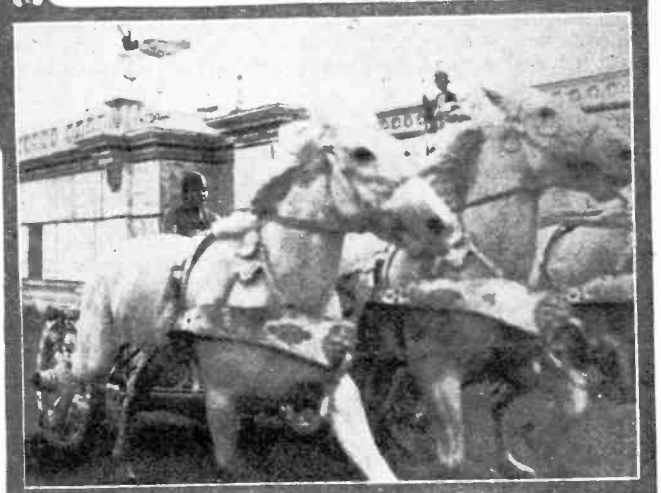


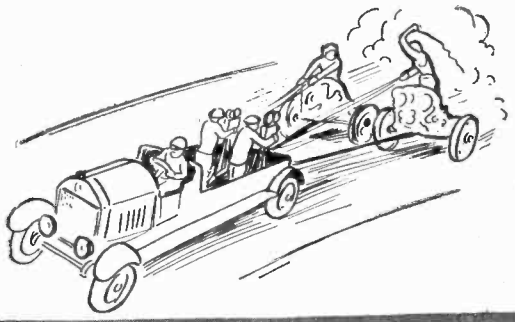


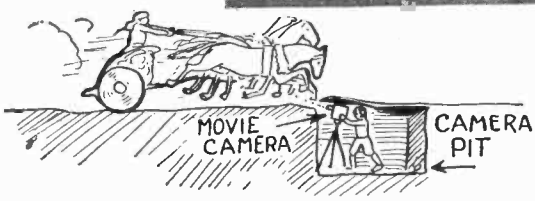


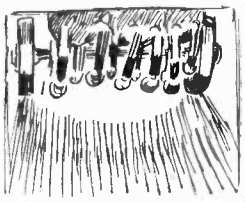
How roof garden effects are produced with painted scenes.

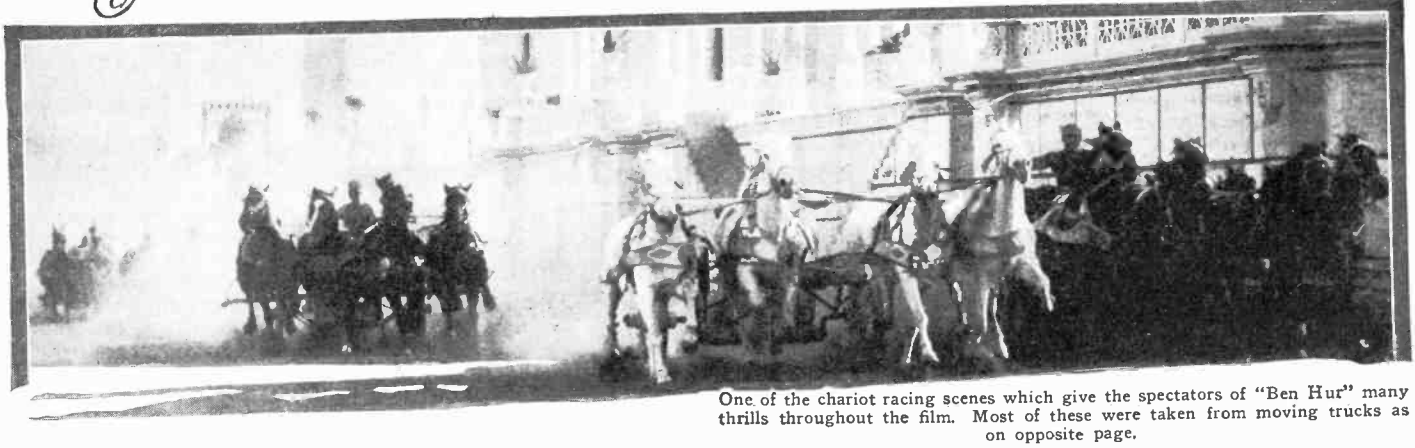
The picturization of the story of Ben Hur by Metro-Goldwyn-Mayer has recently been completed at an approximate cost of $3,500,000. Two years were required for the completion of the film, some of the scenes being taken in Europe and some of them in Hollywood, Calif. The line illustrations across the top of this page depict how the opening scenes of the picture were photographed. The effect of the star of Bethlehem appearing across the sky was produced by close-up shots of a stream of powder burning on a metal screen, after which the film was reversed to give proper sequence. The three wise men and their camels were produced against the background of the star and the heavens as shown. Photos such as that directly above were made by means of the system shown immediately below, the chariots being fastened to the truck. Close-ups of running feet of horses were taken from pit shown.



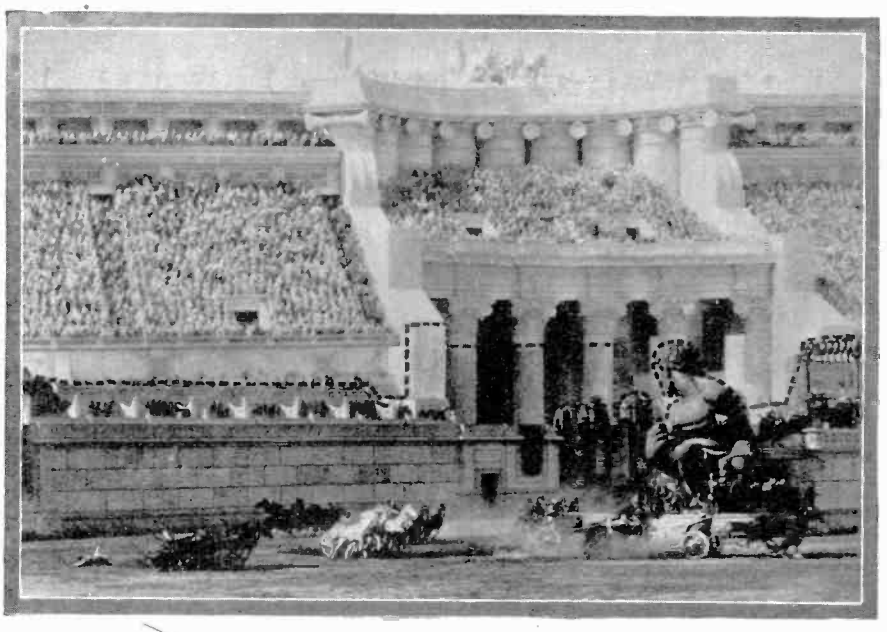


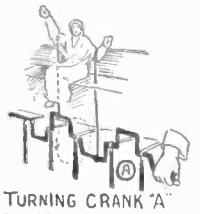




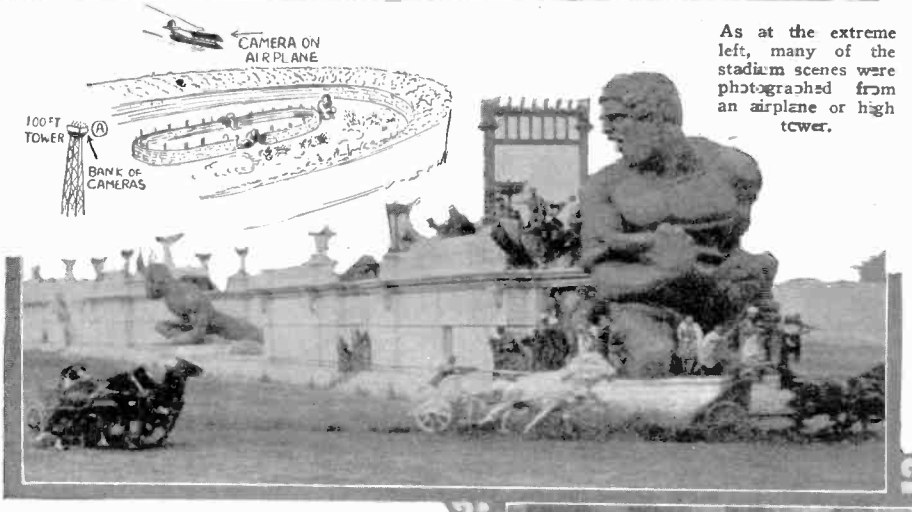


One of the chariot racing scenes which give the spectators of "Ben Hur" many thrills throughout the film. Most of these were taken from moving trucks as on opposite page.

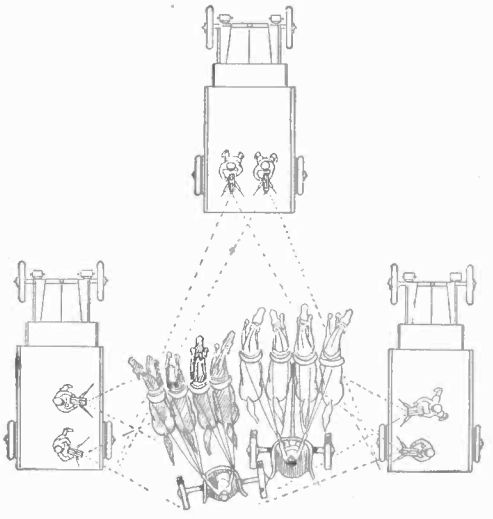




The part of the photo at the left located below the dotted line was a full size setting and that above was a miniature, photographed as in the lower right-hand corner. Dolls populated the upper seats and were moved as shown in the drawing above.



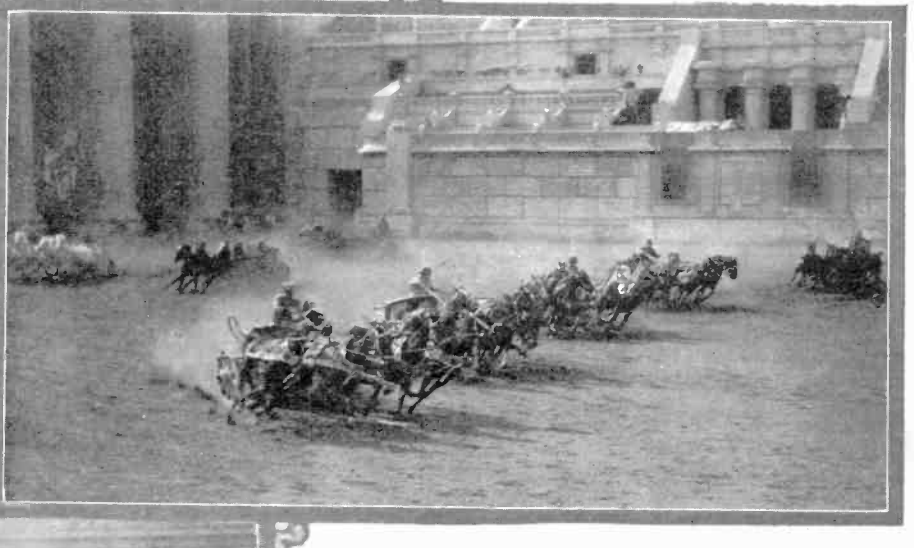
As at the extreme left, many of the stadium scenes were photographed from an airplane or high tower.



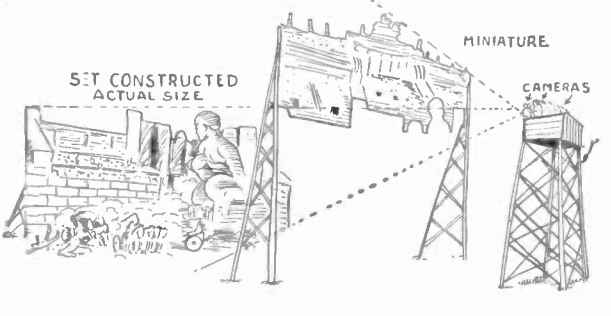
Above: How many of the chariot racing scenes were taken. Note that the wheels of the two racing chariots are interlocked. A foot-operated bolt released a chariot wheel at the desired moment.

Throughout the famous chariot race of Ben Hur many accidents occurred and the methods of filming these are shown. On some of the chariots, one of the wheels was so arranged that the driver could, at the proper time, release that wheel so as to cause an accident such as that shown in the photo below. The same method was used where two chariots locked wheels as shown in the drawing on this page.

Thousands of feet of film were "shot" in making this picture and the various points from which the scenes were photographed and the methods used are illustrated in this article. Often six or more cameras were used for one scene.



Above: One of the premeditated accidents that was staged at a predetermined moment when the chariot would be at a most advantageous position within the camera lines. Many actors risked injury in such scenes as this.



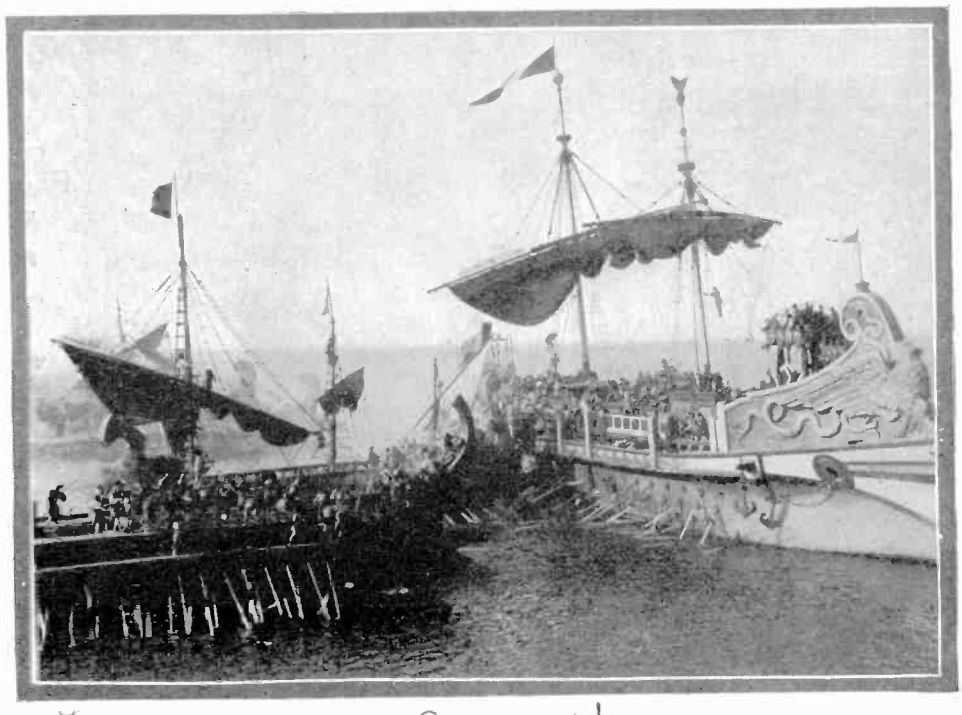
How full sized and miniature scenes were used in combination in order to give an effect such as that shown in the upper left-hand corner of this page.

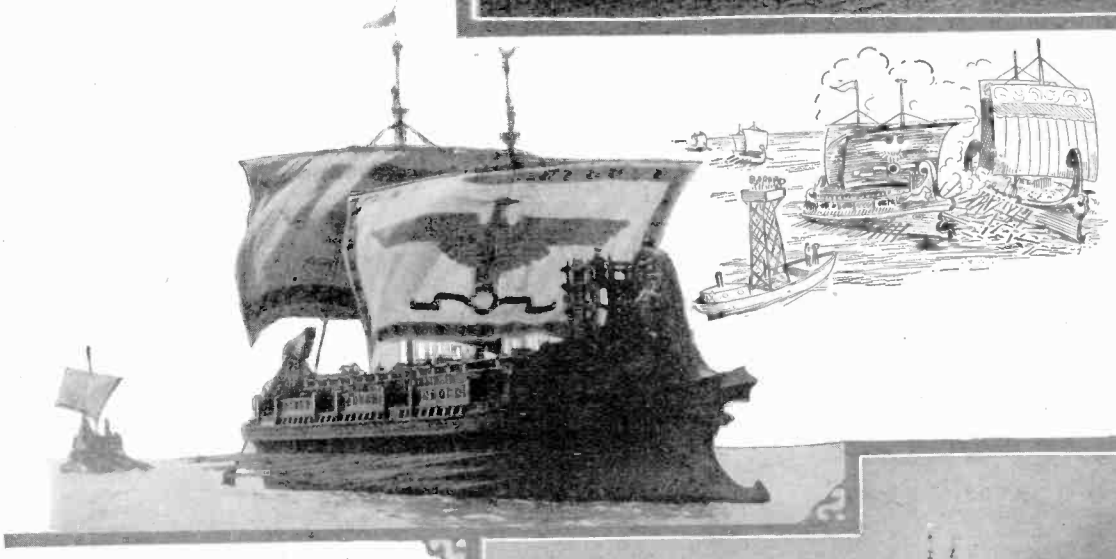
(Continued on next page.)

Naval Scene In "Ben Hur"

IN order to realistically reproduce some of the naval scenes called for by the story of "Ben Hur," many complete reproductions of the ancient Roman ships and pirate galleys were actually built and sailed. A battle between two such ships is shown in the photograph at the right and from this, an excellent idea of the completeness of detail that was carried through the building of these ships can be obtained.

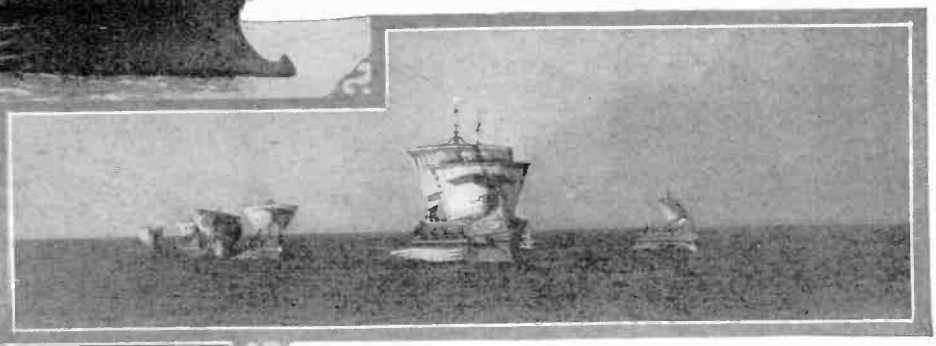
During one of the naval battles, one of the large ships catches fire and all of the ensuing scene was taken of an actual life sized vessel in full blaze. The actors on board this ship stayed in position until they were in actual danger of their lives and then finally jumped and swam. They were offered bonuses for staying on board as long as it was physically possible for them to do so. Scenes such as this and others taken of the various vessels were photographed from high towers erected on barges that were maneuvered to advantageous positions. In the story, the hero, Ben Hur, performs an heroic rescue act wherein he saves the commander. Below: One of the huge ancient types of vessels that was especially built for this picture of "Ben Hur." Note the antique superstructure and sails.

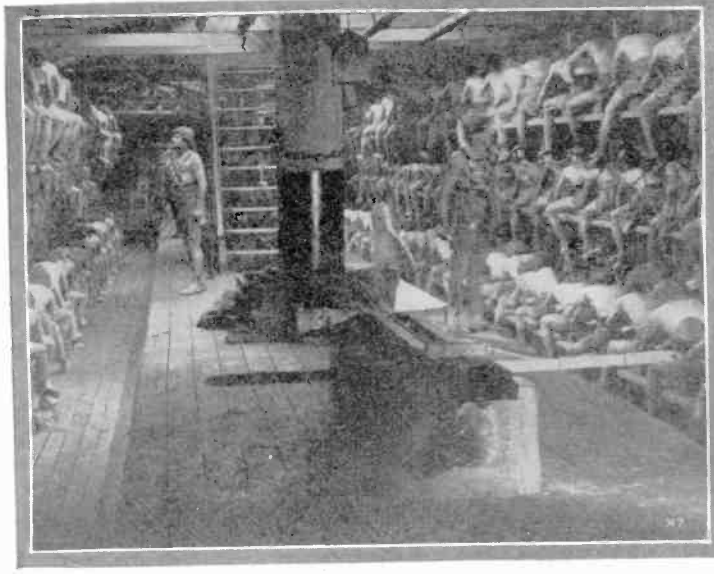




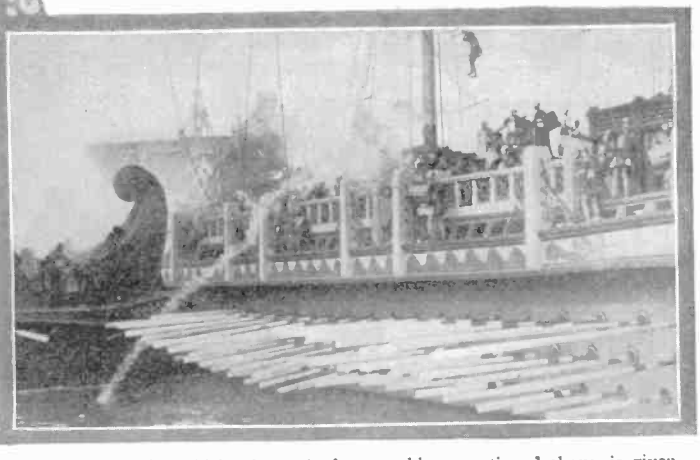
The drawing at the left shows how the sea battles were filmed from a tall tower located on another boat nearby. During this scene, one ship actually rammed the other whereupon the pirate crew boarded the Roman vessel which latter was then fired as mentioned above. This drawing illustrates the action of photo above

In order to assist in the filming of some of these naval scenes, a complete miniature fleet was also constructed and this was photographed in action in a studio tank, giving the effect shown in the photograph at the immediate right. This was so cleverly done as to be practically undetectable.





In many of the scenes in this film, natives of various eastern countries were hired to play the parts of "extras" so as to lend local color and atmosphere to the film.



Above: A scene inside of one of the Roman galleys. Here again, the completeness of reproduction of various ancient ship building phases is particularly noticeable. In this scene, Ben Hur is at one of the oars.

A close-up of the collision between the two ships, mentioned above, is given in this photograph. Note how the three banks of oars are in perfect alignment. In the film, they are operated in absolute unison.

TRAINING WILD ANIMALS

By DR. ERNEST BADE

Although the trainer carries a whip, it is seldom that he uses it to inflict pain. Rather, it is employed for its psychological effect on the brute's mind. The beasts soon learn to respect their master's voice and the cracking of the whip.

THE training of wild animals is an ancient calling which came into popular favor at the time of the Roman Cæsars. At that time, in the mighty Colloseum, the ampitheatre of Rome, where the gladiators battled, the performing of trained wild animals was one of the main attractions. Untold numbers of lions, leopards and other wild beasts were brought to the capitol by their mighty fleets. Trained lions drew the chariot of the emperor and tame lions were kept by the noble women of Rome. The training of wild animals gradually degenerated until, finally, it practically ceased and they were only shown in bloody combat.

The highest pinnacle in the training of animals was attained after the zoölogical gardens, as we know them today, were developed. It was then that the traffic in animals of all kinds rose to its height and that fearless men again took up the profession of training these creatures from foreign lands.

It was not love for the wild creatures that induced man to take up the hazardous task of training the majestic and stately beasts of prey, but rather the thought of the gain it would bring the person showing such *trained* beasts. Unspeakable were some of the means employed to bring the lords of the wild under the subjection of man and subservient to his will. The poor creatures were so ill-treated and misused and even tortured by the trainer, that they climbed the bars of the cage in fright or whimperingly crept into some far corner, in an attempt to escape their tormentors, of such cruelty were some of the methods used by the trainer of long ago. Is it any wonder that under such conditions the animal will await its chance and pounce upon its tormentor at the first opportunity in payment for all its long suffering?

FUNDAMENTALS OF ANIMAL TRAINING

Not so many decades ago a number of persons in sympathy with the unfortunate wild animals brought about a gradual reorganization in the methods used in training. It is not brutal force alone, but a study of each individual creature which is the key to the work, and through this study the best means of training is soon found. Of course, it is true that the beasts of prey must be subservient to the will of the trainer. The large yellow-striped beast and the spotted cat all must learn that man is the master, and in order to help make them understand this vital fact, it is absolutely essential for the trainer to know when and when not to use the whip.

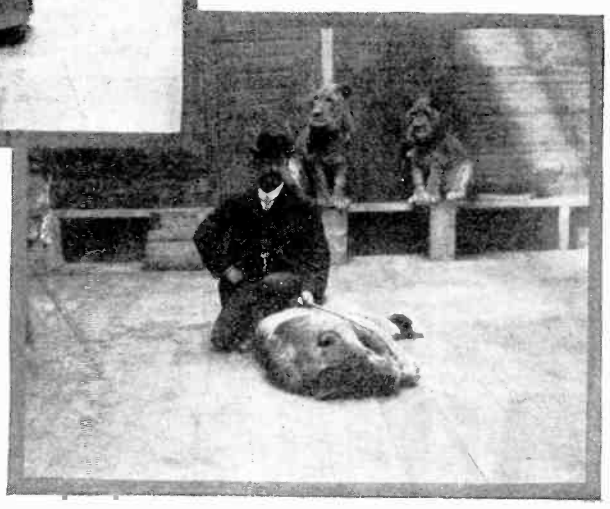
The training of wild animals is by no means an easy accomplishment. It requires infinite patience and much hard labor and demands a knowledge, based upon study, of the inherent characteristics of each animal. But the results, which are then obtained, are certainly marvelous, to say the least. The unconscious, underlying thought of everyone watching the performance of trained animals is that the mind of man is *apparently* triumphant over brute force. The power of the eye has nothing to do with it, it is a fairy tale for the story book. But only he who has ever been fortunate enough to witness the trainer putting the animals through their paces during the morning practice hours can appreciate the time and the patience and the hard work that is back of every animal act and the influence the training has, usually for good, upon the animal itself.

In spite of all this, the beast of prey remains an uncertain quantity. Its entire nature rebels against the work it is forced to accomplish and, at some opportune moment, often without cause, it forgets the mental superiority of man, who forced his will upon it, and attacks his lord and master. As a rule, such attacks are so sudden and so unpremeditated that is is impossible to prevent them.

GREAT PATIENCE REQUIRED

There are three main requirements demanded of trainers; these are patience, then some more patience, and finally still more patience. At first, the animal probably finds the tricks it is to do entertaining and does them with a certain amount of joy. This is followed by a period of distaste for these same tricks, when custom and obedience seem to fall away and sulkiness takes its place. This is the time that the trainer must show that he is the master and that no caprices and disobedience will be permitted. But this is only possible when a certain amount of punishment is provided, but, above all, the trainer must never lose his patience. It is only with unfailing good humor that the trainer can arrive at his purpose; he must make the animal perform the same trick over and over again, hundreds of times,

(*Continued on page* 1050)

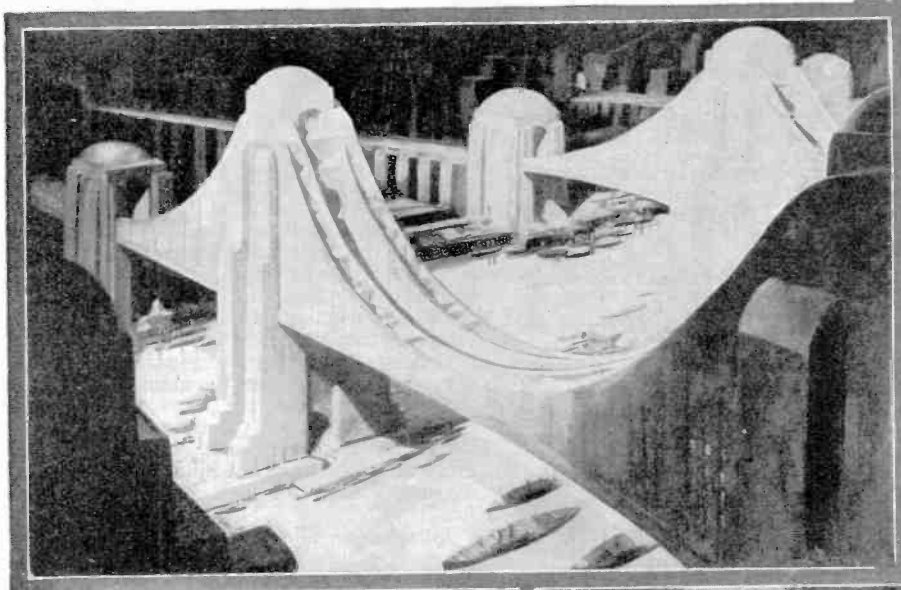


Rather an unusual type of fur neckpiece is shown in the photograph above. Would many of the ladies like to carry a live wild animal around for this purpose? However, both the lady and the animal in the picture seem to be enjoying the experience. In the photo at the right, another animal trainer is shown with some of his obedient beasts.

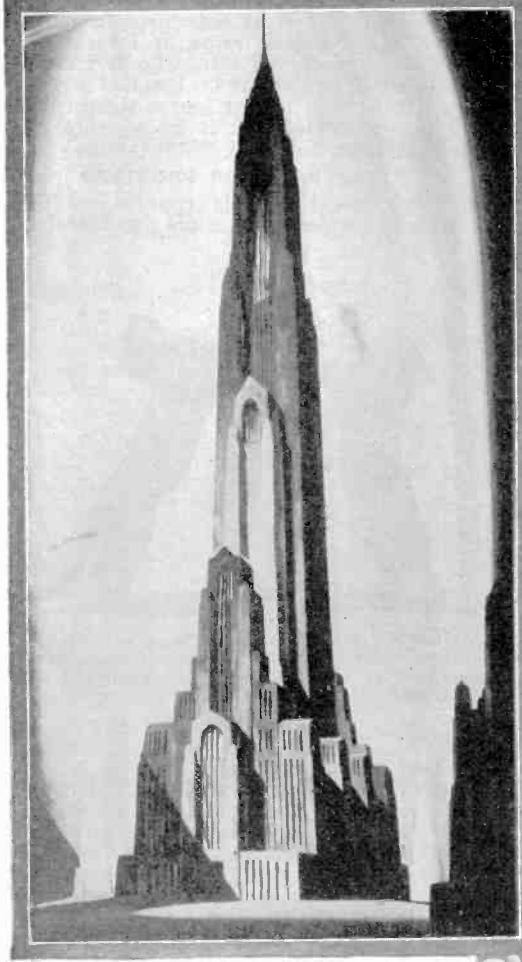
Rather a playful pastime it must be to hold two wild animals at arms' length, as demonstrated by the young lady in the above photograph. If you want to sample this, try it on the family cat.

Architecture of the Future

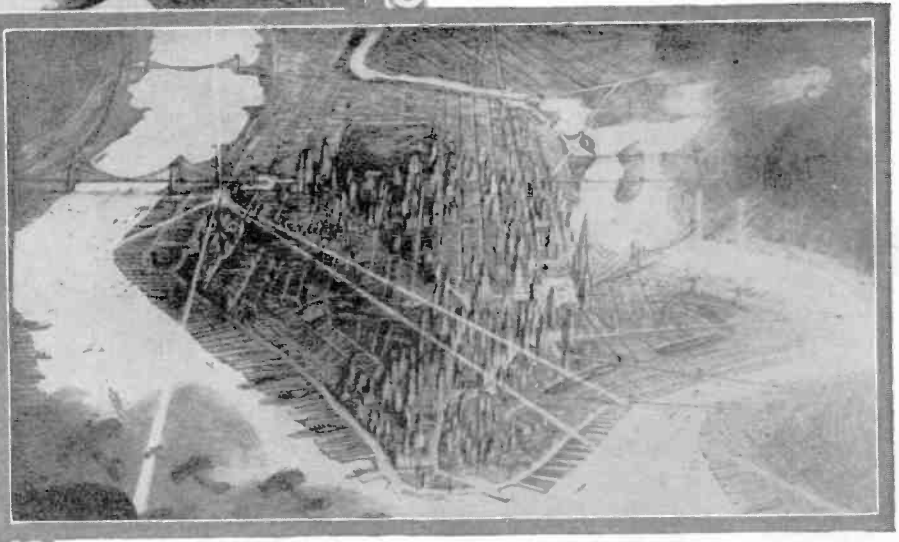
The illustrations on this page are reproductions of paintings made for the tercentenary anniversary of New York City and exhibited in John Wanamaker's. The one below shows a possible construction of bridges of the future, in the columns of which offices and apartments are located. This is made possible by the extreme width and height of these supports.



Above: Looking upward from a street surrounded by buildings, such as some of the present-day artists believe will constitute the architecture of the future. Note the unusual constructional details of the various edifices and the strange types of aircraft above them. Of unusual design is the lighter-than-air craft seen in the center of the picture. Will any of the present generation live to see sights such as these depicted?

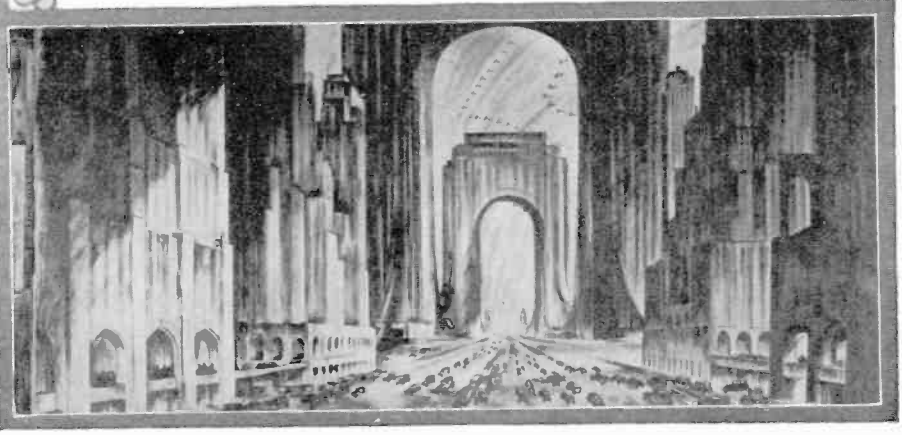


An architect of the present day has designed a skyscraper that could be built by following the present zoning laws. An artist's conception of this design is shown in the illustration directly above. Note the method of terracing the various heights, so that the building will be mechanically strong and able to withstand the stresses to which it may be subjected.



Above: A view of Manhattan Island taken from the air, as it may appear in the future. Even our present-day Woolworth Building is dwarfed to insignificance by the grandeur and enormous size of surrounding buildings. Note the Hudson River bridges and the central distributing point for radio power from which aircraft and other motive units obtain their power for propulsion.

Below: Looking down a street of the future. The sidewalks are elevated and protected and the stores are all of the arcade type. The streets are amply wide enough for motor traffic and every available space is made use of. Air travel of the future is touched upon in this illustration by showing a series of airplanes in flight above the arch in the background.



Is Einstein Right?

By Prof. Donald H. Menzel, Ph.D.

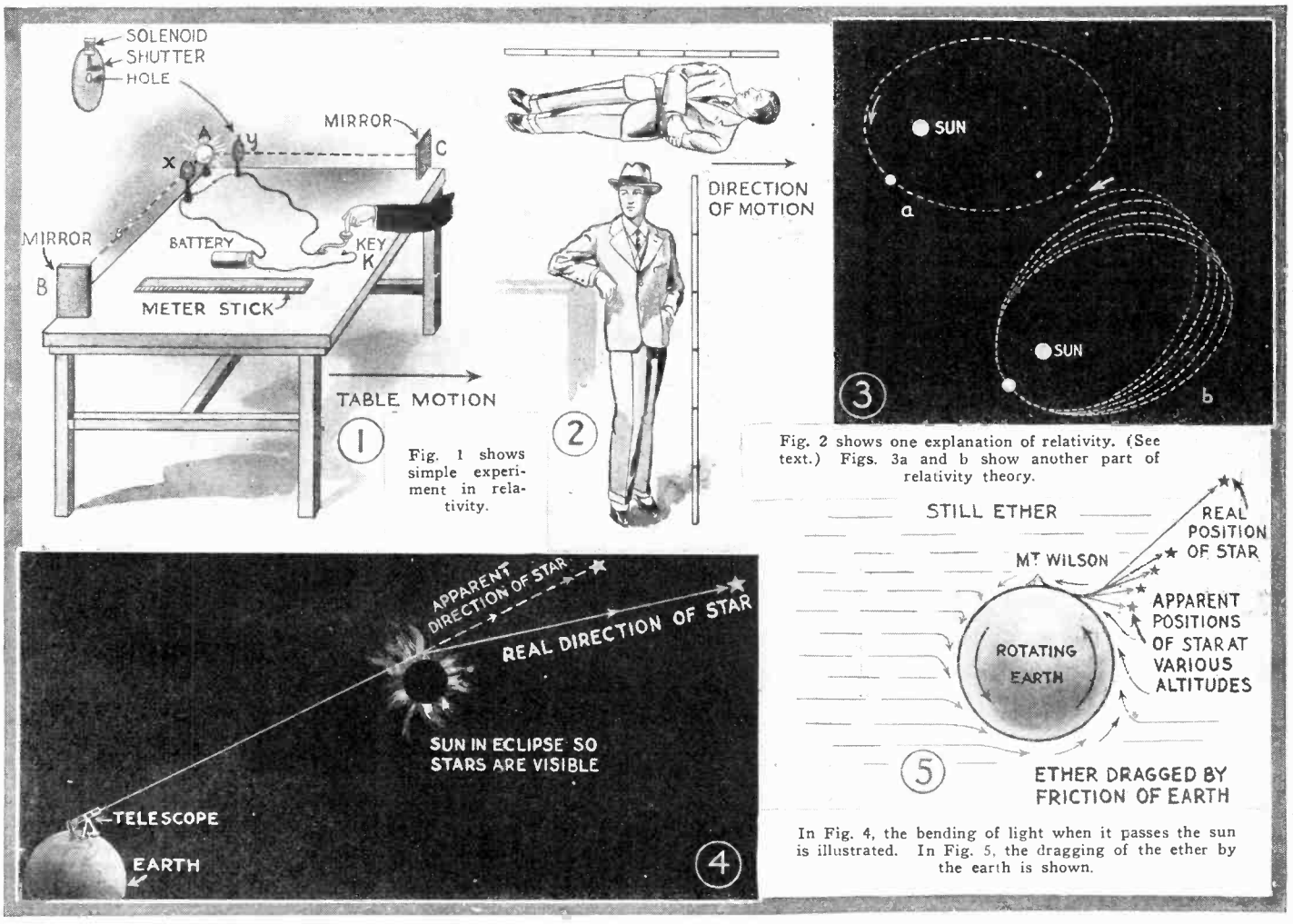


Fig. 1 shows simple experiment in relativity.

Fig. 2 shows one explanation of relativity. (See text.) Figs. 3a and b show another part of relativity theory.

In Fig. 4, the bending of light when it passes the sun is illustrated. In Fig. 5, the dragging of the ether by the earth is shown.

Every so often, arguments are put forth, pro and con, regarding the Einstein theory of relativity. "Is Einstein right, or is he wrong?" is the question of the day. First one experimenter puts forth proofs that fully support the famous theorist, and then another one comes along, performs some other experiments and immediately proceeds to tear down all of the work of years that has been done. The battle still continues and in the pages of this magazine we are attempting to put forth the various phases of the situation and so aid our readers in obtaining a knowledge of the Einstein theory. The article presented here and illustrated above is to be heartily recommended.

FOR the past year newspapers have repeatedly been printing notices to the effect that Einstein has been disproved—so much so that the layman is likely to get the notion that the famous theory of relativity is now to be regarded more as a mathematical curiosity than as a representation of physical facts. Nothing can be further from the truth. Those scientists who insist today that Einstein is wrong are, on the whole, those who have never believed that he was right. They have made few converts to their side, though their opinions should be respected. It is to them that we owe many of our advances for, in order to convince them, we have sought new proofs—new demonstrations which have placed the Einstein theory on a firmer foundation than it has ever stood upon before.

NEWTON'S LAW OF GRAVITATION STANDS

The Einstein theory, like all great advances in scientific thought, embodies a mental effort in picturing the new. The contemporaries of Columbus found it almost impossible to visualize a spherical earth—a fact that we now accept without question. Like other great theories, it does not overturn all that has preceded it, but includes it as part of a greater whole. Talk of discarding the law of gravitation and belittling Newton is nonsense. The discovery that the earth was round did not destroy the usefulness of plane surveying. There is no denying that the mathematics used in developing the theory of relativity are too difficult for the average person to understand. Many of the consequences of the theory, however, may be grasped by those who have no previous knowledge of mathematics and physics.

OBSERVATION AND THE EINSTEIN THEORY

In the July issue of SCIENCE AND INVENTION, the author published an article in which the relation of the Einstein theory to the law of gravitation was discussed. Considerable comment has arisen from the remarks contained therein—most of them in the form of letters berating the theory of relativity as contrary to experience. Those who have raised the question are entirely misinformed as to what the theory pretends to accomplish. It appears to explain many minute discrepancies which, hitherto, remained a mystery according to the simple laws of gravitation. The deviations of which we speak are so small that no one could detect them as a result of experience. they would only become noticeable at very high velocities or near exceptionally large masses. Can one judge the effects of a rifle bullet accurately from experiments on a feather blown gently into the air? Experience? What is it but a personal interpretation of events with which we are familiar? Any new and unexplainable event is called a miracle.

Upon what, then, are we to build our theories: experience, which deals with things as they seem to be; or experiment, which deals with things as they are? To one who has studied astronomy—and the immensity of the universe—the smallness of man is so apparent that personal interpretation of events is realized often to be in error. *Experiment* is the real criterion for judging truth; and the Einstein theory rests its case upon the following evidence—that it fits the facts.

THE KEYSTONE OF RELATIVITY

The foundation of the theory of relativity may be grasped from the demonstration diagrammed in Fig. 1. A is a source of light. x and y are screens with a single hole, fitted with a shutter controlled by the key K. Pressing it opens and closes both of them simultaneously so that a short flash is sent speeding to the mirrors B and C, where they are reflected back over the same path, the shutters conveniently opening to let them return to the starting point.

If the table upon which the instruments are set is perfectly at rest and if the distance AB and AC are made equal, it is obvious that the two flashes will return at the same instant. If, however, the table is

(*Continued on page* 1048)

The Radio

Also Containing a Summary

By JOSEPH H.

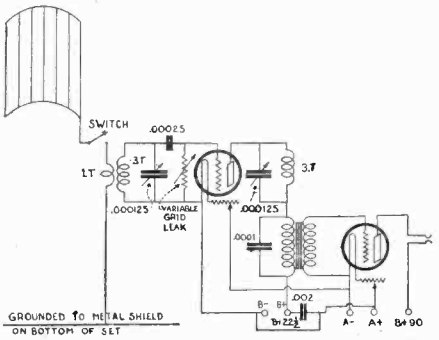


Fig. 1. The above diagram gives the circuit of the radio gold exploring device and shows particularly the receiving part of the apparatus. It will be noted that this is a short wave receiver, using the parabolic radio wave reflector as an antenna and a metal shield on the box as a counterpoise.

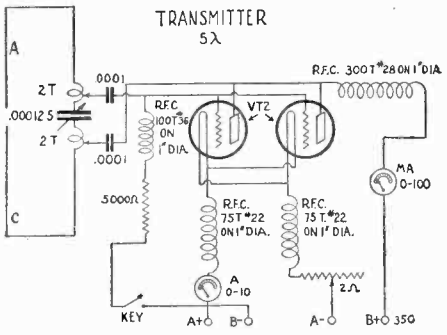


Fig. 2. The diagram of the five meter transmitter, a part of this radio ore locator, is given above. A indicates the antenna, and C the counterpoise. The transmitted beam is reflected by ore bodies and picked up at the receiver.

THE quest for hidden gold has caused the expenditure of countless fortunes. All sorts of contrivances and devices have been used. Frequently absolutely fraudulent systems have met with success, and on the other hand even the scientific ore locators have produced no fruitful returns. The difficulty with most scientific gold explorers and locators is that so much time is required in plotting a certain area and removing all possible chance of error. This difficulty is particularly apparent in the Eotvos balance illustrated in Fig. 3. This balance is quite heavy, difficult to transport and in operation is completely shielded by metal shields. The balance is extremely sensitive, however, and consequently must be secured and adjusted in place before measurements

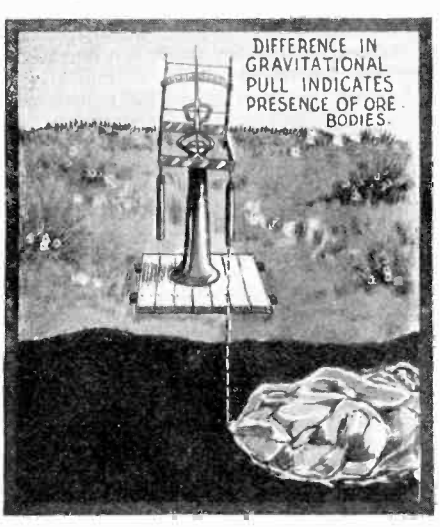


Fig. 3. The above illustration shows the method of using the Eotvos Torsion Balance. This was designed by Baron Roland von Eotvos of Budapest. It is placed near to the edge of a supposed mineral ore area, and due to difference in gravitational pull, indicates the presence of these bodies beneath the surface of the earth.

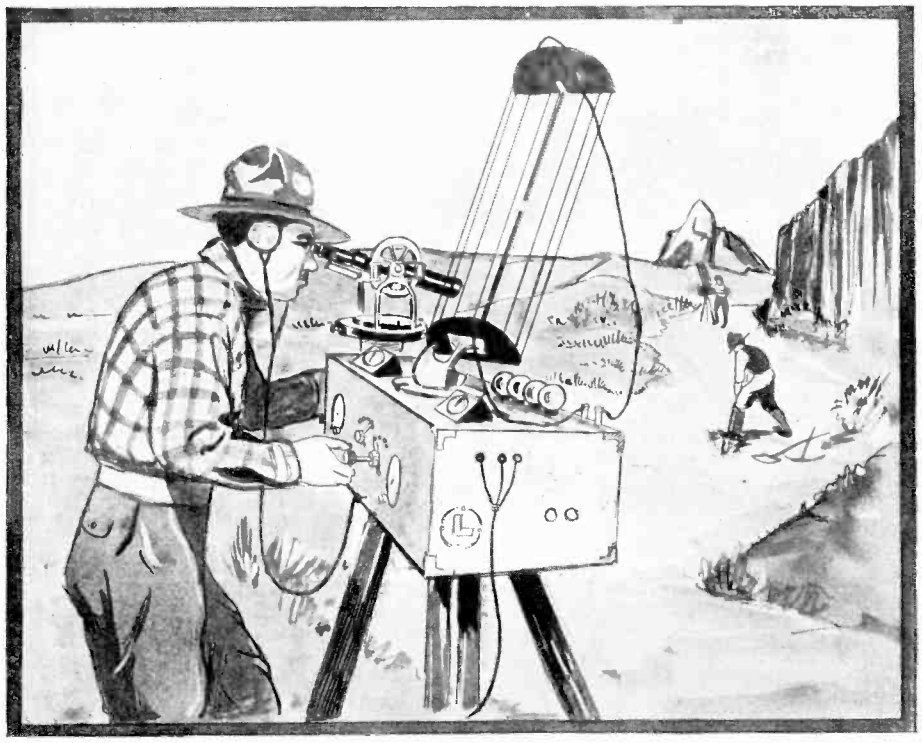


Fig. 4. The above illustration shows the radio gold explorer in operation. The directive radio beam being sent out from the apparatus in the distance, which at the present time is being used as the transmitting end, is picked up at the set in the foreground. The beam from the transmitter is reflected by subterranean ore bodies or chests of gold. By means of the surveying instruments the exact position of the hidden treasure can be pointed out and attempts to secure it can easily be made.

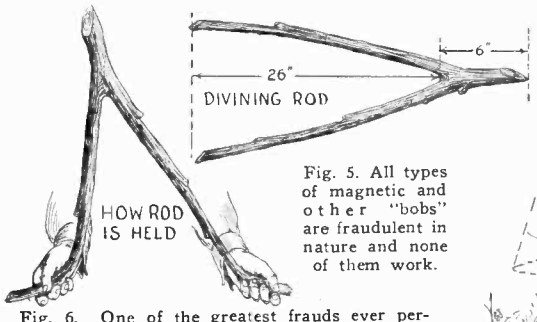


Fig. 6. One of the greatest frauds ever perpetrated is the "divining rod." The diagram above, illustrates how a divining rod is held. The one in the center shows the actual dimensions of a twig to be used for this purpose. Hazel wood is generally used.

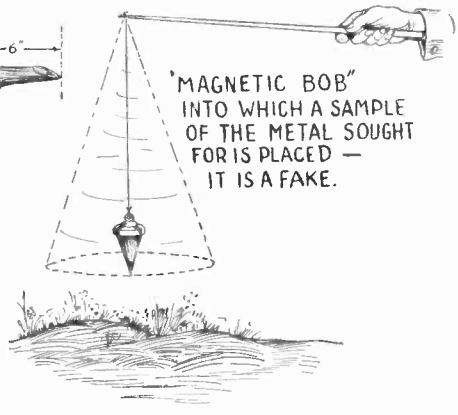


Fig. 5. All types of magnetic and other "bobs" are fraudulent in nature and none of them work.

are made. Should the balance center itself over a vein of ore, it would give no reading, whereas if placed at the edge of such a vein, the gravitational pull upon one arm of the balance would be greater than that upon the other, and consequently the balance would give a reading. By moving the balance, the area of the ore body can then be determined.

A really scientific ore locator is the one employing the principle of reflection of radio waves by subterranean metals. It has long been known that a radio wave is reflected by any metallic body, the same as a light ray is reflected by means of a mirror. If a very directive radio beam is sent out, and the submerged body offers a relatively flat surface, such as a casket of gold would furnish, or as a flat vein of ore might be expected to produce, that radio beam is again reflected after it penetrates beneath the soil to the surface of the ore and is picked up by the receiver. It is now a simple matter to read off the inclination of the parabolic reflector at both the transmitting and receiving ends, and then set the surveying instruments accordingly. The point of intersection would be the location of the treasure. In view of the fact that short waves do not penetrate the soil to a very great extent, it is

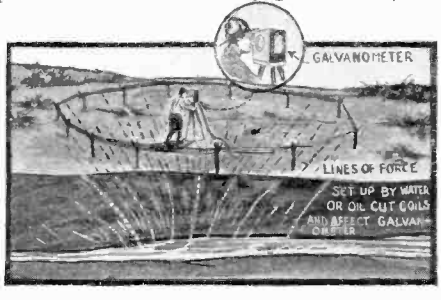


Fig. 7. Mansfield's oil and water locator operates on the principle of electrical currents being set up by flowing water, from which the magnetic lines of force pass upward and cut the earth coil, indicating a current which affects the galvanometer.

Gold Explorer

of Ore Locating Methods

KRAUSE

possible in this way to limit all surveying to the discoveries of metals within easy reach. The circuit diagrams for both the receiving and transmitting end of this particular device are shown in Figs. 1 and 2.

For a great many years faith has been placed in such devices as the divining rod or the magnetic bob or other bobs swinging freely from a pendulum containing, as some inventors claim, such substances as radium or radium salts. The latter device is indicated in Fig. 5, but it may take on any other form, for instance, the device may be a vial suspended from a string, or it may be a ball suspended from a string. The stick itself

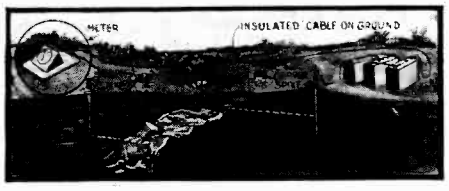


Fig. 8. Veins of ore have been located by means of the earth conduction system illustrated above. It is evident that the resistance of the earth would change if there were a conducting vein of ore somewhere between the two copper electrodes driven into the earth. A mineral spring would also change the earth's resistance.

is not a requirement. The inventors of these devices claim that if a piece of gold is put into the vial or into the bob, that the bob will sway back and forth pointing in the direction where the body of gold has been buried, and when the bob is directly over the treasure, it is reported to assume a circular motion, as Fig. 5 indicates. These devices are all fakes, they never did work and they never will. In order to induce a purchaser to buy a device of this nature, he is frequently permitted to manipulate the apparatus himself. A coin or some other piece of metal is hidden from view in his presence, and he is then instructed to use the device to locate it. The subconscious action on the part of the user makes the bob sway as he is told it would sway, and when he is at or near the position of the concealed object, the bob takes on a circular motion. If the object

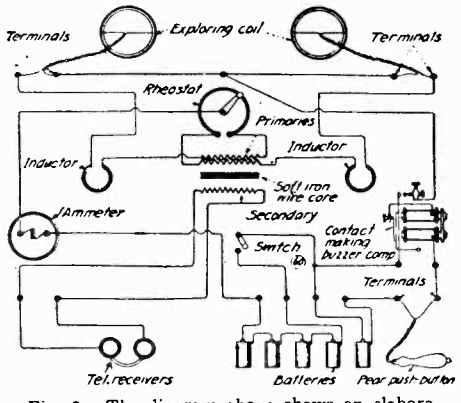


Fig. 9. The diagram above shows an elaboration upon the Hughes induction balance. This particular balance and all it's details was described in the August 1921 issue of SCIENCE AND INVENTION Magazine. A small laboratory instrument for demonstrating how the Hughes induction balance works is shown at the extreme right of this page.

Fig. 10. The diagram at the right shows the circuit of the Hughes induction balance as built for laboratory purposes. A buzzer is caused to make and break the circuit in the inducing coils. The pick up coils are connected in series with a receiver, and when balanced no sound is produced. When a metal body is held near one of them, the receiver buzzes loudly.

is concealed and he does not know its whereabouts, it will be impossible for him to find it. The same is true of the divining rod in Fig. 6, and farmers all over the country will tell you that waters and metals have been located by aid of the divining rod with an uncanny degree of accuracy. In many cases, however, water is found closer to the surface than at those parts where the divining rod tipped downward. The slightest movement on the part of the operator will cause the stick to bend toward the earth. It is always held in a very unstable position. When once the rod starts to move, the operator attempts to hold it back. In doing so he further bends the ends of the hazel twig which he holds and causes the rod to move downward still more violently. If the operator were to be blindfolded and made to go over the ground, the rod would never point to the same spot twice in succession.

A more scientific water locator is illustrated in Fig. 7. This depends upon the fact that subterranean waters generally induce magnetic lines of force in the surrounding soil. These lines of force passing through the soil cut a coil of wire placed at the surface, and in so doing induce current in the wire coil. This current affects a sensitive galvanometer and in this way determines the location of bodies of water or oil.

Large veins of ore may be located by the method of determining the electrical resistance of the earth between two points at a definite known distance apart. If one thousand feet of soil in the immediate area where

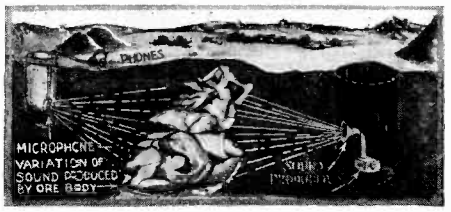
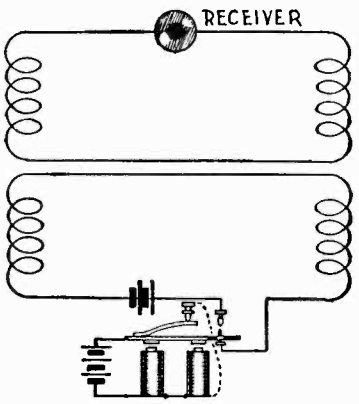


Fig. 11. The Fessenden ore locator works on the principle of changes in intensity of sound waves when an ore body is placed in the path of the waves. Another feature is that the ore body reflects the sound waves, and for this reason one sound producer and three sound receiving wells are employed. Each sound receiving well is equipped with an oscillograph to record the sound picked up.

the prospecting is to be done has a resistance of let us say, ten thousand ohms, and if measurements are made in various directions, and we finally strike one certain position of the stakes where the resistance suddenly drops to five hundred ohms or even less, it is reasonably safe to assume that the soil contains some particular substance which makes it more conductive and which may be either mineral salts (springs), or metals. This method is illustrated in Fig. 8.

The Hughes induction balance shown in Figs. 9, 10 and 14 is of course a well-known device and is frequently used for demonstra-



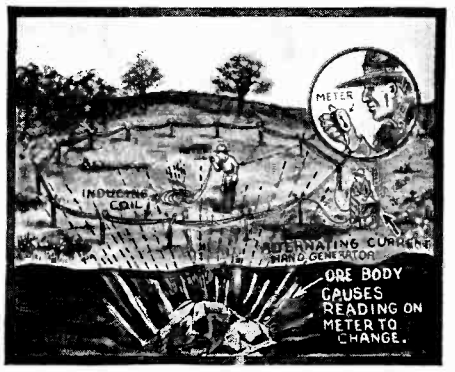
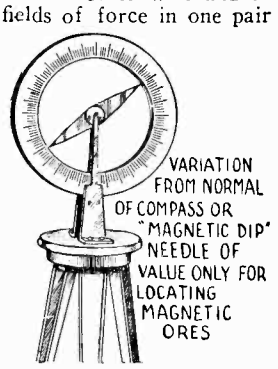


Fig. 12. Another method for determining locations of concealed metals is illustrated in the diagram above. A large coil is placed near the ground, preferably on insulated stakes. Current from an alternating current generator passes through the turns of this coil, and if a subterranean body of ore is under the exploring coil, a marked deflection is produced in the galvanometer.

tive purposes in the laboratories. This balance opens a great field of possibilities and it is surprising to note what little experimental work has been done upon the original idea. Essentially the device consists of four coils wound with bell or other wire and so mounted that the fields of force in one pair

Fig. 13. It has been claimed that a compass or a magnetic dip needle may be used in locating hidden treasures. Such devices are of value only for locating magnetic ores.



buck those in the other pair. When the balance is properly adjusted no sound is heard in the telephone receiver, but when it is disturbed due to the presence of a metal, a distinct sound is heard.

In the Fessenden ore locator illustrated in Fig. 11 four wells are generally sunk at the four corners of a five mile square. Each contain a sound detector connecting with a surface oscillograph. One of them also contains an engine-driven high frequency alternator. The sound waves transmitted through the earth are picked up by the oscillographs and the deflective waves, due to the location of an ore body, are likewise recorded. In this way the positions of the ore bodies may be definitely determined.

In Fig. 12 the principle upon which the device operates is dependent upon a large inducing coil affecting the subterranean body or treasure chest, and the pick up coil locating the point of maximum reflection. Fig. 13 is of value only for magnetic ores.

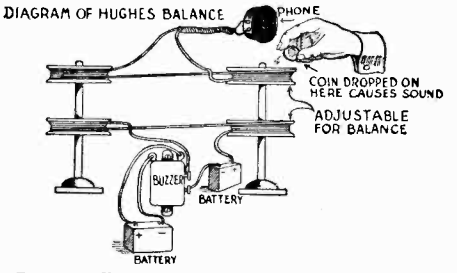
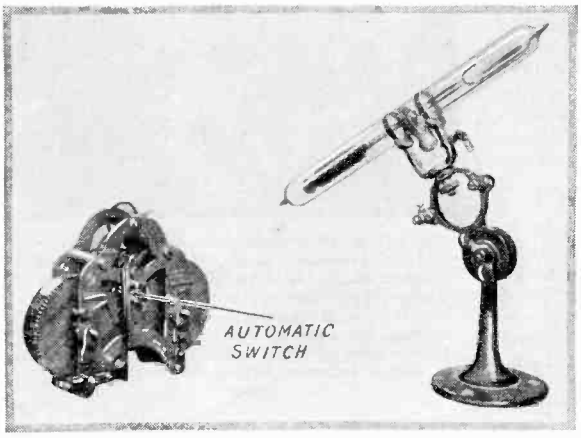
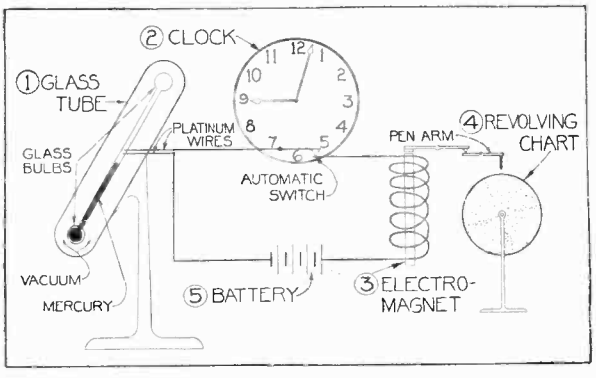


Fig. 14. The illustration below shows a laboratory Hughes balance. The coils are placed upon the uprights in such a way that the induced E.M.F. is opposed. A slight sound in the phones is compensated for by adjusting the distance between the coils. When a coin or metal body is now placed near one of the coils, the balance is disrupted and a distinct sound produced.

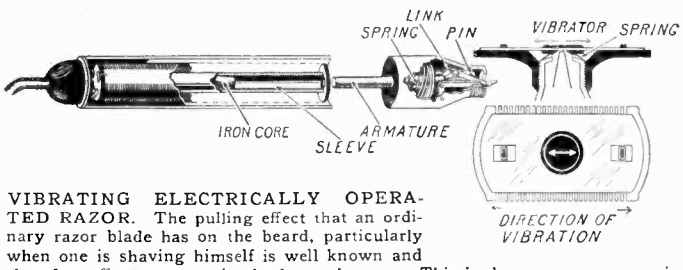
New Devices at the Electrical Show

Thermic Recorder, Electric Razor and Artificial Sunlight Described





SUN HEAT RECORDER. Another device for measuring sunlight duration in a different way than that shown in N. Y. Electrical Show review last month is illustrated above. A special thermometer, the mercury bulb of which is blackened so as to increase heat absorption, is connected in an electrical circuit with a local battery and an electro-magnet. When a certain temperature is reached, the circuit is closed and the pen makes a mark on the revolving chart. When the sun is obscured and the temperature drops, the electro-magnet releases the pen arm and a space appears on the chart. These records are used in conjunction with those obtained by the pyrheliometer above mentioned.

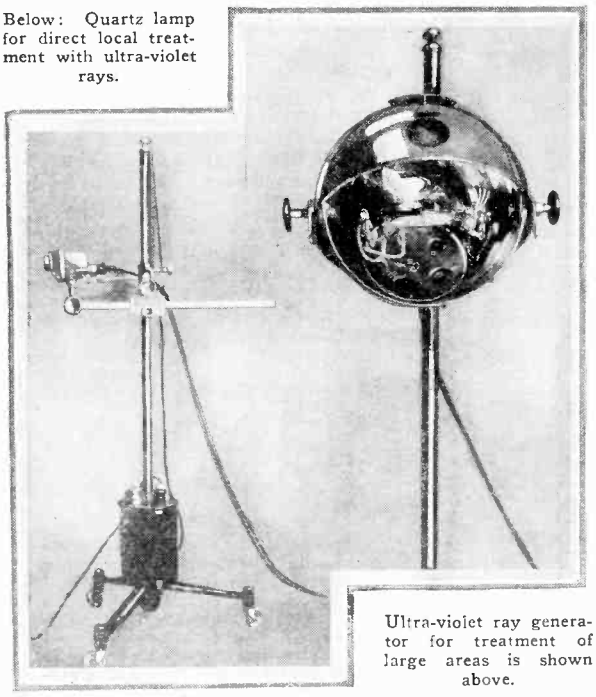


VIBRATING ELECTRICALLY OPERATED RAZOR. The pulling effect that an ordinary razor blade has on the beard, particularly when one is shaving himself is well known and the after effects are not in the least pleasant. This is, however, overcome in this newly designed type of electrically operated razor, in which the blade vibrates from side to side, as shown in the diagram above. It is actuated by means of a solenoid and an iron core. The core vibrates back and forth and causes the armature to take the same motion. By means of the linking arrangement shown, this reciprocating movement is translated into one which operates the razor blade as mentioned above. The device is extremely simple as can be readily seen from our diagrams reproduced here and is so constructed as to be entirely water-proof and practically free from troubles of all kinds. Not only can this device be used as an electrical razor, but by taking off the blade and guard, and substituting a massage arm for them, the device can be used as an electrically operated vibrator for scalp or facial massaging.

Photographs courtesy Vibro-Shave Corp.

Artificial Sunlight Aids Sick

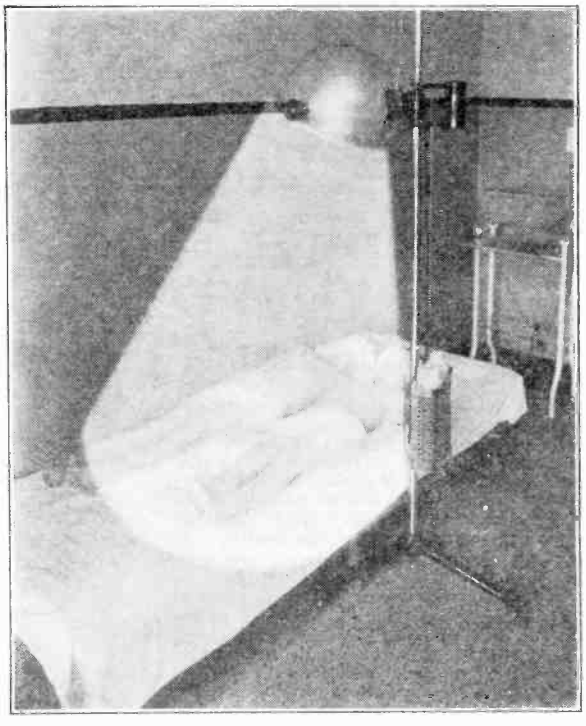
Below: Quartz lamp for direct local treatment with ultra-violet rays.

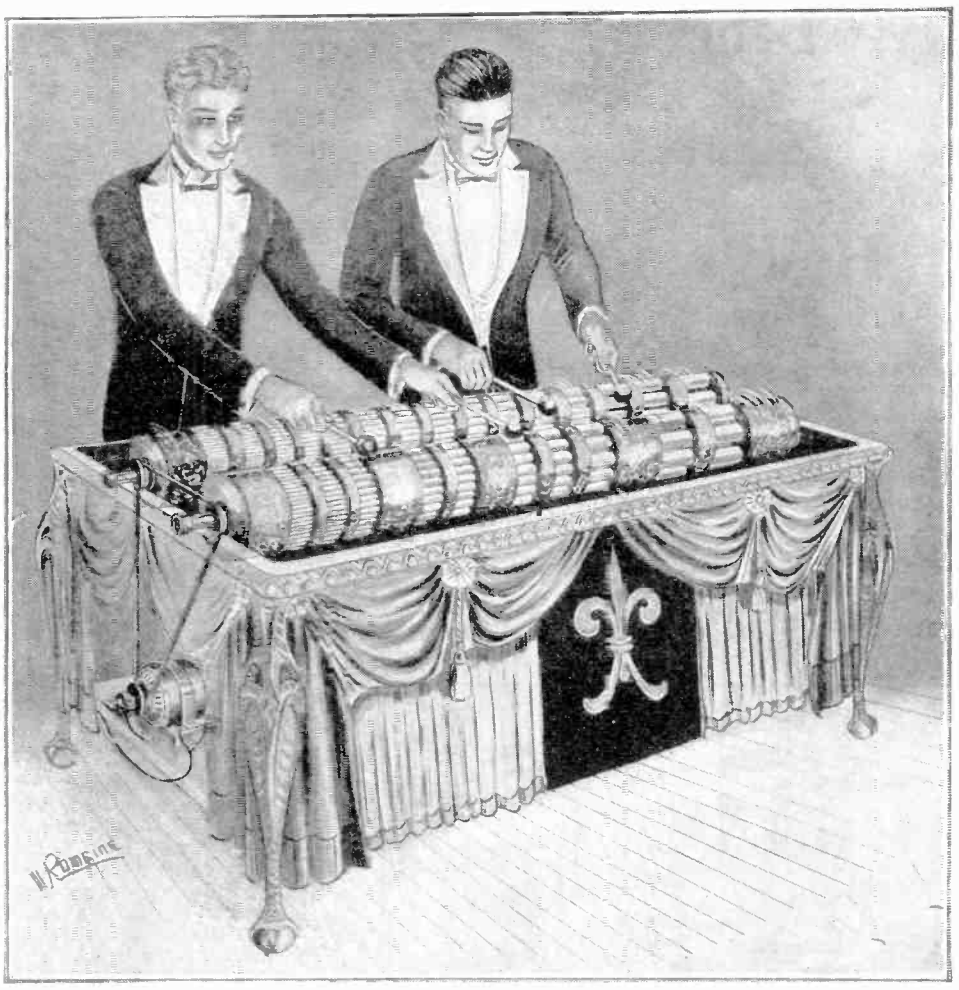


Ultra-violet ray generator for treatment of large areas is shown above.

ARTIFICIAL SUNLIGHT. The value of ultra-violet rays for treatment of certain diseases is becoming more and more recognized and various appliances are being developed for the use of practitioners in their own offices. The two photographs at the left illustrate forms of ultra-violet ray generators that are entirely portable and so designed that they can be used on either A.C. or D.C. with a few minor changes. The photograph at the right shows one of the large lamps in action; it is being used for the treatment of tuberculosis. The rays are far superior in their curative properties to sunlight, the effects of which are well known. Furthermore, they can be used at any time in any location.

Photographs courtesy Hanovia Chemical & Manufacturing Co.





Musical Logs

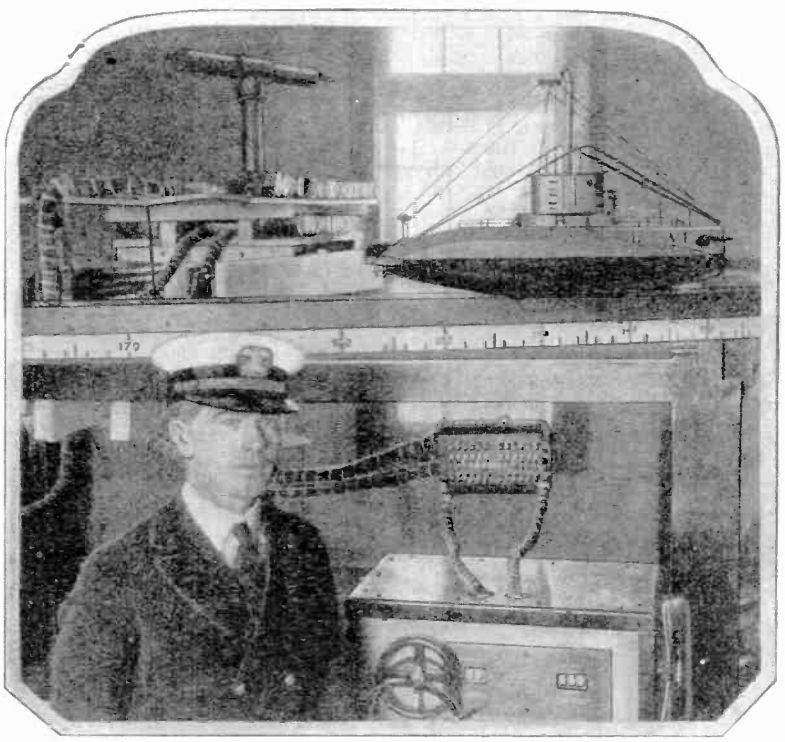
HERE we have the very latest in spectacular musical instruments. This one gives a tone that might be placed as being midway between the sound of a buzz-saw and that emanating from church chimes. The mechanism consists of two sets of rollers, shown in the illustration at the left, both rotating in the same direction and being driven by a small electric motor. The rolls are divided into sections of varying widths, alternate ones being coated with gold foil and illuminated by means of colored lights. The other sectors carry horizontally placed metal tubes mounted on felt and placed side by side around the entire circumference. As these sets of tubes rotate, the operators hold small hammers in contact with one or another set, producing musical tones.

—GEORGE R. HOLMES.

Snapped Before Parachute Opened

ONE of the most unusual photographs that has ever been taken in the air is the one shown directly below. Chief Petty Officer Lyman Ford, of the United States Navy, had jumped from an airplane at a height of 2,000 feet, and had not yet pulled the cord to open his parachute when this photograph was taken. He was traveling at a speed of 65 feet per second at the time of exposure, yet every detail in the photo is perfect. He is equipped with two parachutes, one on his back and one in front, for safety.

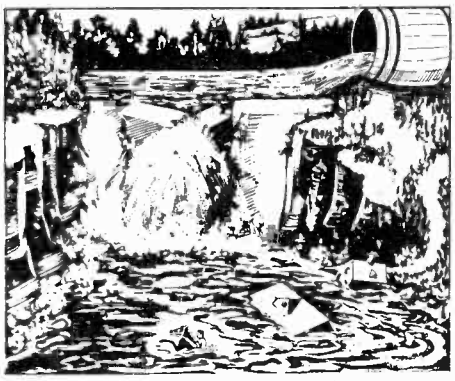
Sub-Sea School on Land



The United States Navy is using a series of apparatus located on land to educate naval students in the handling of sonic depth finders and other sound devices such as are employed in submarines. The photo above shows part of the apparatus. The model submarine runs around a track, simulating the sound produced by a submarine under water. Students take bearings on this model by means of electric compensator devices, such as shown in the foreground. The sound is picked up by microphones, several of which can be seen in the upper left-hand corner above. —S. R. Winters.

Behind the Scenes in Hollywood

By CAPTAIN FRANK G. KERK

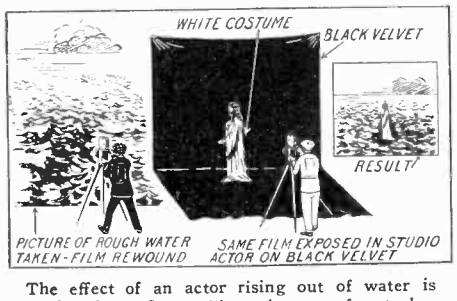


In the filming of a scene wherein a dam broke, the large dam was reproduced in miniature. Water from a barrel supplied the flood. The rider seen in the foreground is a dummy.

HOW FLOODS AND BURSTING DAMS ARE ACCOMPLISHED

IN A RECENT picture a man on horseback rode a long distance down a canyon to warn the people of the town that the dam had burst and a flood was almost at their heels. People who own dams don't like to have them burst, even to please movie producers; besides, it would muss up their canyon. Therefore, an exact reproduction in miniature, built to scale, was made, but painted all in black, and after the dangerous ride through the real canyon, the miniature was put into action. At the studio all the previous scenes were double exposed through the slow motion-picture camera, while about fifty gallons of water from a barrel were allowed to flow down through the miniature canyon to slow music and fast exposure. The breaking of a dam is obtained by first showing a leak in the miniature wall, and water slowly seeping through until the force of the water breaks a section. (The section is given a final yank with piano wires, to which it is attached, and starts the flood of water.)

When projected on the screen, the flood appears to reach the enormous heights of a real canyon. A fast "cut-in" shows a horse and rider being caught in the onrush of the water. This was obtained by photographing a dummy horse and rider in the tank. To give some realism to the action, another rider and horse are seen swimming in fast-moving waters and later climbing an embankment to safety.

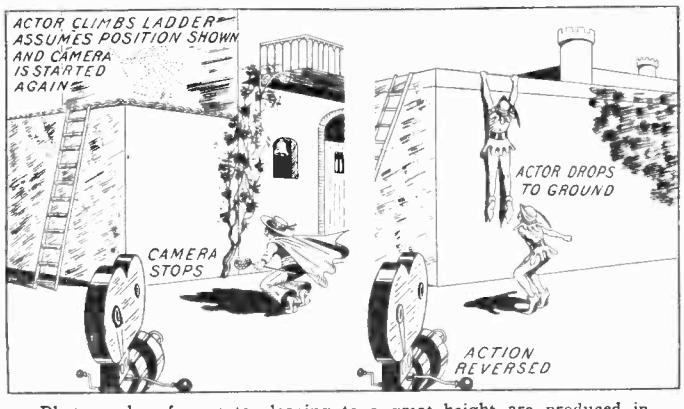


The effect of an actor rising out of water is produced by first taking pictures of a turbulent sea, then rewinding the film and again exposing it in the studio, while the actor walks across a black velvet carpet.

HOW LIVING FIGURE WALKS, DESCENDS AND RISES OUT OF THE WATER, ENACTED IN THE PICTURE, "LIFE OF CHRIST"

The camera is set up on a location and a water scene is taken of rough or smooth water, as may be desired. The film is then rewound and a picture taken of the actor walking on black velvet with a background of the same material. This gives the effect of the actor walking upon the water. The costumes of the actors in scenes of this kind are always white or of light colored material, so that the deposit will be heavy on the developed negative, and thus prevent the waves from printing through the figures of the actors.

Where the action calls for the figures to disappear as though sinking into the water, the camera is placed on a rocker cradle. It is then slowly tilted upward, while pictures of the actor are taken on black velvet. This gives the same effect as though the actor were lowered out of sight of the lens or into the water.



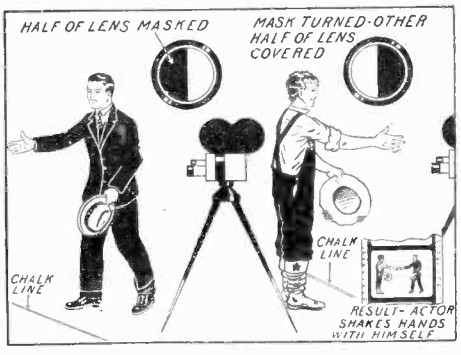
Photographs of an actor leaping to a great height are produced in one of two ways. The actor may assume the position illustrated at the left and then climb to the top of the wall, while the camera is stopped; or the actor may drop from the wall and a picture taken with the camera wound in a reverse direction.

To have the actor rise out of the water is just as easily accomplished by reversing the direction of tilting the camera, *i. e.*, starting without the actor showing, the camera is then slowly tilted downward, thus bringing the actor into the picture, apparently out of the water.

ACTOR SHAKES HANDS WITH HIMSELF

In many pictures there are actors who play a dual rôle, or two distinct parts, and usually in the course of the action, he has to meet and possibly shake hands with the other character, or, in other words, shake hands with himself.

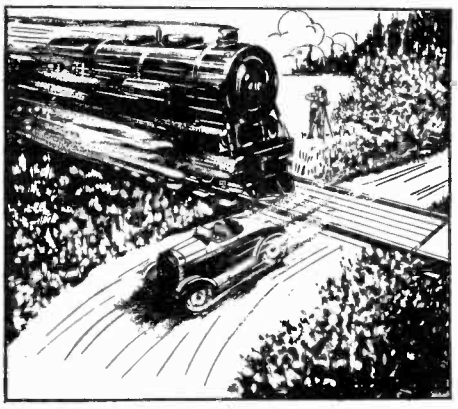
To accomplish this, the camera is set up on the set. A mask is inserted in the camera lens to cover one-half of the lens opening. Mr. Actor then walks on, looking as though he was approaching someone, and halts just before reaching the center line of the set (chalk line on the floor). He extends his hand, holds it there for a short time, then drops it to his side and talks to his imaginary character.



In event that an actor plays a dual role and has to shake hands with himself, the picture is taken with the lens half masked, as illustrated.

The camera man would then rewind the film, while the actor would change his costume to suit the other part, and upon signal, he would approach from the other side and go through the same actions, timed as nearly as possible to the previous action.

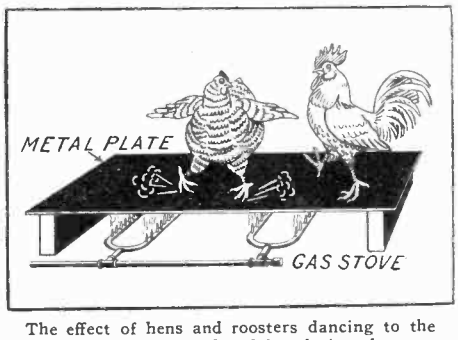
The mask having been shifted in the camera, it would be covering the portion of the film previously exposed. If the act of grasping hands was correctly timed, the picture would be perfect, otherwise it would have to be retaken again and again until a perfect match resulted.



A dive across the tracks just in time to prevent being hit by an oncoming express train is accomplished by permitting the automobile to pass first, then stopping the camera and waiting for the train to arrive on the scene of action. The camera is then ground again.

AUTOMOBILE AND TRAIN AT CROSSING

One of the commonest and most thrilling punches found in motion pictures is that of a train and automobile approaching a grade crossing as though they were to crash together at that point. The tremendous speed of the automobile and train is accomplished by taking the pictures at about one-quarter speed, thus multiplying the real speed by four, and the heart beats of the audience by one hundred.



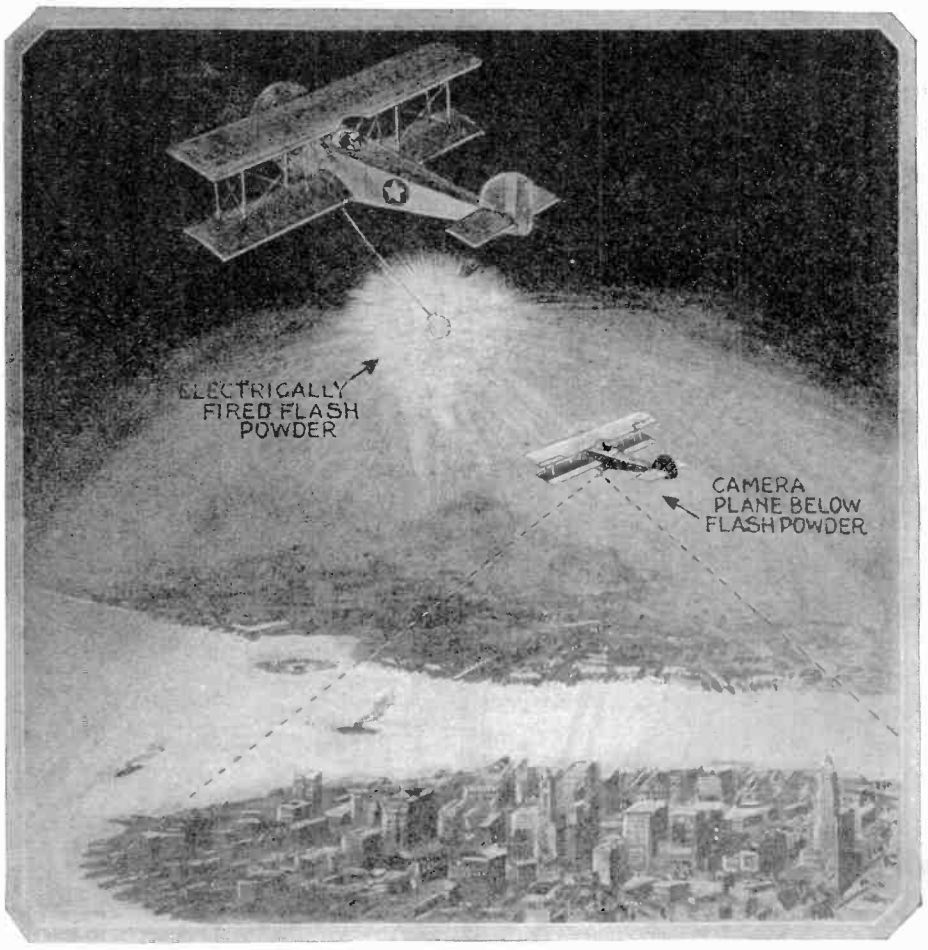
The effect of hens and roosters dancing to the notes of music is produced by placing them on a warmed metal plate. The heat causes them to lift their legs, one at a time, and thus produces the effect of dancing.

The actual crossing of the automobile in front of the train is accomplished by what Lawyer Chew would call "trick and device." A picture is taken of the automobile crossing the tracks, then the camera stops until a train comes along, fifteen minutes, or per-

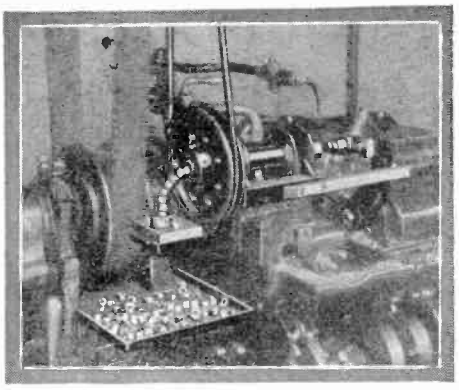
(*Continued on page* 1038)

Photographing New York at Night

The Army Air Service is perfecting details of a method whereby it may be possible for them to photograph the entire City of New York at night, using an enormous quantity of flashlight powder, set off by an electric spark. Our illustration at the right shows how this would be accomplished. A plane would carry the flashlight powder, suspended on the end of a trailing wire and below this would be another plane carrying the camera. In this way, taking the picture as shown, the light would not strike the camera lens.

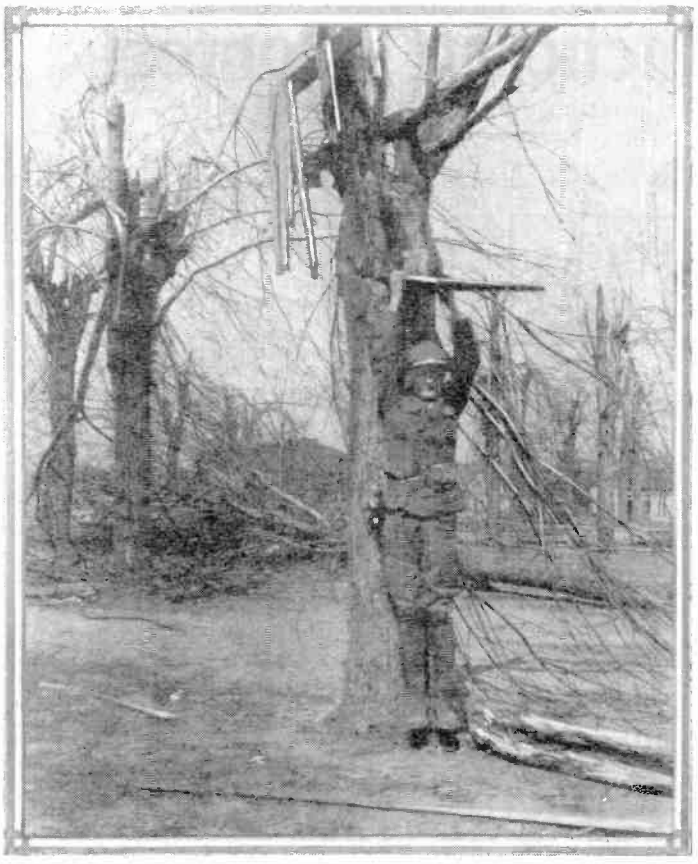


Nut Threader



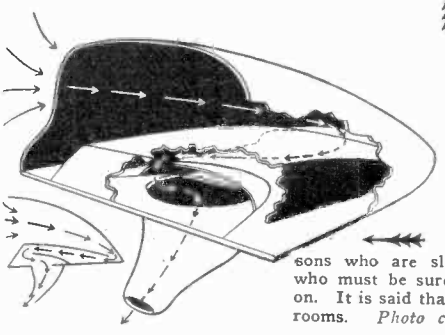
The simple device shown above is designed so as to tap nuts or other parts as they are formed by an automatic screw machine. The nuts are fed on to a tap, the threads are formed and the nuts are ejected from the machine as shown.
Photo courtesy Automatic Nut-Thread Corp.

Terrific Power of Cyclone



Recently a cyclone devastated the town of Murphyboro, Ill., and one of the freak things observed after it had passed was a piece of board 1 inch thick by 10 inches wide driven into a tree as shown in the photograph at the left. It was so firmly imbeded in the trunk that it bore the weight of a 150 pound man without loosening. Directly above the board, a carpenter's sawhorse was also blown into the tree by the extraordinary force of the wind.
—W. H. Richards.

Aid to Hearing

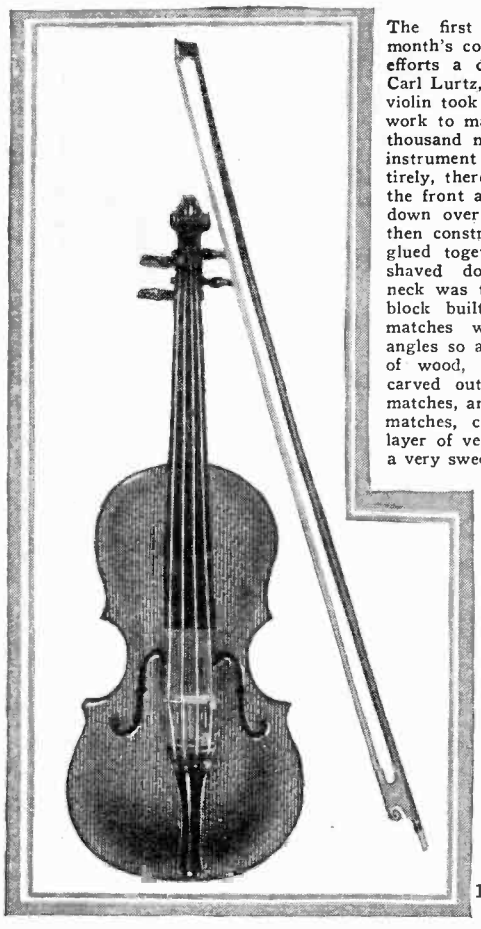


A new device has recently been designed which is to be placed over the ears as shown in the above photograph and which serves to concentrate sound so that it will affect the ear drums with the greatest possible volume. The shells are light in weight and supported by a narrow head band. The principle of the device is shown at the left. It is very useful to persons who are slightly hard of hearing or who must be sure to hear everything going on. It is said that judges use them in courtrooms. *Photo courtesy Super-Ear Corp.*

Awards In $5,000 Matchcraft Contest

Violin Made Entirely of Matches

WINS FIRST PRIZE—$100.00

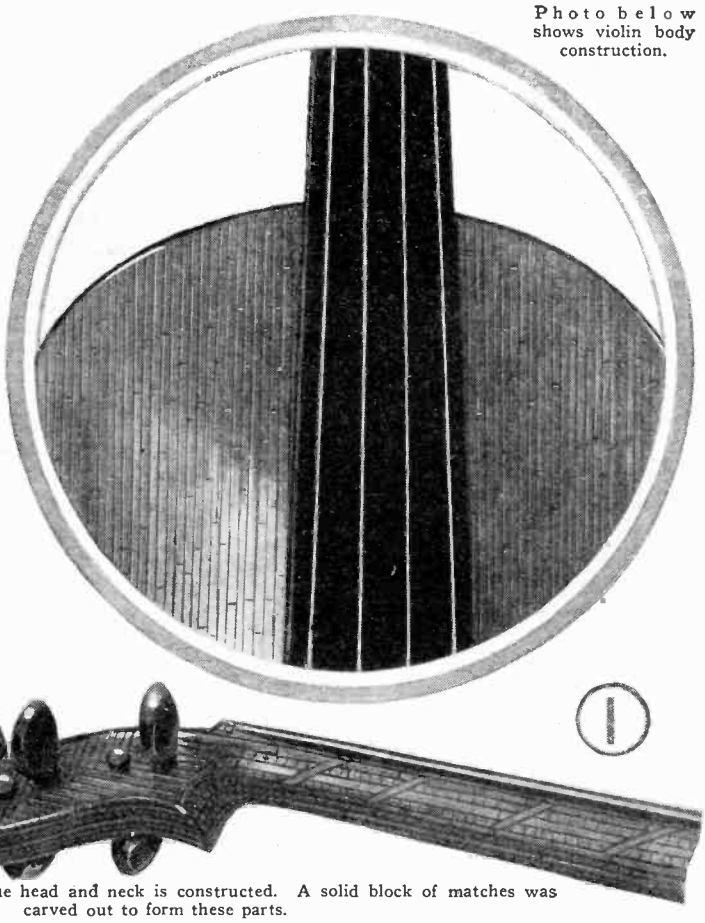


The first prize winner for this month's contest who receives for his efforts a check for $100.00 is Mr. Carl Lurtz, of Brooklyn, N. Y. This violin took almost a month of steady work to make and contains over ten thousand matches. The body of the instrument is made of matches entirely, there being a double layer for the front and back, which were laid down over a form. The sides were then constructed and the entire was glued together after being carefully shaved down and polished. The neck was then made out of a solid block built up of matches. These matches were placed at different angles so as to strengthen the block of wood, and the neck was then carved out. The scund post is of matches, and the finger board also of matches, covered with a very thin layer of veneer. The instrument has a very sweet, mellow tone.

Who will win the first prize next month?

Photo at the left shows a complete full-size violin. This is not a miniature but a regular professional full-size type of instrument.

Photo below shows violin body construction.



In photo above note how the head and neck is constructed. A solid block of matches was carved out to form these parts.

$5,000.00 Prize "Matchcraft" Contest

WATCH FOR PRIZES IN APRIL ISSUE

FOR the next twelve months, SCIENCE AND INVENTION magazine will award a total of $5,000 in prizes, in a new contest. You are asked to make models, fashioning the same entirely from safety matches. Please read the text of the Matchcraft article carefully and observe the following simple rules:

(1) Models submitted must contain at least 90 per cent. safety matches in their construction.

(2) Models made of toothpicks, paper matches, or non-safety matches, are not eligible in this contest.

(3) Models can not be built around boxes or other supporting articles. Walls, roofs, etc., must all be self-supporting and made of matches.

(4) All liquid adhesives, such as glue, shellac, cements, etc., are permissible.

(5) Models may be painted, gilded or silvered.

(6) Models may be of any size.

(7) In order to win a prize, it is necessary that either models be submitted, or, if this is not practical, owing to their size, a photograph (large-sized) of the model may be sent in lieu of the model itself. The best models submitted each month will be awarded the prizes scheduled herewith.

(8) All models submitted to SCIENCE AND INVENTION Magazine will be promptly returned to the builder, who will prepay all charges.

16 Monthly Prizes

First Prize	$100.00
Second Prize	75.00
Third Prize	50.00
Fourth Prize	35.00
Fifth Prize	25.00
Sixth Prize	20.00
Seventh Prize	15.00
Eighth Prize	12.50
9th to 16th Prizes of $10.00 each	$80.00

(9) Where SCIENCE AND INVENTION has any doubts as to the model (where photos only are submitted) complying with all the regulations, the judges may, at their discretion, request that the actual model be sent in for inspection, paying transportation charges both ways.

(10) This is a monthly contest, lasting for twelve months, each monthly contest closing on the first of the month following date of issue. This contest for the month of March will close April 1, 1926, and prize winning announcements will be made in the June, 1926, issue. The April issue will contain January prize winning entries.

(11) Models must be shipped in a strong wooden box, never in a cardboard box, as SCIENCE AND INVENTION can not be held responsible for breakage in transit due to models having been improperly packed.

(12) When models are sent, be sure to affix tag, giving your name and address, to the model itself. In addition, put name and address on outside wrapper of package.

(13) When photographs are submitted, it is necessary that they be at least 5" x 7", not smaller, and that your name and address appear on the back of each photograph.

(14) In this contest, manuscripts or description of the models are not required, unless the model contains something unusual requiring explanation. Keep all descriptions short.

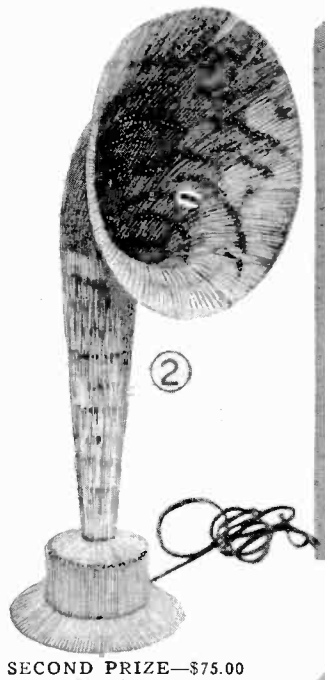
(15) Address all letters, packages, etc., to Editor, "Matchcraft" Contest, care SCIENCE AND INVENTION Magazine, 53 Park Place, New York.

Caution—Soak or cut heads from matches before building your model so that the models may be expressed or mailed.

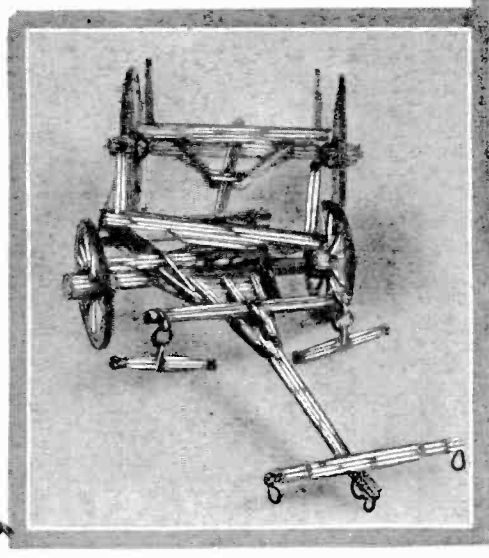
REMEMBER— This is a monthly contest offering sixteen prizes every month. Don't hesitate, send in your model now!

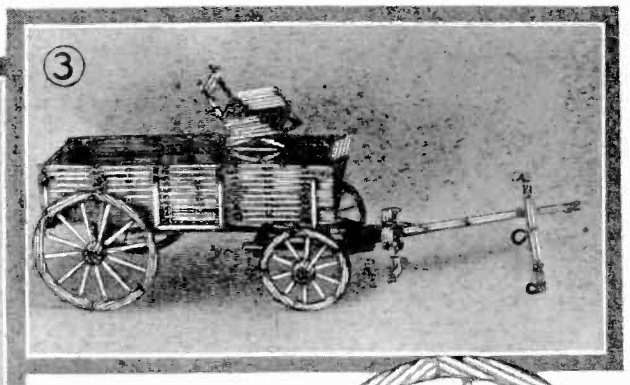
$5,000.00 In Prizes

On April 1st the Contest For the Month of March Closes. Have You Sent Your Model In Yet? Sixteen Prizes Are Awarded Monthly—Get Busy

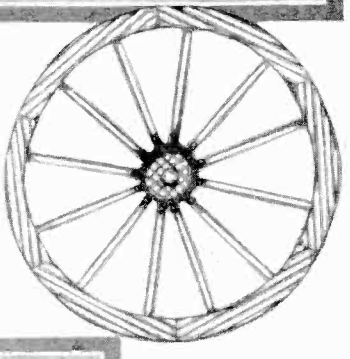


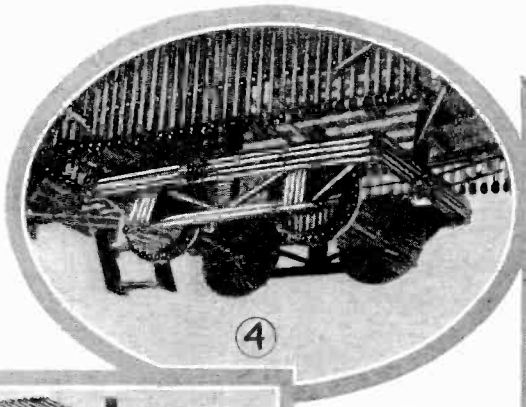
SECOND PRIZE—$75.00
The model which won second prize for the December contest was the loud speaker horn illustrated above. This horn stands twenty-four inches high and has a bell of ten and a quarter inches. Except for the unit, it contains 100 per cent. matches. It was built by E. Russel Vass, seventeen years of age, of Chicago. He holds a SCIENCE and INVENTION reporter card No. 20806.

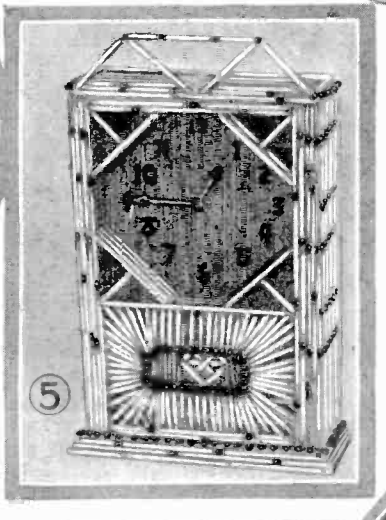




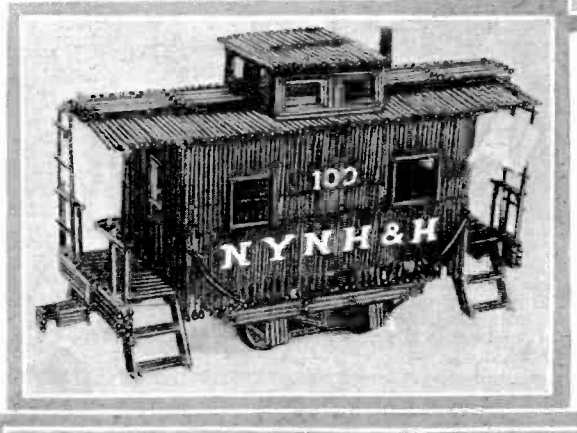
THIRD PRIZE—
$50.00
For the wagon construction containing 100 per cent. matches shown above, Mr. Fred Spinden of Abingdon, Illinois, won the third prize. The photo at the right shows the construction of the wheel. Chain links, springs and in fact the entire model is built of matches only.



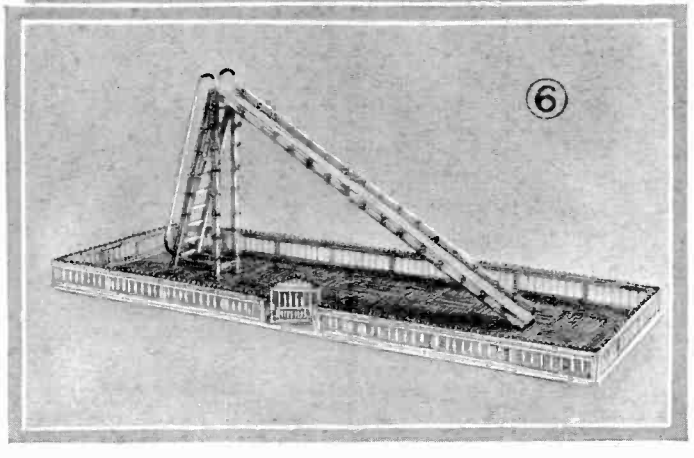




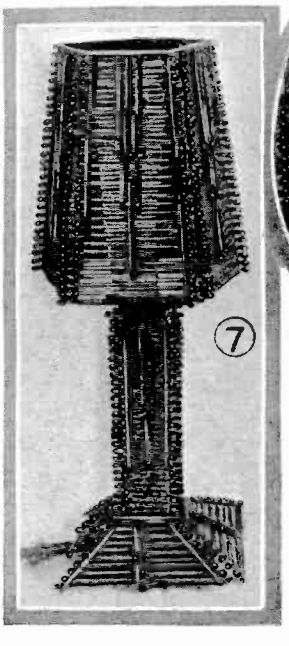
TENTH PRIZE—
$10.00
The clock illustrated at the left is made of matches as the photo clearly shows. By gluing the matches together to form a unique design and exercising a little care in his construction, Mr. Lee Ray, of West Asheville, North Carolina, has classed himself among the prize winners for the month of December, which closed on January 1st.

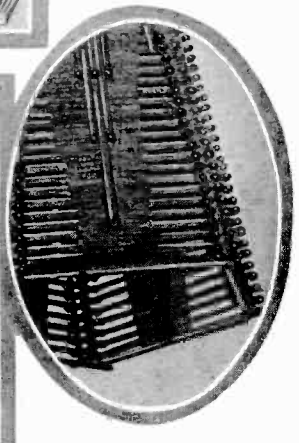


FOURTH PRIZE
—$35.00
Great pains and care were taken in the construction of the model of the caboose illustrated above and to the left. The construction is perfect in almost every detail. The truck is mounted on a rubber band and the wheels are of match sticks. The winner is Mr. Frank J. Cargill, of New York City.



FIFTH PRIZE
—$25.00
This award was won by Dr. J. Toro, of San Juan, Porto Rico, who sent the model of the playground shown at the left. Even the gate hinges and latch are made of matches. The construction is very beautiful.



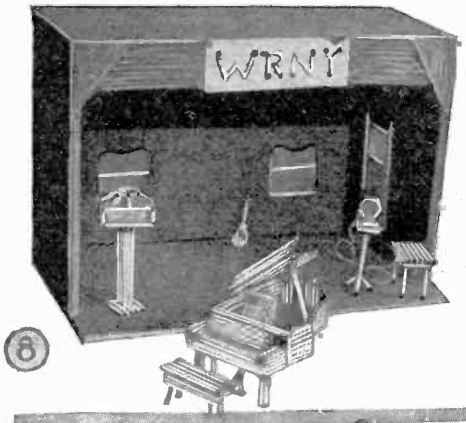


SEVENTH PRIZE
—$15.00
This award was won by Mr. Guy B. Richards, Rochester, N. H., who entered the model of lamp and shade shown to the left, Fig. 7. The insert above shows the construction of one part of the shade. Note how the matches interlock.

MATCHCRAFT

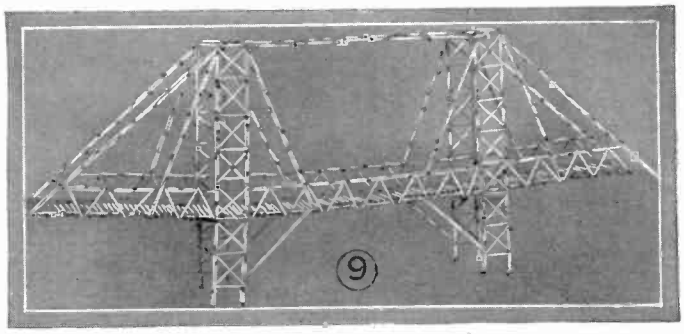
More Winning Ideas

Continuing with the December Awards—Sixteen in all. Sixteen more next month.



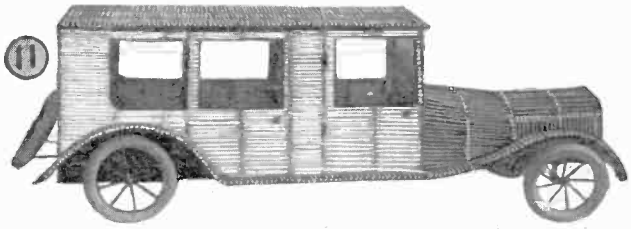
FIFTEENTH PRIZE
$10.00

The piano and piano stool illustrated at the left carried the fifteenth prize. The piano is constructed entirely of matches and the strings inside are tiny silk threads. The top opens up as the photograph shows and the piano stool is also hinged and contains the music. The setting of the WRNY studio is merely a dressing and was not considered in the awarding of the prize to Mr. Peter H. Ernst, of N. Y. City.

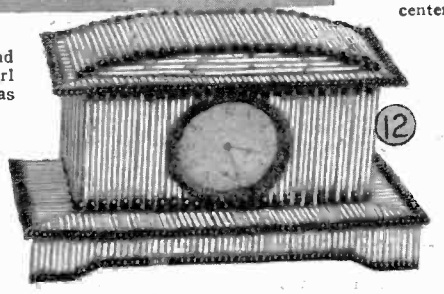


SIXTEENTH PRIZE—$10.00. The last award for a matchcraft model for the month of December went to Joseph T. Kaufman of Paterson, N. J., for the model of the bridge illustrated in Fig. 9 above. This bridge is quite wide and strongly constructed by reason of the suspending girders which are of matches. This bridge construction is more than three feet long.

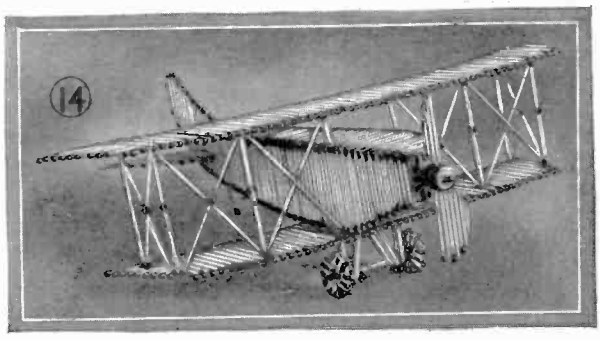
TWELFTH PRICE—$10.00.
For the checker board, checkers and box for holding the checkers, Mr. Karl Fichtner, of Philadelphia, Pa., was awarded the twelfth prize.



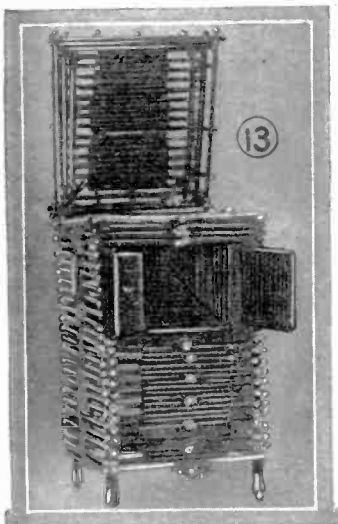
ELEVENTH PRIZE—$10.00.
The automobile shown in photo 11 above won the eleventh prize. With the exception of the tires and celluloid windows on the doors and wind shield and the axles, the construction is of matches. The spokes of the wheels are matches driven into rubber rings and fastened together at the center. This award was won by Mr. Charles Komunicki, of New York City.



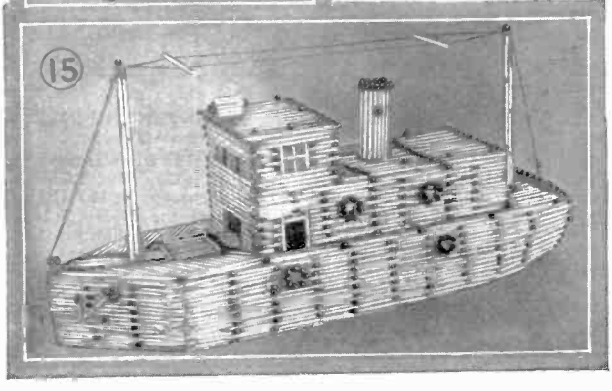
FOURTEENTH PRIZE—$10.00
The neat clock case illustrated in photo 12 carried away the honors for the fourteenth prize. The watch mounted in the front of the case is wound up after the top lid has been removed. The winner is Mr. James E. Rummer, of Wichita, Kansas.



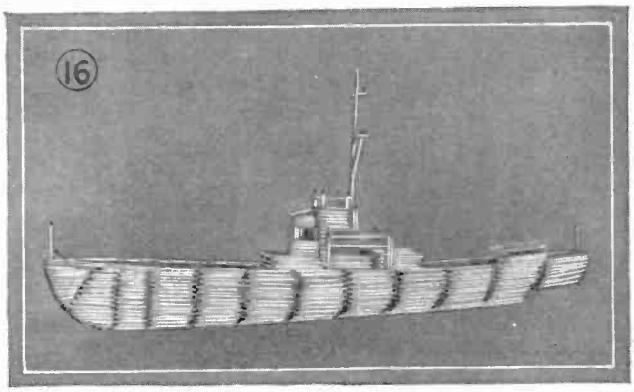
NINTH PRIZE—$10.00.
The airplane above was considered by the judges to be worthy of the ninth award in this monthly prize contest. The construction is 100 per cent. matches, as the photo clearly shows. Even the cross bracing wires are matches shaved down very thin. The winner is Mr. Oscar Solow, of New York City.



THIRTEENTH PRIZE—$10.00.
The phonograph made of matches illustrated in photo 13, won the thirteenth prize, which proves that number thirteen is not unlucky. The horn, turn table, reproducer and tone arm were made of matches entirely. Adhesive tape forms the hinges of the door and top. Won by Mr. W. T. Markowski, of Camden.

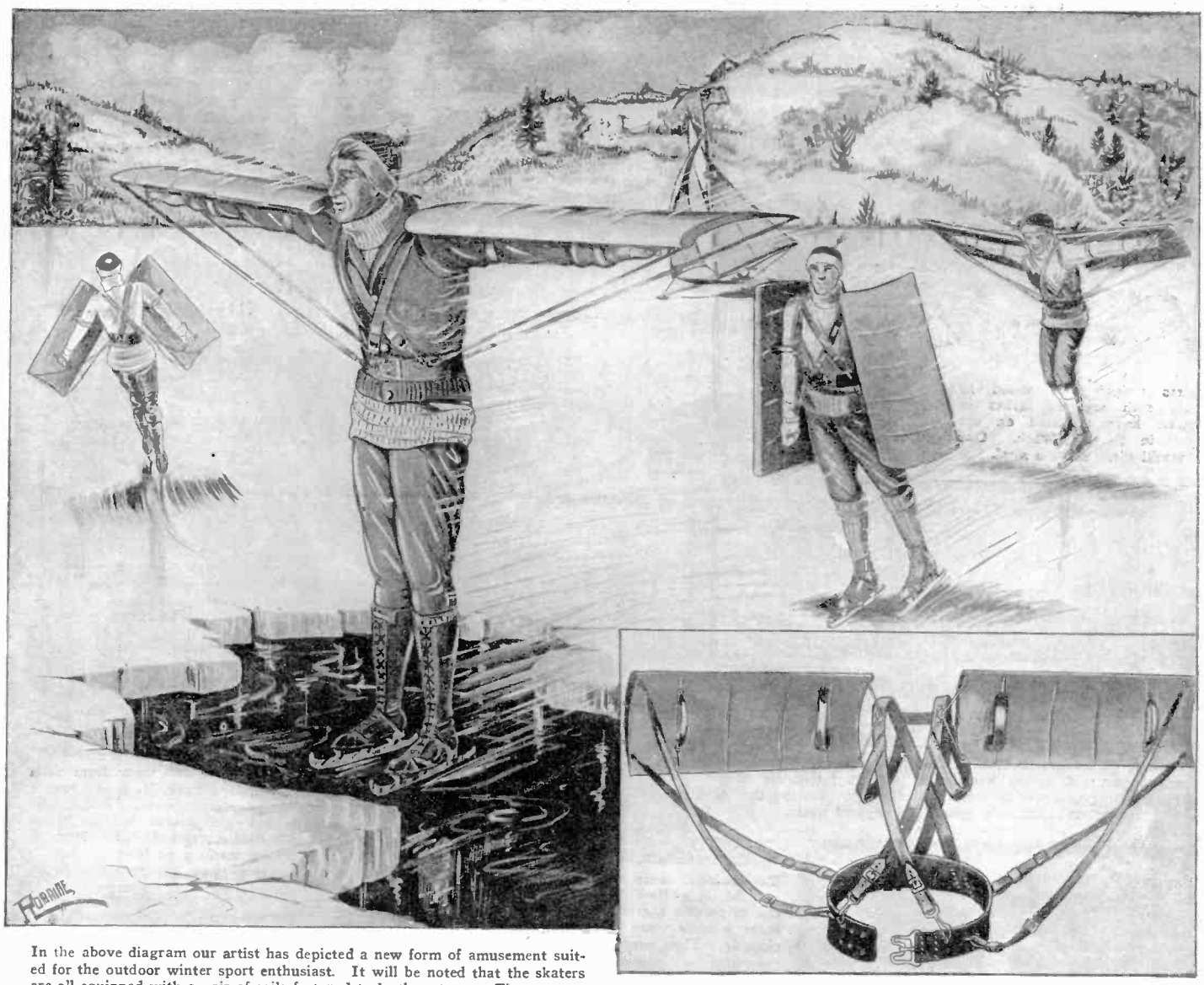


EIGHTH PRIZE
$12.50.
The boat illustrated in photo 15 was built by Mr. Lawrence I. Kihnel, of New Orleans, La.



SIXTH PRIZE—$20.00
The U. S. Naval Academy sends us Midshipman F. P. Pyzick's model made to scale of a submarine chaser. This model is also composed of 100 per cent. matches. The hatches of the vessel may be removed so that a view of the interior may be freely obtained.

Wings for Skaters



In the above diagram our artist has depicted a new form of amusement suited for the outdoor winter sport enthusiast. It will be noted that the skaters are all equipped with a pair of sails fastened to leather straps. These straps are secured around the shoulders and waist of the individuals using the same. In order to relieve the upward strain on the end of the sails, two leather belts fastened around the waist are likewise attached to the front and back of the sail near the free end. These sails are intended to serve a double purpose. They may be used as the sails of an ordinary sail boat, and by simply shifting them the user can tack into the wind or sail before the wind. Should he gain considerable momentum, the sails will serve to aid him in making long leaps. The device is not cumbersome and may easily be folded up and carried to the pond or lake. The struts of each wing should be of light wood, and the framework should preferably be covered with airplane fabric. The illustration above shows a skater sailing before the wind, another just about to tack, and the other two users negotiating leaps.

—J. Kay London.

$11,000 for Spirits

More than two years ago SCIENCE AND INVENTION Magazine offered a prize of $11,000.00 to anyone who could demonstrate his or her ability to communicate with the spirits or to give some definite form of a psychical demonstration which in itself was not trickery. During these years we have challenged a great many organizations to produce a manifestation in our presence, which because of its very nature, should be entirely free of fraud.

The result has been that mediums and spiritual organizations have been afraid to place proofs before us. Those weak attempts which have been made to demonstrate psychical phenomena were almost instantly proven fraudulent, and no medium has dared to contradict our findings.

In view of these facts, should we not consider all mediums fraudulent? Should we not consider every psychical manifestation as being trickery pure and simple, intended primarily to fleece those who visit the circle and who find solace in the words from the worst forms of charlatans, namely those who are being permitted to practice upon the poor, seeking words from loved ones?

Remember, there is nothing in spirit phenomena. Don't let a few amateur magicians fool you in the dark, and don't think because they work in broad daylight that they really communicate with departed spirits.

We have $11,000.00 offered by this publication and Joseph F. Rinn which will be awarded wholly or in part to the one producing a phenomenon devoid of trickery.

THE $250.00 Rat Trap Contest awards will be announced in the April issue of SCIENCE AND INVENTION Magazine, so if you submitted an entry in this contest look for your name among the prize winners in the next issue.

$5,000 for Perpetual Motion

When SCIENCE AND INVENTION Magazine was still in its infancy, the editors denied the possibility of constructing a perpetual motion machine using those forces of nature as we now know them.

Since that time the editors have received thousands of different designs for perpetual motion devices, and have receivd hundreds of circular letters soliciting finances for the building of perpetual motion machines.

The editors know that if they receive these letters, there are thousands of others in this country who get similar letters and who fall for the claims made in the numerous prospectuses giving the earning capacities of the various machines.

Most of the shares of stock for these perpetual motion machines are being sold at a rate of $1.00 per share, although some inventors are trying to sell shares of stock at $100.00 per share.

Therefore the editors of this publication say, "Just come in and show us—merely SHOW us,—a working model of a perpetual motion machine and we will give you $5,000.00. But the machine must not be made to operate by tides, winds, waterpower, natural evaporation or humidity. It must be perpetual motion."

So if someone asks you to buy shares of stock in a perpetual motion machine, tell him he can get more money from us and he need only show us the working model. Meanwhile, don't you put your money into a device, the working model of which has not even been built and don't invest in any machine which is to be entered in this contest.

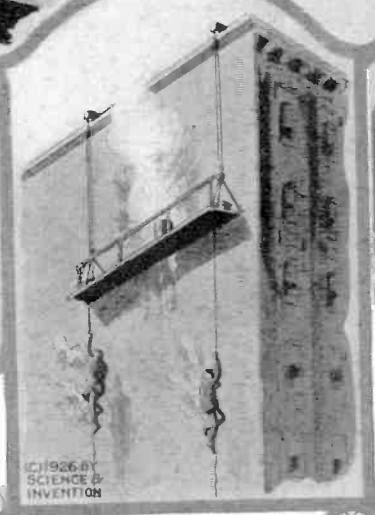
The Month's Science News Illustrated

By GEORGE WALL

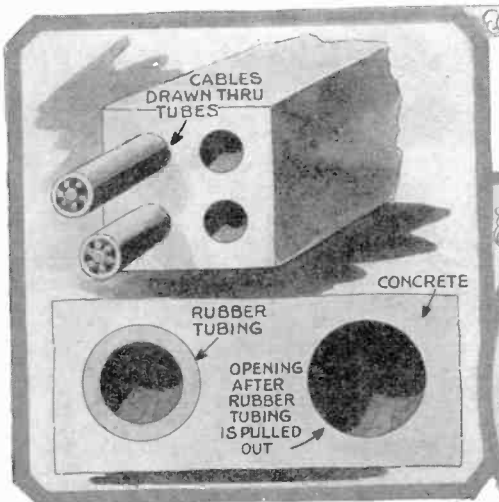
Oysters weighing 1 pound 10 ounces each and 13 inches in diameter have appeared on the market in Seattle, Wash. One would easily make a meal.

In Tokyo, a fly extermination campaign was recently held and the dead flies were counted by the municipal office staff. 22,900,231 flies were turned in as a result of the campaign. This drive was fostered by a great increase in the number of flies.

There are all kinds of hobbies in the world and here is one of the strangest. A young Frenchman recently fasted for 30 days, breaking his previous record of 23 days. During that time he consumed only opium and sugared water.



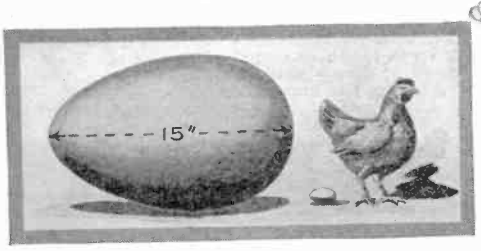
Recently two boys ran away from their home at Highland Park, N. J. and sought refuge in a storm sewer. Police officers donned gas masks against sewer gas and finally rescued them from a precarious position.



Conduit holes are made by pouring concrete around rubber tubes that have been placed in position and the collapsible tubes are then withdrawn.

Two painters were recently working on a scaffold on a New York building when a can of paraffin that they were using ignited from a blow torch and set fire to their clothing. They escaped as shown above.

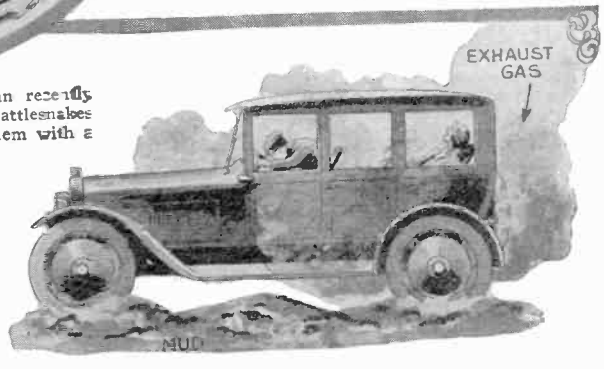
A tube containing $80e,000 worth of radium was recently lost in a St. Paul, Minn., hospital. It was found in a sewer pipe leading from the building by means of an electroscope as above.



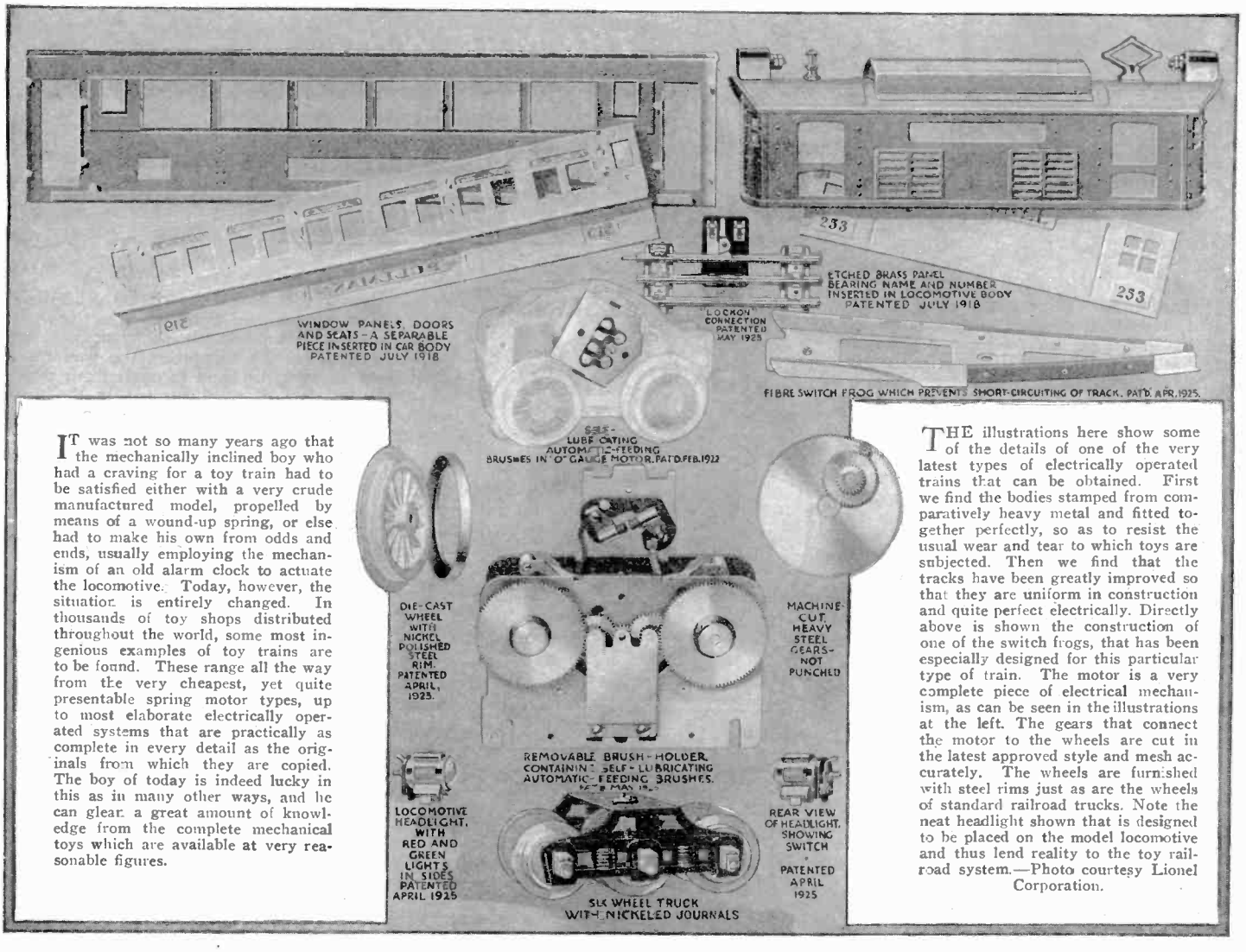
A new record for egg laying has been made by a Dominique hen. In one year, she layed 227 eggs, which if made into one large egg would be over 15 inches long, quite a lot of food for a small hen to produce in one year.

At Fort Lupton, Colo., a woman recently waged a two-hour battle with rattlesnakes and as a result, killed 140 of them with a club.

A couple were recently asphyxiated in a sedan type of automobile by the exhaust gas which contains carbon monoxide. The car was stalled in heavy mud and they kept the motor running to keep warm.



Improved Toy Electric Train

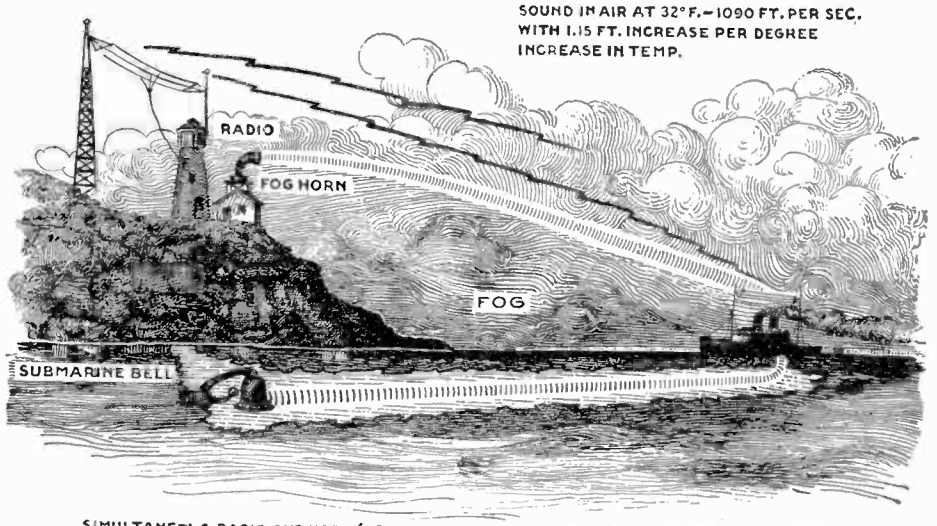


IT was not so many years ago that the mechanically inclined boy who had a craving for a toy train had to be satisfied either with a very crude manufactured model, propelled by means of a wound-up spring, or else had to make his own from odds and ends, usually employing the mechanism of an old alarm clock to actuate the locomotive. Today, however, the situation is entirely changed. In thousands of toy shops distributed throughout the world, some most ingenious examples of toy trains are to be found. These range all the way from the very cheapest, yet quite presentable spring motor types, up to most elaborate electrically operated systems that are practically as complete in every detail as the originals from which they are copied. The boy of today is indeed lucky in this as in many other ways, and he can glean a great amount of knowledge from the complete mechanical toys which are available at very reasonable figures.

THE illustrations here show some of the details of one of the very latest types of electrically operated trains that can be obtained. First we find the bodies stamped from comparatively heavy metal and fitted together perfectly, so as to resist the usual wear and tear to which toys are subjected. Then we find that the tracks have been greatly improved so that they are uniform in construction and quite perfect electrically. Directly above is shown the construction of one of the switch frogs, that has been especially designed for this particular type of train. The motor is a very complete piece of electrical mechanism, as can be seen in the illustrations at the left. The gears that connect the motor to the wheels are cut in the latest approved style and mesh accurately. The wheels are furnished with steel rims just as are the wheels of standard railroad trucks. Note the neat headlight shown that is designed to be placed on the model locomotive and thus lend reality to the toy railroad system.—Photo courtesy Lionel Corporation.

Sound—Radio Fog Signal

EVER since man has attempted to cope with the waters of the earth and to travel great distances from land, one of the most fearsome obstacles that he has had to contend with is fog. When a heavy fog sets in at sea, objects even very close by become obliterated and the pilot of a vessel has to depend almost as much upon a sixth sense to guide his charge safely as he does upon the rules and instruments of navigation. Numerous attempts have been made to successfully conquer this terror of the sea and to guide vessels toward any desired point, without the loss of time that is usually encountered when maneouvering to port. The most common among these is the use of loud horns or fog signals, whose notes are supposed to carry for great distances, and generally do, but sometimes fail utterly. Also radio has been used, but now we have a combination of sound and radio that should prove most reliable. By its use, a pilot can determine exactly how far he is from any given point and by means of radio he can keep in constant communication with land. The proposed system is illustrated in detail here. The process of utilizing different signals is as follows:

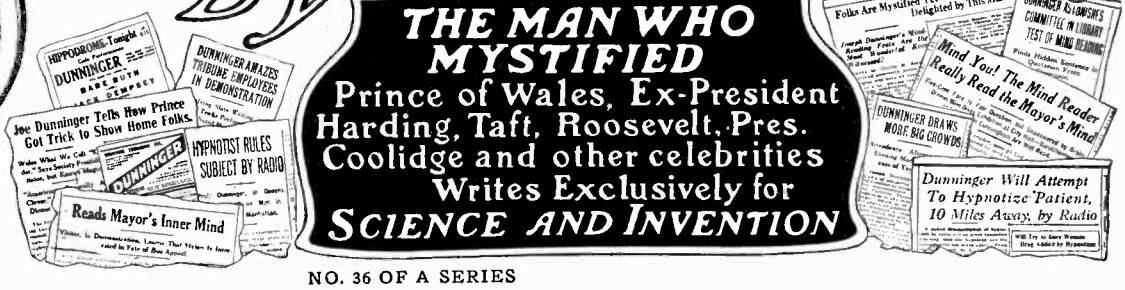


SIMULTANEOUS RADIO AND HORN (OR RADIO AND SUBMARINE BELL) SIGNALS PICKED UP BY SHIP. INTERVAL BETWEEN ARRIVAL OF RADIO AND AIR (OR WATER) SIGNALS USED TO COMPUTE DISTANCE OF SHIP.

A standard signal is adapted such as a certain combination of dots and dashes, followed by a signal dot. This is sent out by radio and simultaneously with the signal dot, a note is sounded on a fog horn and another one on a submarine bell located under the water and as close to the fog horn as possible. Sound travels at different speeds through air and through water and the speed of radio waves is so fast, that the lapse of time between the transmission of the signal and its reception can be disregarded. The operator of this system at the receiving end records the time interval between hearing the radio signal and the water signal, and between the latter and the air signal. Simple calculations based upon the speeds of sound through the air and through water, immediately show the distance between the ship and the shore.—(Author please send address.)

MAGIC By "DUNNINGER"

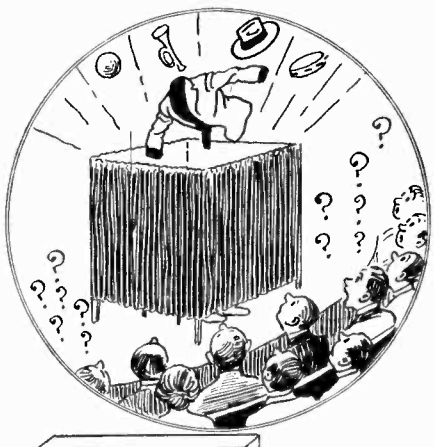
THE MAN WHO MYSTIFIED Prince of Wales, Ex-President Harding, Taft, Roosevelt, Pres. Coolidge and other celebrities Writes Exclusively for SCIENCE AND INVENTION

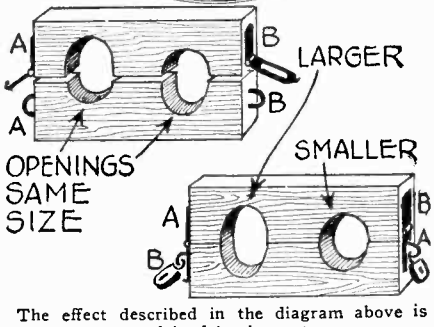


NO. 36 OF A SERIES

Perhaps in the entire array of problems that I have been credited with originating there is none more impressive nor puzzling than the one I am about to describe. It is not alone different in effect, but likewise differs in principle from anything of its kind heretofore presented. Small stocks to encircle just the wrists, and made of wood, are offered for examination. They are then securely locked by means of a hasp and staple arrangement, with two borrowed or unprepared padlocks, and the performer can at once release his hands for spirit manifestations, and can immediately afterwards show them still locked. The performer cannot slip his hands through the wrist holes when they are locked, as illustrated in the first diagram at the right.

The Hand Stocks

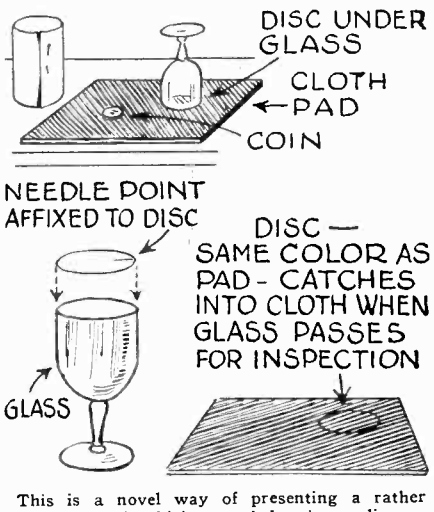




The effect described in the diagram above is explained in the text.

By way of further description concerning the hand stocks, we would say that the wrist holes which encircle the performer's wrist, are small enough to prevent the performer from slipping his hand through them when they are locked, as illustrated in the first diagram. However, when the top section is reversed, as illustrated in the second diagram, one of the wrist holes becomes larger while the other becomes smaller. The larger one then permits the hand to be easily freed and allows for the manipulation of various things while the performer is seemingly securely locked. When the wrist cuffs are removed from his wrist, the performer takes care to again reverse the position of the cuff sections before he passes them out for examination. It is evident that unprepared locks may be used.

The Glass and Coin Trick

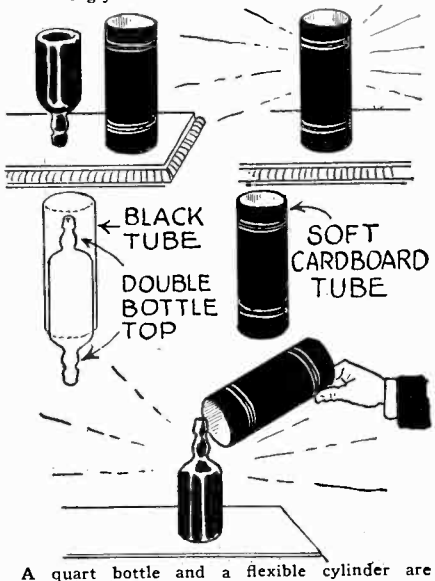


This is a novel way of presenting a rather simple trick which nevertheless is puzzling.

A piece of colored felt placed upon an unprepared table, a drinking glass and a coin in the nature of a half dollar or other similar coin, constitute the necessary apparatus. Beneath the cover of a paper cylinder, a drinking glass is placed mouth down, and both are then put directly over the coin. The paper cylinder is removed and the coin will be found to have vanished. The cylinder of paper is again replaced, the glass once more lifted, and the coin reappears. After several demonstrations of this strange reappearance and disappearance, both coin and tumbler are passed for examination. Students of conjuring will appreciate the fact that this particular feat of inspection has been quite impossible in other forms of this trick. A disk of felt corresponding in nature and color to the felt pad used on the table, fits over the mouth of the glass. To the under side of the felt disk a needle is fixed. This needle serves to catch into the felt pad and pulls the disk away from the mouth of the glass when the glass is to be passed for examination.

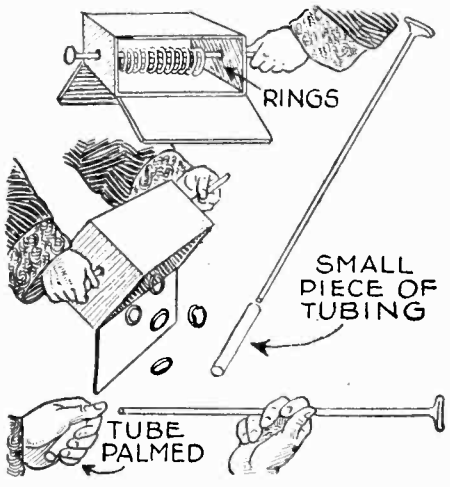
The Mystic Bottle

In the trick illustrated below a bottle seemingly inverts itself under a cover.



A quart bottle and a flexible cylinder are shown. The bottle is placed on the table in an inverted position. When sliding the cardboard tube down upon the table, the extra section of the bottle slides down flush with the table and causes the illusion of inverting the bottle.

The Mystic Box



A small box about twelve inches long by six inches square, lid and bottom hanging down so as to permit absolute view of the interior, is exhibited. The box has two small holes in opposite sides. A stick or rod, and four or five small endless brass rings are shown. The stick has a projecting knob upon the one end larger than the holes in the sides of the box. The stick is run through these holes so as to permit the rings to slide over same upon the interior of the box, and the two doors closed. The magician explains that the rings cannot be removed from the stick because he holds the end firmly in his hand. Yet at command, the rings drop off.

The secret—A small piece of tubing corresponding in color with the stick, slides over one end of the stick. This tubing, projecting from the hole, gives the audience the impression that the stick is held firmly in place, whereas in reality, the knob at the opposite end is pulled out slightly, so as to permit the rings to slide off the rod, and drop into the box. When the apparatus is passed for inspection, the small piece of tubing is secretly palmed.

Fig. 5 above shows the moon about to occult a star, which will vanish and then reappear instantaneously after the moon has passed.

The Moon's Atmosphere

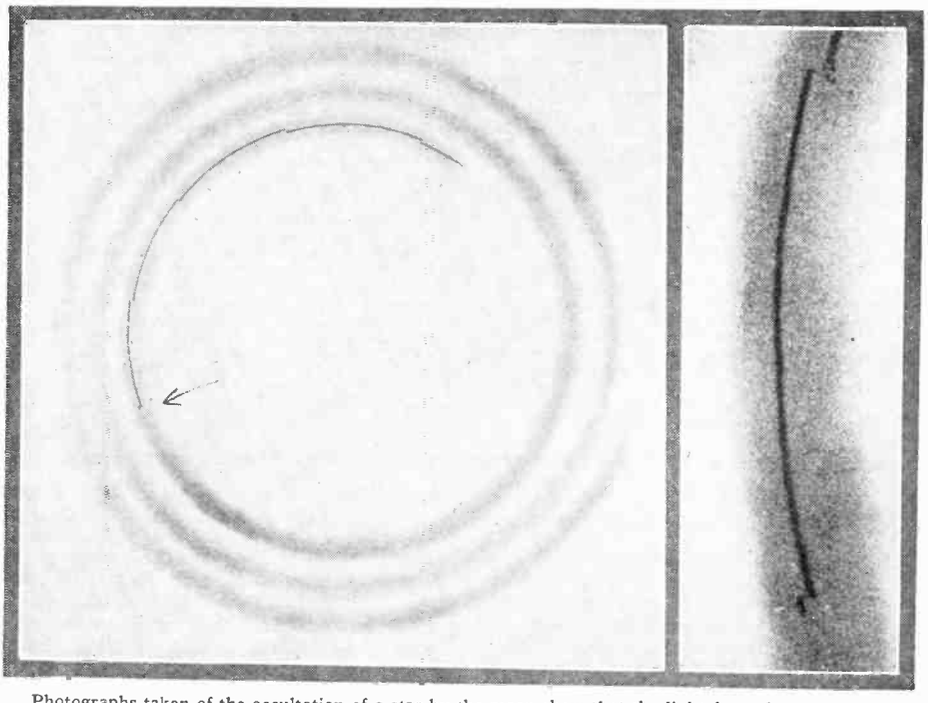
By DONALD H. MENZEL, Ph.D

Latest Astronomical Research Indicates Moon May Have An Atmosphere

FOR many years astronomers have considered the moon as a dead world. Since the days of the invention of the telescope, no marked changes have been recorded in its surface features—erosion by the atmosphere or any shift which might possibly be attributed to the action of earthquakes. The dark areas which so excited the imaginaton of the early astronomers who thought them to be seas, have proved to be dry, dead plateaus, rolling country resembling our great plains more than anything else within our knowledge. The lunar craters have never exhibited the slightest sign of volcanic activity, so observation of so uninteresting an object gradually ceased, nearly everyone accepting the general opinion that the moon's surface was dull, dead, exposed to the blazing glare of the sun during the day and, during the long lunar night, lasting for fourteen terrestrial days, subjected to the cold of interstellar space.

Had the moon an atmosphere? Clouds were never seen floating above its calm surface; no mists or obstructions of any kind were ever detected and certain observations proved conclusively that the quantity of the lunar atmosphere, if any at all, was exceedingly small. During the course of a single revolution, the moon passes in front of a number of stars, completely hiding them from view. If the disappearance of a star is observed from the surface of the earth, the presence of a lunar atmosphere would be revealed because the light, in its passage through the gas, would be refracted and weakened in intensity. The star should, therefore, fade out gradually and not disappear suddenly. (Fig. 1).

Fig. 5 shows the moon about to occult a star. It is a well-known fact that the stars vanish and reappear instantaneously. This is proved by the photograph in Fig. 3. A camera was pointed at the dark edge of the moon at the point where it was computed that the star would reappear. By a clockwork arrangement, the plate-holder was revolved in a circle, a break taking place every ten seconds. The image of the star and the dark edge of the moon (the latter, on account of the revolution of the plate, appearing as a shadowy spiral path) were thus taken together and the speed with which the star emerged is proven by the sharpness of its image marked by the arrow. Fig. 6-A is an enlarged portion of the same photograph.



Photographs taken of the occultation of a star by the moon show that the light from the star ceases instantly and is then seen as quickly. Fig. 6 at left above shows photo taken on revolving plate and Fig. 6A at right above shows an enlarged section of same plate.

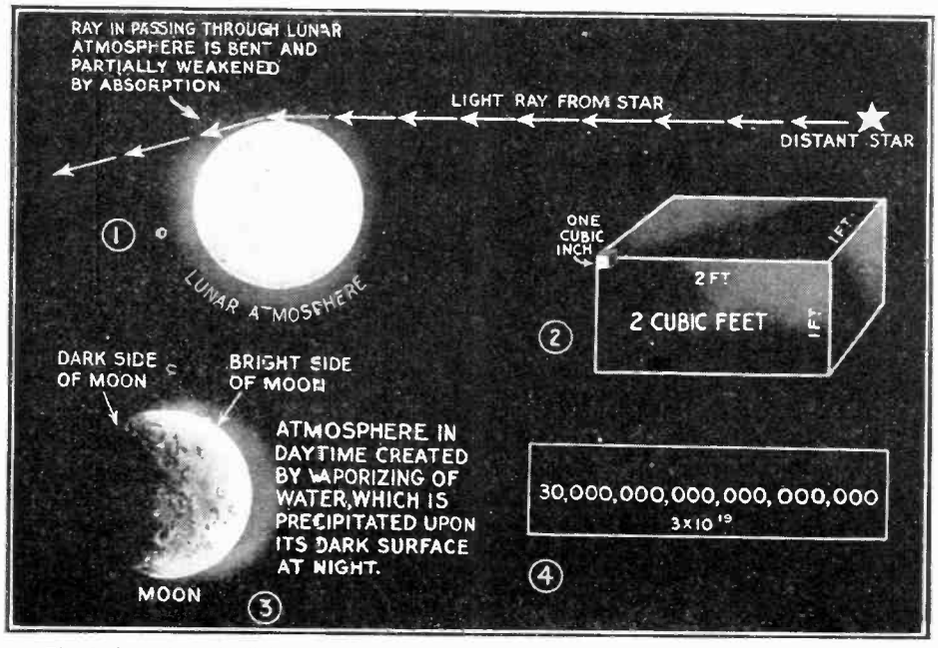


Fig. 1 shows how the light from a distant star passing through the moon's atmosphere is bent. if one cubic inch of normal air is allowed to fill a container, as shown in Fig. 2, the result will be the density of the moon's atmosphere. Fig. 3 shows how the moon's atmosphere changes. Fig. 4 shows the number of molecules in a cubic centimeter of air at normal pressure.

PROF. PICKERING'S THEORY

Notwithstanding the certainty of the above observations, Prof. William H. Pickering, an astronomer who has devoted practically his entire life to the study of the moon and the planets, believes that there is some lag in the disappearance of a star behind the *bright* limb of the moon. Behind the dark limb, he admits, it is instantaneous. The difficulty of observing a faint star close to the bright surface of the moon, often makes it difficult to determine the exact time of its disappearance or reappearance—a problem not met with at the dark edge. *This would suggest the presence of an atmosphere only upon one side of the moon* and, Professor Pickering points out, this is not inconsistent with the recent observations of lunar temperatures. It merely means that the lunar atmosphere is precipitated in liquid air or solid form upon its surface during the night, when the temperature approaches absolute zero, and evaporates during the day as the temperature rises (See Fig. 3).

From the amount of the displacement of the star, Professor Pickering concludes that the pressure at the surface of the moon is about one thirty-six-hundredths of the pressure at the surface of the earth. Small as this may seem (it is equivalent to the pres-

(*Continued on page* 1049)

Tarrano the Conqueror

NINTH INSTALLMENT

By RAY CUMMINGS

SYNOPSIS

IN the spring of the year 2325, all of the rulers of the various countries of the earth are mysteriously murdered. Jac and Grayson, employees of a large news organization, find that the murders are the result of a plot on the part of the inhabitants of Venus. Tarrano, an erstwhile lower official of the Cold Country of Venus is found to be at the head of a plot to rule the universe.

Dr. Brende, a friend of Jac's has discovered a medical method whereby human beings may be kept from growing old. The Doctor is killed by a group of "Venus-Men" and Jac, Elza, the Doctor's daughter and Georg, the Doctor's son, are captured and taken to Venia, a city on the earth inhabited by people of Venus. Here they are imprisoned and Wolfgar, a Venus-man, friendly to the people of the earth, surrounds them by an electrical isolation barrage in an attempt to rescue them. The barrage is broken down and in the resulting confusion, Georg escapes to Washington in company with Princess Maida of Venus.

The next day, Tarrano offers to return the papers and models of the invention made by Georg's father, which he has confiscated and brands young Brende as an impostor. To offset this accusation, Georg is to tell his story to the earth as well as to Venus and Mars by radio and helio. He and Princess Maida go to the station but there they disappear.

Jac, Wolfgar and Elza, still captives, are removed from their prison and taken to the top of an enormous tower. Here, in the instrument room, where communication with the various planets is held, they view the disappearance of the Princess Maida and Georg by television. The abduction has been done by Tarrano's agents. On Mars, Tarrano's followers are attacking the ruling class and Tarrano offers Dr. Brende's secret to the public if they will surrender to his cohorts. They agree. Tarrano then announces to the earth people, that he will not give them the Brende secret and declares war upon them, challenging them to attempt to conquer him.

The air war vessels of the earth government start to attack Venia, but Tarrano sends up a bomb of surrender and then, with Elza, Jac and Wolfgar, he escapes through an underground passageway to a space-flyer. They go on board and are taken to Venus to where Georg and the Princess Maida have previously been transported. They are royally welcomed and go to the palace of the Princess Maida. Here they are attacked by Argo, one of Tarrano's men, who shoots a violet-colored beam of light across the room, separating Maida from the rest of the party. He threatens to kill her, when suddenly Wolfgar throws himself into and through the violet beam of death.

Wolfgar dies soon after he confesses to Maida that he loves her and Maida has made a similar declaration. With great pomp and ceremony, the body of Wolfgar is laid to rest in the WATERS OF ETERNAL PEACE.

The evening after the burial of Wolfgar, Jac chances to be alone in a small boat near the palace and he is warned by a SLAAN, a Venus man, to guard himself well. He also sees below the surface of the water and encased in a diver's cap, the face of an Earth man. Later that evening, preparations are rushed through for the great Water Carnival of Venus and to it proceed Georg and Maida; Elza and Tarrano; and Jac without a partner. They disguise themselves with long robes and masks and soon reach the scene of the festival.

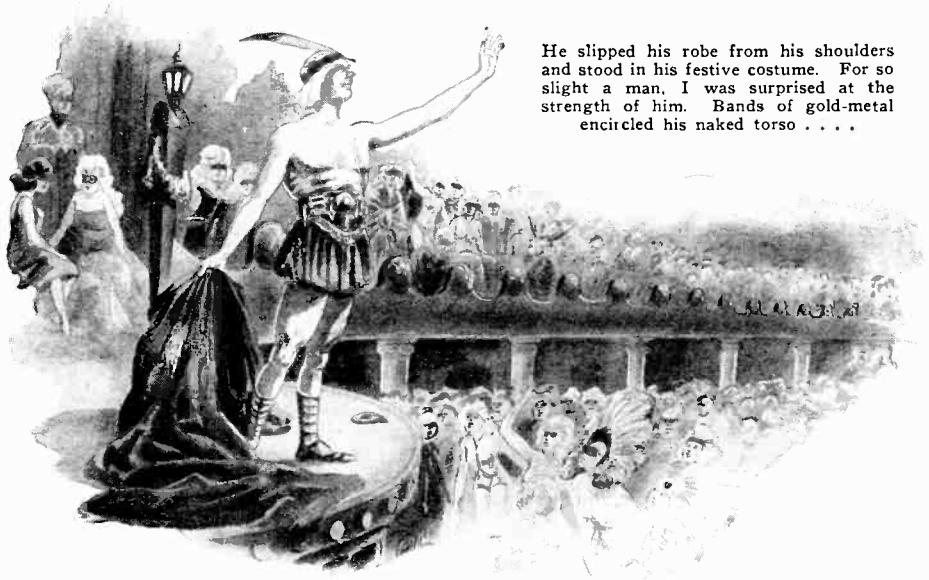
CHAPTER XXI

LOVE AND MUSIC—AND A WARNING

THE Water Festival! As our barge rounded a bend in the canal, under the archways of dangling colored lights, the festival spread before us. Involuntarily I stood up to gaze. The canal opened into an artificial lake—a broad circular sheet of water some 800 *helans** in diameter. Sloping hillsides enclosed the lake—hillsides which I saw were terraced with huge banks of seats in tiers one above the other.

The seats were crowded with people. White ribbons of roads gave access from the neighboring countryside for land-surface vehicles, and there were stages for the accommodation of air-craft. The rural populace, and people from the nearby smaller cities, had gathered to view this national spectacle—a million or more of them probably, with their individual electrical telescopes for direct distant vision, and small pocket mirrors for that which otherwise would be hidden. A million people at least, seated here on these gigantic spreading tiers.

The lake itself was thus the stage as it were, of a tremendous arena. Tiny artificial islands dotted the lake—a hundred of them. Islands, some no more than a few feet broad; some larger, and in the center of the lake, one quite large. All the islands were covered with luxuriant vegetation. The tiny ones were no more than shadowed nooks of leaves and flowers.



He slipped his robe from his shoulders and stood in his festive costume. For so slight a man, I was surprised at the strength of him. Bands of gold-metal encircled his naked torso . . . .

. . . . fell with him into the water. I watched the splash and the ripples where they went down. In a moment, the girl came up—but the man did not.

Between the islands, crooked lanes of the placid water wended their way in and out, broadening into occasional lagoons. Bridges crossed the lanes; archways of lights spanned them at intervals.

From this distance the whole scene was a riot of color and great red and purple auroral lights of Venus, which at this midnight hour rode the upper sky, tinged everything vividly. The archway lights were soft rose, silver and gold. Some of the tiny islands, from sources hidden, were bathed in bright silver. Others darker, in deep purple and red; still others, quite unlighted, dim and shadowed, touched only by the reflected glow from those near them.

From the main island lights were flashing into the sky; occasional color bombs mounted and burst, painting the heavens.

A riot of color. And then as we approached, I became aware of sound and movement as well. Music from scores of unseen sources. Music from single isolated instruments floating softly over the water—lovers playing accompaniment to their pleading voices; or again, groups of voices—the curiously mellow voices of young girls—and, on an island apart, music from an aerial carrying strains from the public *concclan*† of the Great City.

It was all music of a type unfamiliar to me of Earth. The intellectuality of our Earth-music was missing. This music of Venus was built upon queer minor strains; unfinished cadences; a rhythm of the sort we of Earth could never encompass. I listened, and felt the appeal of my senses. The lavish, abandoned music of barbarism? I had almost thought it that. Yet it was not. Rather was it decadent. This whole scene; the color, the music, the heavy cloying scents with which the night air was redolent; the warm, sensuous abandonment, felt rather than made obvious—it was not barbarism, but decadence. And I realized then how close are the two extremes. A reversion to type, merely. And I knew, then, that from the pinnacle of civilization which we of Earth had reached, naught lay before us but this.

Music everywhere throughout the festival. And movement. As we floated out of the canal, passing slowly along one of the broader waterways, boats and barges slipped past us. Barges crowded with revelers. And the small boats, generally with but a man

*About 4,000 feet. †Orchestra.

and a girl—fugitive couples with the holiday spirit upon them, seeking the shadowed nooks of islands for their love-making.

In one lagoon we came upon such a boat. The man in it—a gay youth in red and black motley, with the mask fallen from his laughing, perspiring face—was in its stern, manipulating it with a long, thin paddle. The girl was lying face down on cushions in its prow. She was facing forward, with her long white hair tumbling about her. Around the boat were clustered a number of other boats. Each small, with a man alone in it. A ring of boats, beseiging the girl. Our barge paused to watch. A boat would dash forward, its occupant standing up to thrust it on. But the girl, swung to meet it by the efforts of her escort, would turn her cylinder of *alcholite** upon the attacker. Befuddled, her adversary would retreat; or another, momentarily drunk, would fall into the water to be sobered.

All with gay shouts of laughter; until at last the couple were victorious and scurried away to their island.

We passed on. There were mimic battles often on the islands. A hidden couple found out and dragged back. A lone man attacked and pelted with flowers by a band of marauding girls. A diving platform at one end of an oval lagoon. Girls mounting it to dive into the red-shimmering water, where waiting youths were swimming, and by their prowess in downing other contenders would seize upon the girls and carry them off to where a barge was loading its passengers for the main island.

To this main island we came at last. It was heavily wooded, and indented with shallow, placid waterways. In one of them we landed; and amid a sudden quiet and awe at the presence of Tarrano, we went ashore. Georg walking with Maida; Tarrano forcing Elza to hold his arm; and I, beside Elza until Tarrano sternly bade me walk behind.

We were masked, but the revelers knew us. Amid the throng with which the island was packed, we moved slowly forward toward a gay pavilion which was in the center of the grove. Music came from it—a broad, roofed-over pavilion with a dancing floor in the depression of its center space, and tiers of balconies above it.

Within the pavilion, where the air was heavy with the smell of wine, arrant-smoke, intoxicating whiffs of surreptitiously used alcholite-cylinders and sensuous perfumes upon the garments of the women—in here, the throng pressed around us; the dancers stopped to gaze; the music momentarily hushed; the spectators on the balconies—girls reclining on cushions with young gallants seated beside them with trays of food and drink—all turned to crane down at us.

"Honor to the Master Tarrano!"

A girl shouted it. A murmur of applause swept about us.

Abruptly Tarrano removed his mask. His face, which had been concealed, showed with the flush of pleasure and his lips were parted with a smile of gratification and triumph. But, as the red silk mask was doffed, another took its place—the mask of imperturbability—that grave, inscrutable look with which he always masked his real emotions.

"Honor to the Master Tarrano!"

Tarrano raised his hand; his quiet, calm voice carried throughout the silent room.

"There is no Master here tonight. No Master—only the Mistress of Love. Let us honor her. Let *her* rule us all—tonight."

For just an instant his gaze seemed to linger upon Elza; then he gravely replaced his red mask. Applause swept the room; the music started again. The lights overhead began whirling their kaleidoscope of colors down upon the dancers.

We took our places in a canopied enclosure upon the first balcony, some twenty feet above the dance floor. Tarrano refused the cushions; he placed Elza deferentially upon them, and spread food and drink and sweetmeats before her. Near them sat Georg and Maida. I would have sat between Elza and Georg, but Tarrano pulled me away from them.

. . . . From high overhead in the silver shaft a shape appeared, slowly floating downward. A woman's figure. It came down . . . .

"You are wanted below." He said it very softly, for my ears alone; but through his mask I could see his eyes blazing at me.

"They are diving into the pool outside—cannot you hear them, Jac Hallen?" Impatience came to his voice; in truth, I must have been staring at him witless. "Maidens out there, Jac Hallen, who are seeking handsome youths like yourself for escort. Must I speak plainly? You are not wanted here. Go!"

"I——"

"Another word will be your last." His voice was still almost emotionless, but I did not miss the gesture of his hand to his belt. "You had best obey, Jac Hallen."

I was hardly so witless as not to realize the truth of his admonition. I turned away; and with all the laughter and movement around us, I think that Georg, Maida and Elza did not see me go.

For the space of an hour or more, I stood alone on the lower floor of the pavilion, watching the balcony where Tarrano and the others sat. Stood there alone, feeling helpless and with my heart heavy with foreboding. Beneath my grey robe I was dressed in holiday fashion of the Great City—beribboned and gartered, with feathers at my scarlet shoulders for all the world like a male *nada*.** My red mask I kept on, and folded my cloak around me.

The dance floor was crowded. I saw now that it was cut into small circles marked with black—circles in diameter about the length of a man. At intervals—perhaps five minutes apart—a signal in the music caused each of the dancing couples to select a circle and to dance wholly within it. And then one of the circles, by mechanical device, was raised into the air above all the others. The couple on it, thus prominent, danced at their best, to be judged by Tarrano for a prize.

For an hour I stood there. I could see Elza plainly. She had removed her mask. Her face was flushed, her lips laughing. Once, in a chance silence, her shout of applause rang out. The quality of abandonment in it turned me cold. Did I see Tarrano's hand move back to his belt? Was he intoxicating her? Then I saw Maida make a gesture—wave something from beneath her cloak at Elza. A scent to sober her? It seemed so, for Elza looked confused; and I saw Maida flash her a look of warning.

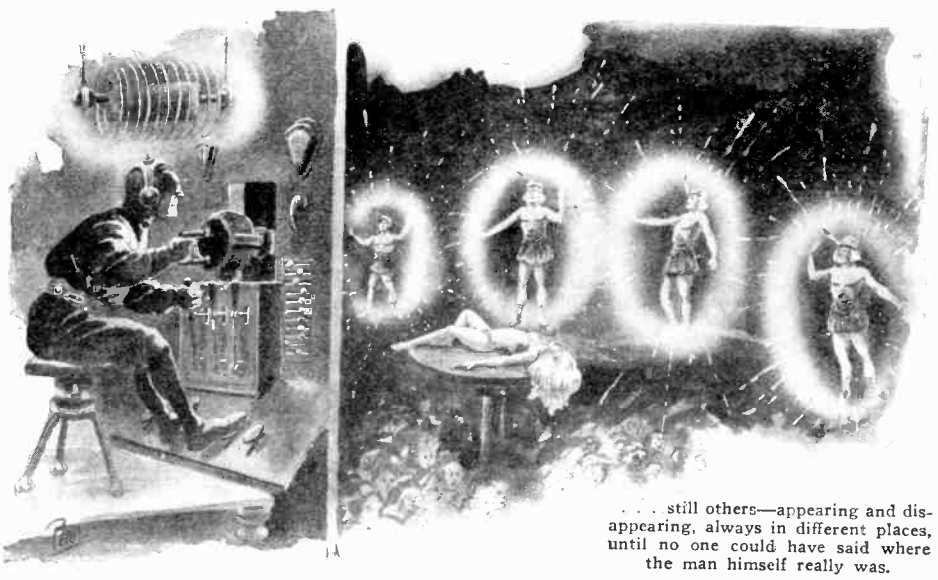
Abruptly, from an alcove near me, a group of girls rushed out. Their cloaks and white veils fell from them as they came my way—laughing as they ran for the doorway leading outside to the pool. I was in their way and they bumped into me; one of them gripped me. I tried to jerk loose, but she clung. A slim girl, enveloped in her long, white tresses. Her eyes laughed at me; her red mouth went up alluringly to my face.

"I love you—*you*, Jac Hallen." Her arms wound about my neck as she clung. I was trying to cast her off when her fingers lifted a corner of my mask.

"I was afraid you were *not* Jac Hallen." Her whisper was relieved, and it had suddenly turned swift and vehement. "I am sister to Maida—my name, Alda. I am to warn you. When Tarrano dances with the Red Woman—when they go up on the raised circle—*you drop to the floor!* You understand? Keep down, or the rays might strike you! But be here, inside, and watch. And *afterward*, go quickly to join the Princess and your Elza. You understand?

She clung to me, with her slim, white body pressed against my cloak. To anyone watching us, she would have seemed merely making love. Her eyes were provocative; her lips mocking me. But she was whispering, *"Drop to the floor when Tarrano dances with the Red Woman—drop or the rays might strike you!"*

(*Continued on page* 1044)

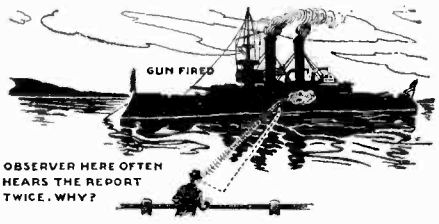


. . . still others—appearing and disappearing, always in different places, until no one could have said where the man himself really was.

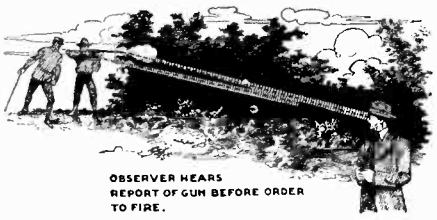
*A scent or perfume, highly intoxicating. **A popinjay—fop.

Oddities of Sound

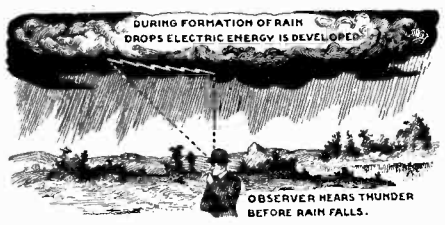
By ERNEST K. CHAPIN



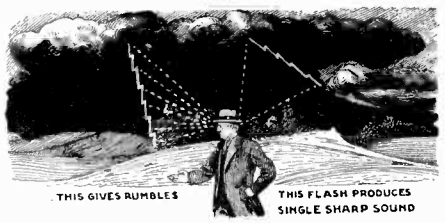
WHEN a gun is fired from a ship quite a distance from shore as indicated above, the sound of a report can often be heard twice. This is because sound travels faster through water than it does through the air and two sound waves are produced, one traveling in water and one in air at different rates of speed. The paths of the two sound waves are shown in our illustration. Note that one of them enters the water and then leaves it.



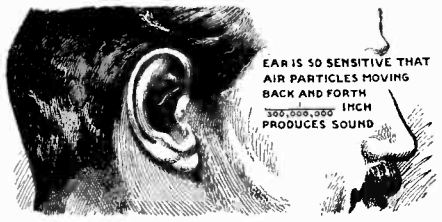
ALTHOUGH the fact illustrated above may not be generally noticeable, still it often happens and a keen observer can easily demonstrate the fact stated. The reason that the report of a gun can sometimes be heard in advance of the vocal order to fire, whereas the true order of events is the reverse, is because a very intense sound such as that of an explosion travels faster than the fainter and less sharp sound of the human voice.



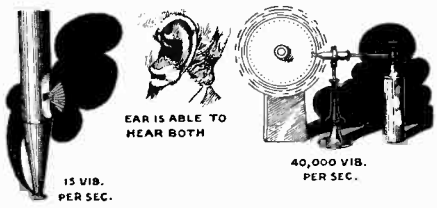
THUNDER is heard in three different forms: a continuous rumble, a sharp, loud sound and a series of rumbles and sharp claps of an intermittent nature. This is usually due to the position of the observer and the direction of the discharge. If the entire length of the discharge is practically equidistant from the observer, a clap is heard. If on the other hand, one end of the discharge is nearer the observer than the other, a rumble is heard. See illustration above.



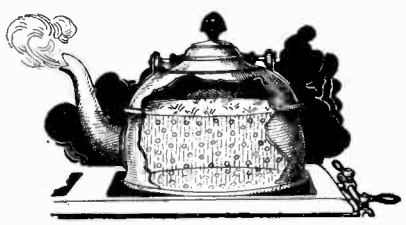
IT is often noticed that a shower of rain immediately follows a sudden peal of thunder. Some think that in some way the thunder causes the rain to fall. This is not so, but it is found that during the formation of the rain drops, electrical energy is developed which causes the discharge and consequently the thunder. The sound of the thunder travels faster than the drops fall and therefore arrives at the surface of the earth before the rain.



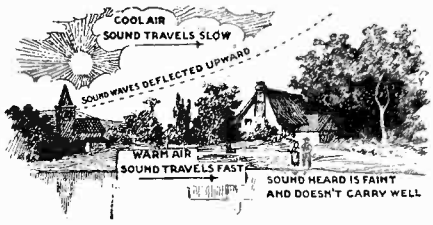
THE more that we investigate the mysteries of the human body, the more we are impressed with the wonderful facilities of its various component parts. The eye is often considered one of the most wonderful organs of the entire system and in studying its various features, we are somewhat inclined to overlook the marvelous abilities of the ear. Sensitive as is the eye, even more may be said about the ear. Many experiments and researches in the realm of sound only serve to strengthen this conclusion and to show us more forcibly just how sensitive is our hearing apparatus. As indicated in the above illustration, audible sound waves which move particles of air back and forth only one three-hundred-millionth of an inch register on the sensitive diaphragm or ear drum, and affecting the nerve ending in the ear.



NOT only is the ear very sensitive but it will also respond to a great range of frequencies. Whistling notes have been heard which have vibration rates as high as 40,000 per second. At the other end of the range we find notes which are the result of sound waves vibrating at a rate as low as 15 per second. The extremes of the sound range audible to different individuals vary with the person and also depend upon other conditions.

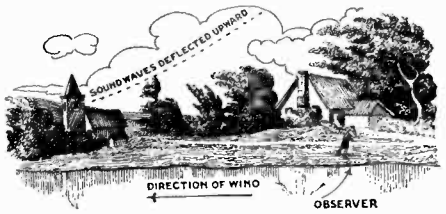


WHAT makes a tea-kettle sing? Probably everyone has noticed that a tea-kettle will produce a singing sound only when the temperature is exactly right for the production of this phenomenon. If the water is too cold, no bubbles will form in it; whereas on the other hand if it is too hot, the water will boil and no sound of a singing nature will be heard. However, when the temperature of the water is just exactly right, bubbles will form near the bottom and will rise to the cooler layers of water found near the top of the kettle. At this point the bubbles will suddenly collapse and by so doing, they will communicate to the walls of the kettle a succession of tiny impulses which will be so rapid as to produce the well-known singing effect.

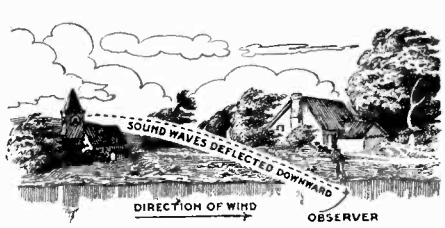


WE have often noticed that sound does not travel as well in the daytime as it does at night and this fact is explained here and in the following caption, and is illustrated in the drawings above and the one immediately below. During the daytime, the air nearest the earth is warmer than that further up and the dragging effect created by one part of the sound wave traveling faster than another, tends to deflect these waves upward as shown.

DURING night time, the reverse is the case. The cool air is near the surface and the warm air is higher. Here again the important factor of refraction enters into the problem, and as a consequence the sound waves are deflected downward and are found to carry far better at night than during the day. Greater clarity of sound is also usually observed at night whereas in the daytime it is weaker and more indistinct.



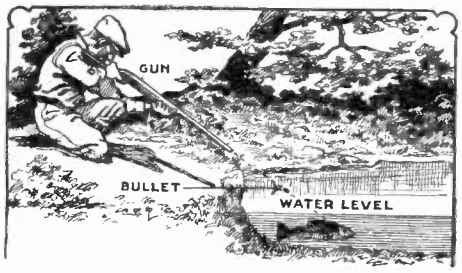
A VERY similar phenomenon is noticed when it is observed that sounds travel better with the wind than against the wind. Here again, the waves are deflected upward when traveling against the wind, due to the fact that the upper layers of the atmosphere are traveling faster than the lower ones, nearest the ground, and refraction takes place, bending the path of the waves.



WHEN the sound waves are traveling in the same direction as the wind, refraction also takes place as mentioned immediately above, but in this particular case, the refraction is in the opposite direction and the sound waves tend to travel close to the earth. Therefore, they carry better and are heard at distances greater than they could ever be heard if they were traveling against the wind.

Unusual Problems of Physics

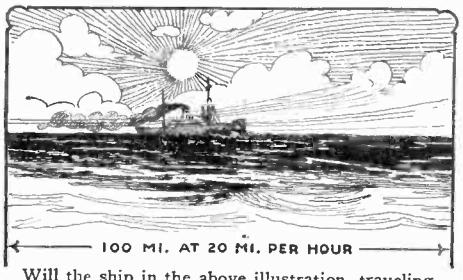
By PROF. E. BOBROWSKI



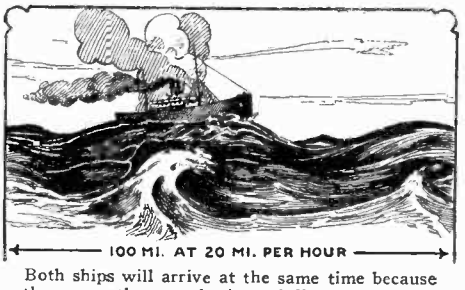
SHOOTING fish with a gun is not such an easy task as it might seem to be upon first consideration. In the illustration above, the gun is pointed directly at the fish. Will the fish be hit or not and if not, how should the gun be directed in order to kill the fish?

Under the conditions shown in the above illustration, the fish will not be killed by the bullet because the bullet will follow the line AE shown in the drawing on page 1038, whereas the fish is actually at the position indicated by D. This is because of the refraction of light when it passes from air to water. Aim along AC in above mentioned illustration to hit the fish.

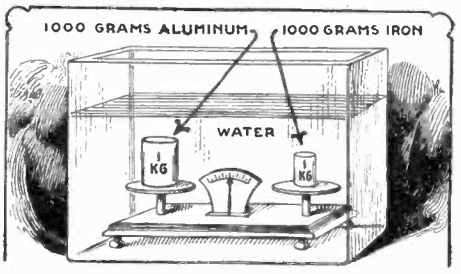
This is one of the phenomena of physics that does not always make itself manifest to the uninitiated until the subject is studied and experiments are carried out to prove refraction.



Will the ship in the above illustration, traveling on a smooth sea reach its destination before the one shown below which appears to be traveling a greater distance as it has to seemingly travel over the waves.



Both ships will arrive at the same time because they cover the same horizontal distance which is not affected by the perpendicular wave motion.



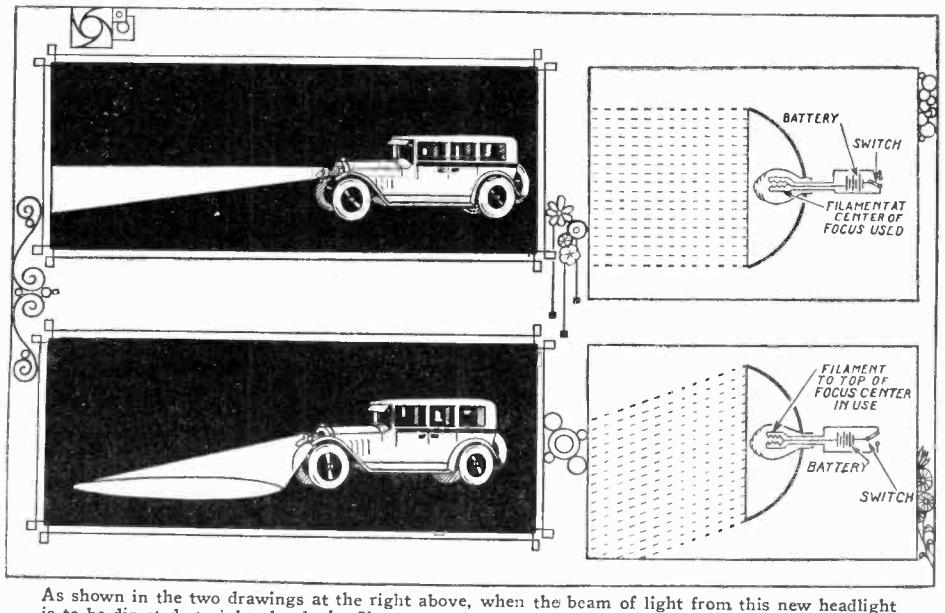
WHEN an aluminum block weighing 1,000 grams is placed on one pan and an iron block of the same weight on the other pan of a scale, the pointer will indicate a balance, if the scale is in air. If, however, the same combination is immersed in water, how will the reading of the scale be affected?

According to Archimedes' law of the displacement of liquids by bodies, the aluminum body being larger will displace a volume of liquid greater than that displaced by the iron. In this particular case, the water displaced by the aluminum will weigh 370 grams and that by the iron 133 grams. In other words, the two objects will lose this amount of weight and the scale reading will be 237 grams.

(*See page* 1038)

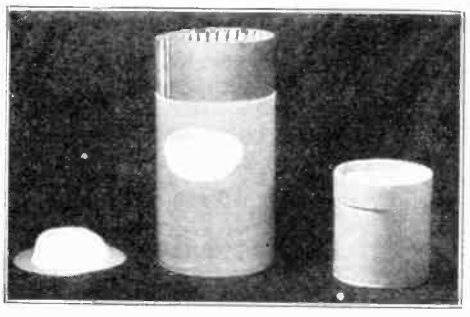
Novel Auto Headlight

ONE of the greatest dangers of driving an automobile at night has always been caused by the necessity of dimming headlights so as not to dazzle the eyes of oncoming drivers. By doing this, however, the driver endangers himself because he has insufficient light on the road for his own safety. However, with the new type of headlight and bulb shown in the illustrations below, the full illumination of the bulb is always used but is so directed that when other vehicles are approaching, the light is focused on the road directly in front of the car, but on other occasions the beam is thrown straight ahead as usual. In this way, full illumination is always had.—*Illustrations courtesy Tung-Sol Lamp Works.*

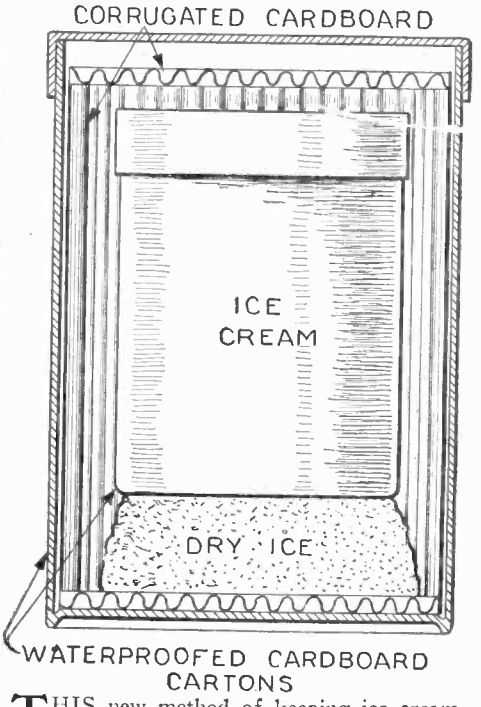


As shown in the two drawings at the right above, when the beam of light from this new headlight is to be directed straight ahead, the filament at the center of focus is turned on. When approaching other cars, the filament above the focus center is used instead.

New Ice Cream Packing Method



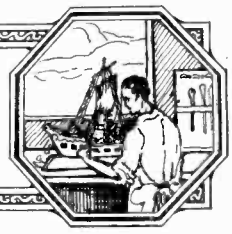
Above are shown the details of the new ice cream packing system designed by W. Hobbes to enable people to purchase ice cream and then carry it over comparatively long distances without the usual result of melting. In this way, ice cream can be kept from 8 to 16 hours.



THIS new method of keeping ice cream, which can also be applied to other substances depends upon the use of a new so-called "dry ice" formed of solidified carbon dioxide gas. In the particular system under discussion, the ice cream is packed in a standard waxed container and then placed within a larger box, in contact with a block of dry ice and surrounded by corrugated cardboard. This is all inclosed within another waterproof carton and a hole is provided in the latter to allow the escape of the carbon dioxide gas as it returns to its natural state. Solidified gas of this type is at a temperature of approximately 110° F. It returns to its natural state very slowly, absorbing heat from surrounding objects.

Photo, courtesy Schraffts.

MODEL DEPARTMENT



Win a Silver Trophy Cup!

Take up "Model Making" as a Hobby. It is Interesting, Instructing and Profitable. Submit Your Results to Us and Compete for the Handsome Engraved Cup Illustrated Below

THE Model Department is here at last! Due to popular request, we have decided to incorporate a Model Department in this magazine and as a further inducement to our readers to build models and to submit them for publication, we are offering a prize of a handsome silver loving cup for the best model submitted each month. Once you have won this cup, it is yours to keep. There is no necessity for you to win it two or three times in succession as is often the case in contests where cups are awarded as prizes.

Here is shown a photographic reproduction of the cup that will be awarded each month for the best model submitted. Isn't it worth working for? It is 17½" high and weighs five pounds.

On the two following pages of this issue you will find complete details covering the construction of one of the finest working models of a steam engine that has come to our attention in some time. This is an example of the kind of work that we want to encourage among our readers. The building of models is a hobby that is wide spread and you will find followers of it in every class and creed throughout the world. You need not have an elaborate machine shop in order to compete in our contest as some excellent models have been made with the very simplest of tools.

After you have viewed the drawings accompanying the following article, do not presume that you have to make similar drawings in order to enter your model. On the contrary, the simplest of detailed sketches will suffice. However, your model must be submitted and from it and from the sketches that you send, our artist will make up drawings that can easily be followed by anyone. So, the work that you do, will benefit the other readers of SCIENCE AND INVENTION as well, providing that your design is published By working hard and turning out the best possible model, you will accomplish many things. First, you will be instructing yourself in some certain line of endeavor. Secondly, you will be acquiring a knowledge of tools and how to handle them to the best advantage. Third, you may be helping others to enter this most fascinating of all pastimes. Fourth, and last but by no means least, you will be paving the way for competition in a contest that may net you a handsome silver trophy cup as a reward for your labors.

In the center column of this page, you will find complete rules for entering our Model Contest. Study them carefully and follow each and every one of them. If you abide by the rules, your entry can be handled quicker when it reaches this office and if it is awarded the prize, we can present it to our readers in the best possible form. Do not forget the main thing and that is that the model itself must be submitted. Remember the Model Engineers of today are the fullfledged engineers of tomorrow. Model building is the stepping stone to engineering if you elect to make it worth your study and thought.

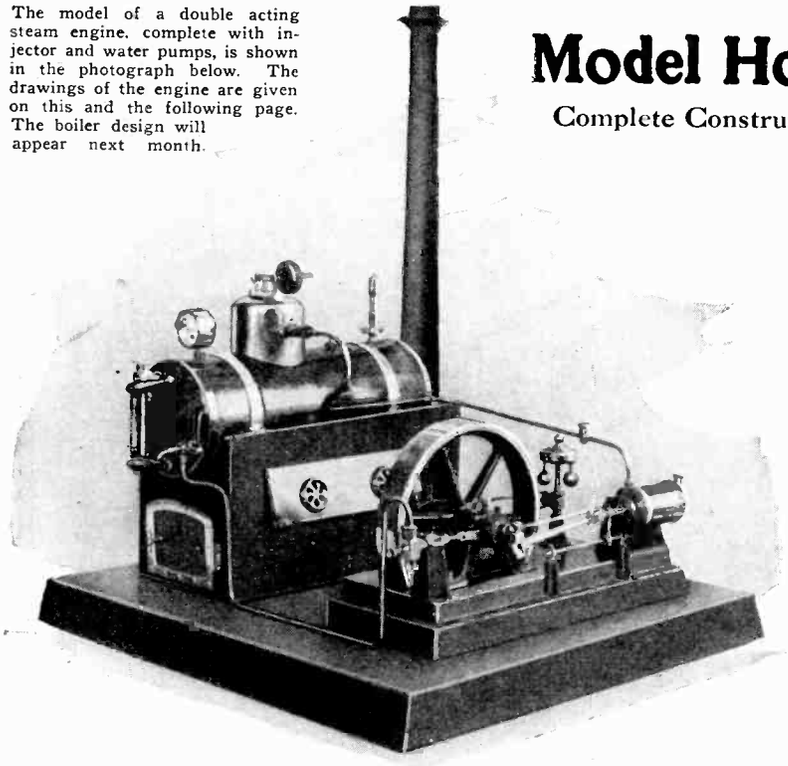
Rules for Model Contest

1. A handsome silver loving cup engraved with your name, will be awarded as the prize for the best model submitted during the month. The decision of the judges will be final.
2. Models of all kinds may be entered. They may be working models or not, according to the subject that is being handled.
3. Models may be made of any available material, preferably something that is cheap and easily obtainable. Models made of matches should not be submitted to this department but should go to our Matchcraft Contest Editor.
4. Models must be submitted in all cases. Good photographs are also highly desirable and where the maker does not desire the model to be taken apart, legible drawings with all dimensions covering parts that are not accessible must be submitted.
5. Models should be securely crated and protected against damage in shipment and sent to us by parcel post, express or freight, prepaid. Models will be returned when requested.
6. Models for entry in any particular contest must reach this office on or before the 25th of the third month preceeding date of publication. For instance, models for the May contest must reach us on or before the 25th of February.
7. Address all entries to Editor Model Department, c/o Science and Invention Magazine, 53 Park Place, New York City.

The comparative size of this beautiful trophy cup can be seen in the above photograph. This is a prize that you will be only too proud to show to your friends as proof of your ability as a model maker.

This illustration shows in detail the appearance of the shield that will be engraved on each cup awarded. The winner's name will be engraved in the blank space shown.

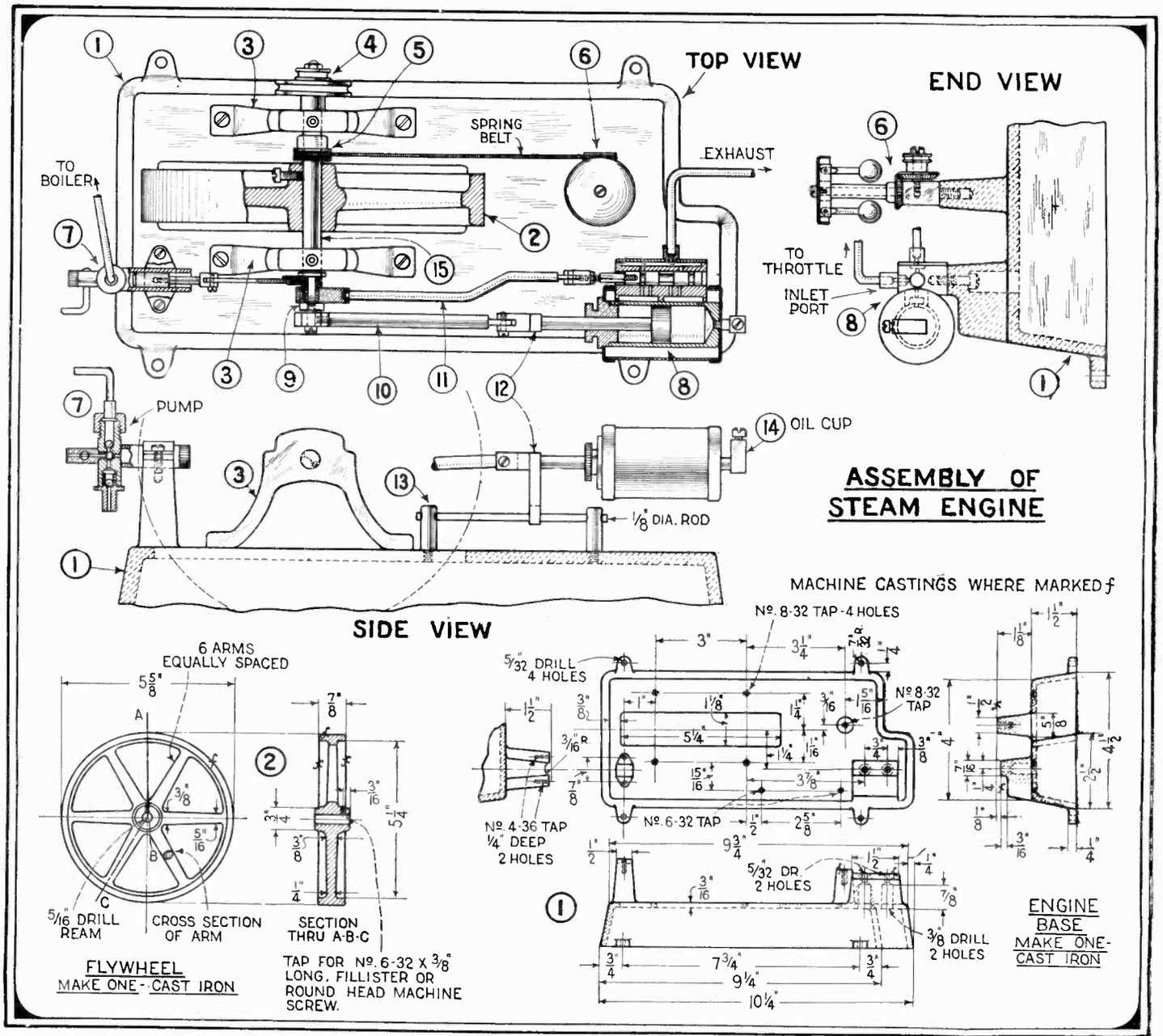
The model of a double acting steam engine, complete with injector and water pumps, is shown in the photograph below. The drawings of the engine are given on this and the following page. The boiler design will appear next month.



Model Horizontal Steam Engine

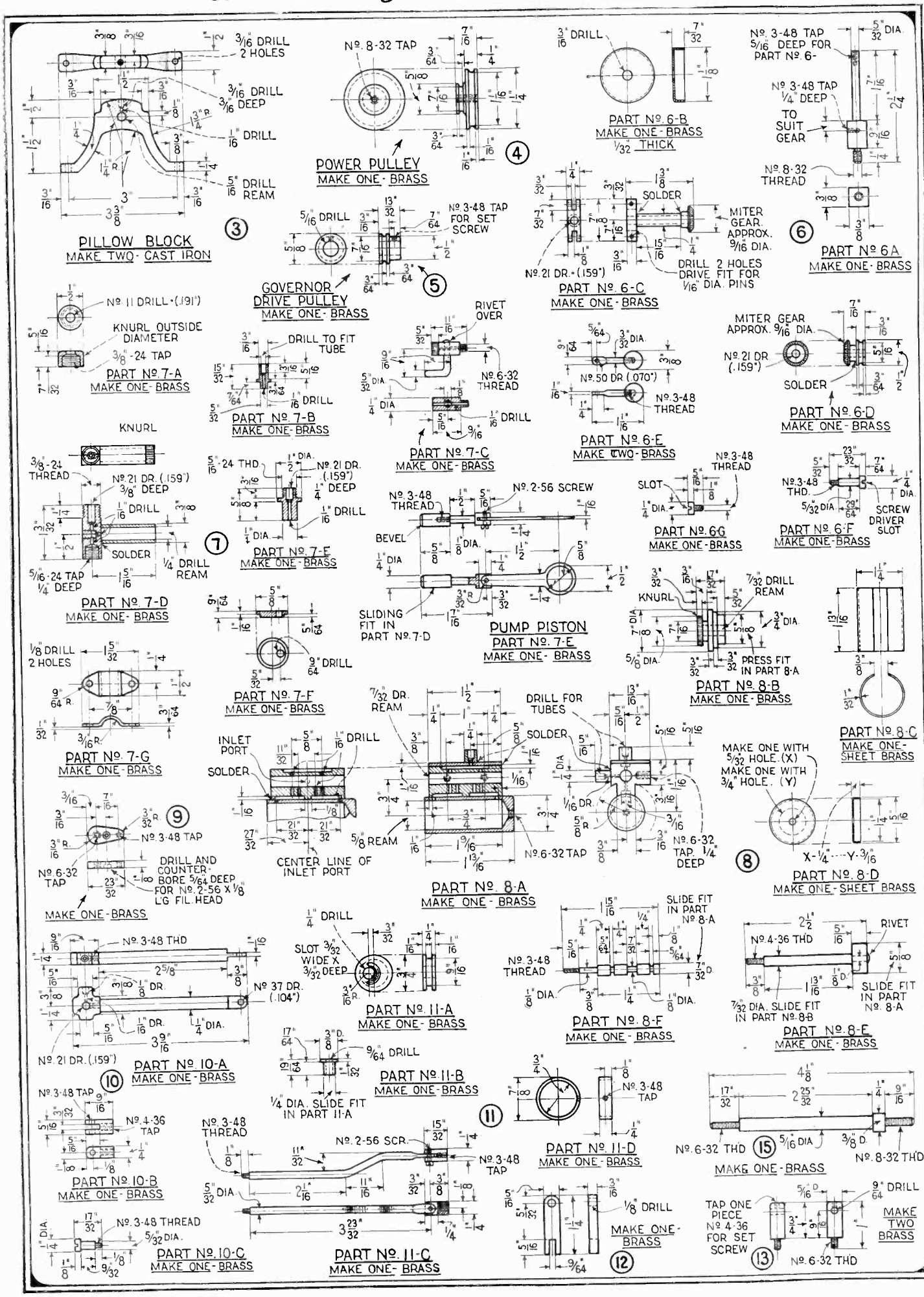
Complete Construction Data For Building the Engine Here Shown

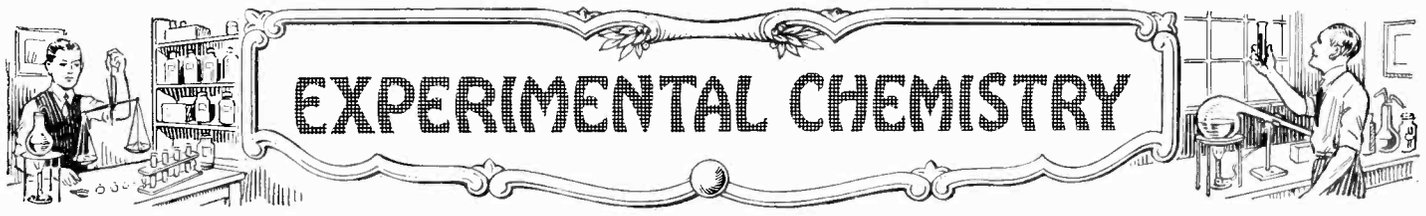
THE double acting steam engine using both strokes as power strokes and developing approximately one thirtieth of a horsepower is shown at the left. The drawings for the complete engine are found below and on the following page. In our next issue we will show the complete construction of a boiler and also give the details for the construction of various types of boilers, such as electrical, alcohol heated and gasoline heated boilers, the latter providing super-heated steam to the engine. This engine developed one-thirtieth of a horsepower, using steam at a pressure of only fifteen pounds per square inch, although it has been tested to a standard pressure of a hundred and twenty pounds per square inch. The diagrams show the simplest construction for a device of this nature. Of course the fly wheel can be carefully turned down and nickel-plated, and the other parts of the mechanism can also be nickel-plated to give the device a professional appearance. Cap nuts can be used in place of knurled nuts. Wherever bearings show, small oil cups may be inserted. All parts should be soldered with hard solder. The injector pump serves to force water into the boiler and is operated while the engine is running. Even cold water being pumped into the boiler does not materially decrease the speed of the engine. Complete engine blueprints may be had from the Model Department. A nominal charge of $1.00 is made for this service. The boiler construction will appear next month and blueprints for the same may be had at the same figure.



Assembly of model Steam Engine shown above.

Construction Design Details of Model Steam Engine



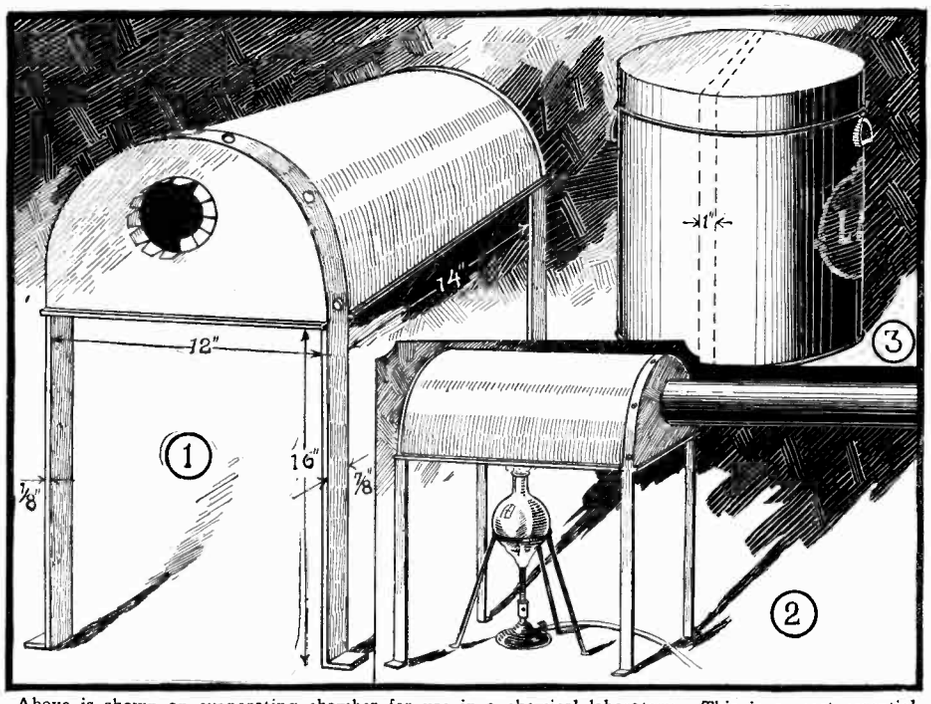


Ventilating Hood for Laboratory

By PHILIPPE A. JUDD

ONE piece of apparatus that is often needed but not always found in the amateur's laboratory is the ventilating hood. Many chemical reactions cause poisonous or noxious vapors, which, to say the least, are not pleasing to the olfactory nerves. A hood may be installed at very little expense to remove unpleasant odors, caused by your experiments in chemistry.

The materials required for its construction are: a lard can (50 lb. size), several sections of stove pipe (3½ inch), some stove bolts (6/32-½-inch), and 9 feet of ⅞ x ⅛ inch strap iron. The lard can may be procured from your grocer or butcher; the other material from a hardware store.



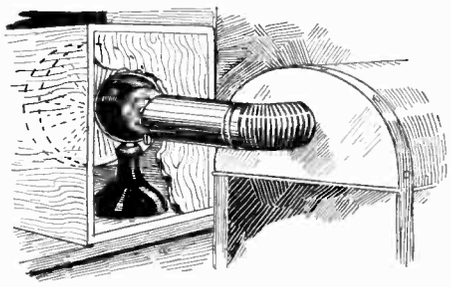
Above is shown an evaporating chamber for use in a chemical laboratory. This is a most essential article for the working chemist, especially if he is doing his operations in a house occupied by a family, because the ordinary person is not habituated to the smell of a laboratory.

To begin, scribe a line around the lard can, vertically and across the ends, as shown at 3, dividing the can in half. Now measure 1 inch to one side of this line to allow for the half round flange. With a pair of tin snips cut the can in two by following the latter line. This gives two trough-shaped pieces, the larger of which is used for the hood. After snipping out the corners to a depth of 1 inch, the edges are bent out and up to form the flanges, and thus to strengthen the finished structure.

The lid, after being cut and flanged, has a hole, 2 inches in diameter, cut in its center by means of an adjustable can-opener. Radial cuts are now made with the snips to a depth of ¾ inch around the periphery of this hole. The sectors thus formed are then bent out at right angles to engage the 3½ inch stove pipe. The lid is fastened to the can by means of the stove bolts, five being sufficient to hold it in place.

Two methods of mounting the hood above the bench top are shown, the one shown at 1—probably being the best for general purposes, as it places the hood in a more accessible position. For this style, 4½ feet of strap iron will be needed for each pair of legs. The legs are formed by bending the strap iron as shown and they are fastened to the hood by means of three stove bolts to each pair of legs.

For an optional style the legs only extend 3 inches beyond the edge of the hood on one side, and are each provided with two holes to take wood screws which secure them to the wall. The legs support the hood 16 inches above the bench top, which is sufficiently high to clear most apparatus. The hood is connected to the chimney through the stove pipe, which should be as short and have as few bends as possible.



The hood connected so as to carry the fumes out-doors using an electric fan to produce a strong draft or suction, making the system a very satisfactory one.

At left is shown a better method of producing a draught, if a small electric fan is available. The fan is mounted in an air-tight wood or sheet metal box so that it draws the vapors through the pipe, and blows them out of the laboratory through the window. This method may also be used in conjunction with the chimney.

A coat of white enamel, both inside and out, will improve the general appearance.

Some Experiments with Colloids

By J. EDMUND WOODS

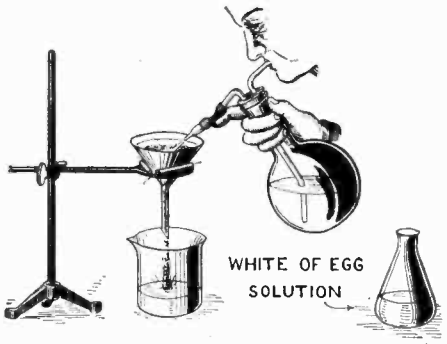
Member of The American Chemical Society

IN any systematic study of Chemistry we learn first to consider the *Molecule* as the fundamental unit of substance. A grain of sand, a crystal of salt, a fragment of sugar—all are made up of millions of separate molecules, each one identical with its neighbors and possessing all the properties which we associate with large or small masses of those materials. It is true that these molecules are themselves complex. A sand molecule, for instance, consists of a silicon *atom* and two oxygen *atoms*, but unless the trio are chemically united as a molecule, we have no sand. Even simple substances—the elements—usually have molecules as the basis of their free existence. If we could isolate the smallest separate particle of oxygen from the air, it would not be an oxygen atom but an oxygen molecule consisting of *two* oxygen atoms.

Having accustomed ourselves to considering every property of matter as a characteristic of the atoms that make up that matter, we may be surprised to learn that certain curious effects are due to *clusters* of molecules—molecular aggregates, they are called. As an illustration, it is possible to prepare a bright red liquid in which the color is entirely due to metallic gold distributed throughout the liquid in particles which are clusters of several hundred gold molecules apiece! The gold is said to be in *colloidal solution*. Such a liquid seems to be perfectly clear and free from suspended matter, and it will pass through fine filter paper without leaving any solid material on the paper. Yet we can prove that it is no ordinary solution where the dissolved molecules are separate from one another, for true solutions of gold are always yellow; besides, in the red liquid we can actually count the suspended particles with the aid of a special instrument—the ultramicroscope—and single molecules are entirely too small for that. Colloidal gold must be very finely divided, because it does not settle out of the colloidal solution, which appears clear and homogeneous. On the other hand, colloidal gold particles are too large to pass through parchment paper or animal membranes, which gold molecules could permeate easily.

Nearly every substance is capable of existing in a state where its molecules have grouped together into masses that are still

too small to be detected by an ordinary high-power microscope, and we speak of this transition stage as *the colloidal state*. As a rule, a substance in the colloidal state exhibits unusual properties which are not found either when its molecules are all separated or when they are bunched together into visible masses. Without going further into the theoretical side of the subject, we shall

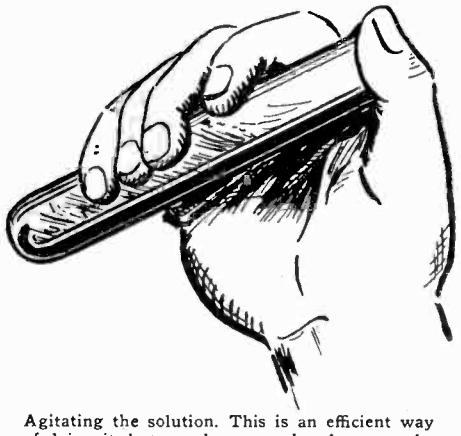


An experiment with albumen, in the division of colloid chemistry. The albumen copper hydroxide gives what may be called a copper colloid.

describe a few experiments that illustrate some of these properties.

Prepare a solution of copper sulphate in a test tube and add to it enough of a dilute sodium hydroxide solution to cause a pale blue precipitate to form. The precipitate is copper hydroxide, Cu $(OH)_2$. Pour it through a filter paper and wash the precipitate that remains on the paper several times by pouring clean water over it. A wash bottle described in one of Dr. Sloane's recent articles will serve best for this operation. Next punch a small hole in the tip of the filter and wash most of the precipitate into a clean beaker. Add dilute ammonia water drop by drop until there is just enough to dissolve the precipitate, whereupon you will get a deep-blue solution. It contains a complex compound of copper and ammonia. Into a clean flask put a solution made by shaking a little white of raw egg with cold water. Dilute the blue copper solution with water and add slowly to the solution of egg albumin. Observe the beautiful range of colors in the flask. This is due to copper particles passing through the colloidal state after being liberated by the albumin.

Colloidal gold solutions are very beautiful, but as gold solutions are not easily obtained, you are advised to try the preparation of colloidal silver. Procure a little silver nitrate or else prepare a little for yourself by dissolving a dime in dilute nitric acid and evaporating the solution until crystals of silver nitrate form. Dissolve the salt, thus crystallized, in a beaker of water and slowly add dilute sodium hydroxide solution, until the solution, after stirring, can just turn red litmus paper blue. Let the precipitate that forms settle to the bottom of the vessel and carefully pour off as much of the liquid as possible. Fill the beaker with hot water, and after the solid matter has settled again, pour this water off, repeating the same treatment with fresh water two or three times. Now transfer the solid, which is silver oxide, Ag_2O, to a large test tube and shake with hot water for some time to dissolve as much as possible of it in the water. Then filter the solution into a small flask, which should be of "Pyrex" or some other "hard" glass if possible. Connect this outlet tube of a hydrogen generating appratus to the flask, as shown, and let this gas pass through your silver solution for half to three-quarters of an hour. It will gradually reduce the silver



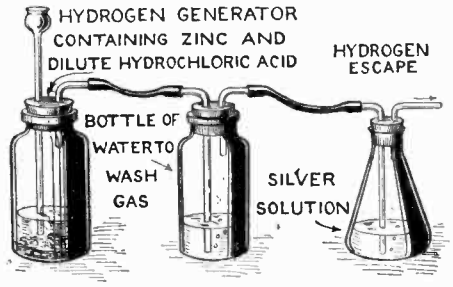
Agitating the solution. This is an efficient way of doing it, but see that your thumb covers the mouth of the test tube or the contents will fly out.

compound to metallic silver which will remain suspended in colloidal condition and impart a red, violet or blue color to the liquid.

Now metallic elements and also chemical compounds may be brought into the colloidal state. Dissolve in water some photographer's "hypo," which is sodium thiosulphate, and add a little dilute hydrochloric acid. The liquid will become cloudy due to the separation of sulphur from the first compound, though you may have to let the solution stand for a little while in order that this may occur. Pour the solution through a filter paper and you will see that the filtration does not clarify it. The suspended particles of sulphur are colloidal in size and are too small to be retained by the paper.

Take 10 cubic centimeters of ordinary hydrogen peroxide and dilute it with an equal volume of pure water. Dissolve a few crystals of potassium permanganate, $KMnO_4$, in 60 cubic centimeters of water and add the peroxide solution. The mixture turns brown and cloudy, due to the reduction of the permanganate to manganese dioxide, MnO_2, which is an insoluble compound and would settle quickly if it were not in the colloidal state.

One is reluctant in these days to suggest experiments involving alcohol, as any attempt to procure this agent, even for legitimate purposes, may heighten the suspicion among neighbors that "moonshine" is the object of your experimentation. Possibly you are fortunate enough to have some 95% alcohol on hand; if not, you can use denatured alcohol or acetone. Make a saturated solution



Making a colloid silver solution. This gives very beautiful colors almost equal to those of gold colloid.

of calcium acetate by dissolving as much as possible of this substance in a large test tube of water. A generous residue of undissolved solid should remain after vigorous shaking to prove that the liquid is really saturated. Pour 10 cubic centimeters of this solution into a beaker and mix it thoroughly with the alcohol or acetone in another beaker by pouring the contents of one beaker into the other and back again. A jelly of "solid alcohol" (or acetone) will set quickly. You can cut a cube of this material and set fire to it. Solid alcohol is a popular fuel for easy transportation. It is a colloidal mixture.

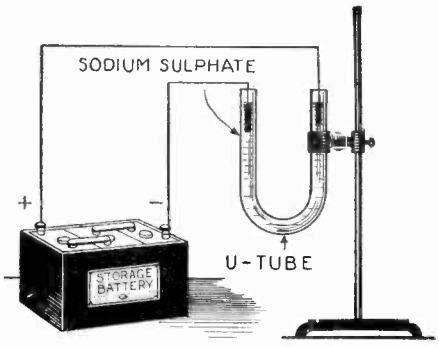
Half fill a test tube with water and saturate the contents with ferric chloride. Saturate a full test tube of water with potassium ferrocyanide. Pour the two into a small beaker. The precipitate formed is Prussian Blue and it will be so dense that you can invert the beaker without having its contents fall out. Nevetheless, the particles are colloidal in size, as you can prove by stirring up the solid with a considerable volume of water and attempting to filter it. The Prussian Blue suspension runs through the filter paper unhindered.

Procure enough of the liquid known as "water glass" to half fill a tall bottle. Add an equal volume of water and mix the solutions. Drop a small fragment of ferric chloride and another of cobalt chloride into the mixture. A tree-like formation will appear above the ferric chloride and later another growth above the cobalt chloride. These growths are built up of colloidal membranes of ferric silicate or cobalt silicate.

A Substitute for Litmus Solution

By DARWIN HARRIS

A NUMBER of interesting experiments can be done with litmus solution. A very cheap and efficient substitute for litmus solution can be made by the following method: Obtain some clean leaves of the purple cabbage and place them with some water in a clean pan. An enameled pan, not very large, is excellent. Heat the water, and let it boil slowly for some time. Add water now and then, to keep the volume constant. Pour off the liquid after the solution seems complete, into a clean bottle, and label. If it has been done rightly, the solution will be of a strong purple color. To demonstrate its indicating properties, add some dilute hydrochloric acid to the purple solution and a cherry-red color will be produced. On adding ammonia to the red solution, the acid will be neutralized and a green color will be produced. In this respect, it is



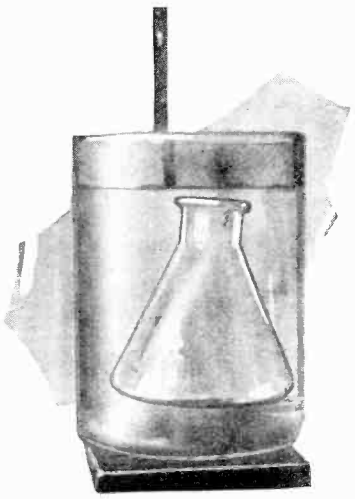
Cabbage leaves of the purple variety are made to give a purple solution affected by acid and alkali. The experiment demonstrates the effects on infusion of the petals of the red dahlia can also be used.

nearly the same as litmus solution. An interesting experiment can be performed with the solution, a U-tube, some sodium sulphate, a storage battery and some other odds and ends. A U-tube is mounted on a ring-stand, as in the illustration, by a standard burette clamp. It is then filled to one-half inch of its top with a saturated solution of sodium sulphate that has a little of the purple cabbage infusion in it. Two carbon electrodes are obtained, preferably from a couple of old flashlight cells, and wires are attached to them. The wires are connected to a six-volt storage battery and the current is passed through the solution. In a little while, a red coloration will be observed around the positive pole and green color around the negative pole. Evidently, the salt has been broken up and an acid and an alkali are the results.

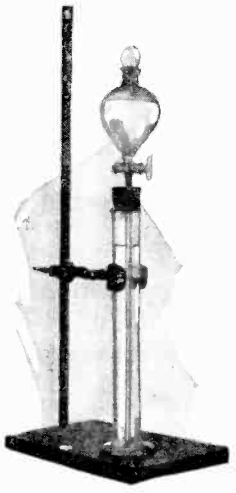
Experiments in Chemical Diffusion

By RAYMOND B. WAILES

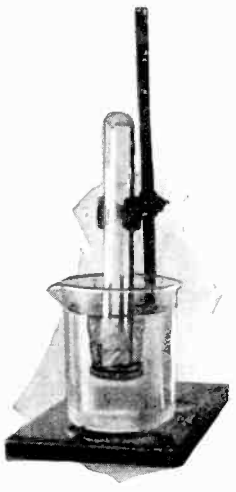
Above: Place several drops of iodine in lower bottle, cover with paper and place upper bottle in position. Under the influence of warmth, the iodine will vaporize and if the paper is removed, the purple vapor so formed will slowly diffuse into the upper bottle.



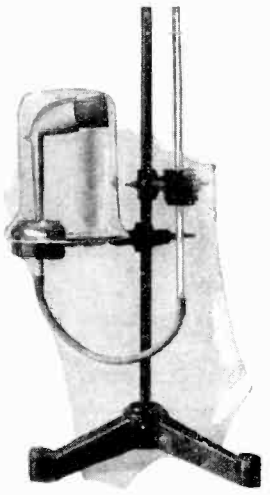
Liquids as well as gases diffuse. If a strong solution of copper sulphate is placed in the flask shown above, and the flask placed in the outer container, filled with water, streamers of the copper sulphate solution will soon form and will flow from the inside flask to diffuse into the water of the outside container. This diffusion is also shown in the next experiment.



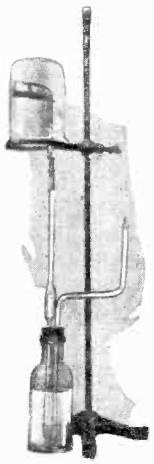
Here the funnel contains the copper sulphate solution and the cylinder contains the water. Opening the stopcock allows the copper sulphate to flow to the bottom of the cylinder forming a layer which will gradually diffuse of its own accord and mix with the clear water.



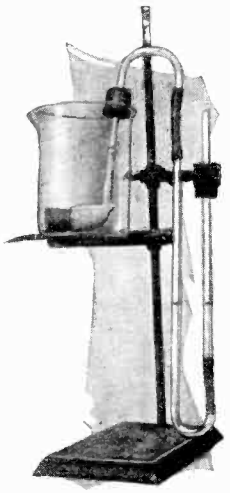
Diffusions can also take place through thin animal membranes. Cover a test tube full of a solution of sugar of lead with a piece of sausage skin and tie the membrane in place. Invert in a solution of potassium iodine. The two chemicals will mix, forming golden spangles on the skin.



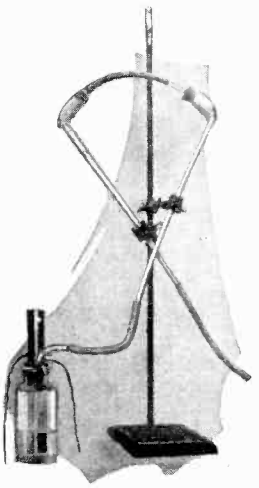
Clay pipes are porous and gases will diffuse through them. Set up apparatus as above and place a drop of ink in the straw or glass tube shown at the right. Introduce illuminating gas into the tumbler and the drop of ink will move up the straw. The gas will diffuse through the pipe and push the air in the bowl ahead of it.



Another experiment with a clay pipe. The illuminating gas forces water out of the bent glass tube.

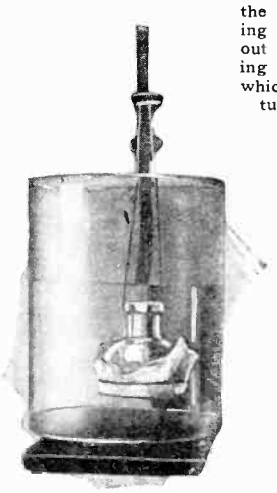


Carbon dioxide and other gases which are heavier than air also diffuse into the air. Place a pinch of baking soda and a drop of acid in the tumbler illustrated above and carbon dioxide will be formed. The gas will diffuse into the bowl of the clay pipe, pushing the air that is in the pipe out through the stem, and moving the water in the U-tube, which is fastened by a rubber tube to the stem of the pipe.



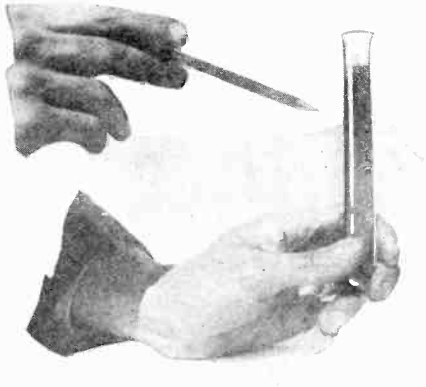
Two long clay pipes of the "Church Warden" variety are connected by stoppers and a rubber tube as above. The bottle of water contains a few drops of sulphuric acid which is electrolyzed by carbon rods connected to a storage battery. Hydrogen and oxygen gas form, and as they flow through the pipes the hydrogen, being lightest, diffuses through the pores, leaving the oxygen to be delivered from the rubber tube. Use the glowing splinter test for oxygen.

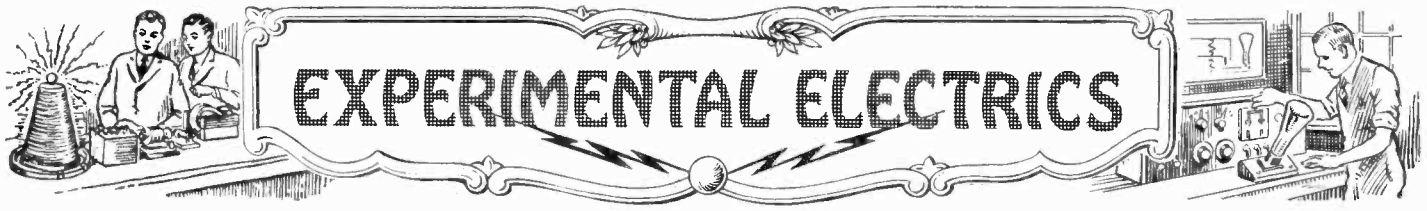
You can easily build a model of one of the gas alarms used in mines and can demonstrate its operation with the simple apparatus illustrated above. When gas is present, it diffuses into the bowl of the clay pipe and pushes the air in the pipe against the acidulated water in the U-tube. This water rises and makes an electrical connection between the two wires in the rubber tube and thus forms a complete circuit so that an alarm bell can be rung by the battery. To test, invert tumbler over pipe and introduce gas.



If starch water is placed in a bottomless bottle and the wide portion is covered with gold beater's skin or parchment paper tied in place and immersed in water, the skin will allow the water to pass through into the water outside, leaving the starch cells in the bottle. It is easily seen that diffusion can also be used as a filtering agency in this manner.

A "Patriotic tube" can be made by mixing gelatine, water, potassium ferrocyanide and phenolphthalein and heating. Cool slightly and add ammonia water. Cool until it jellies. Now pour a solution of ferric chloride on top of the jelly. In several days the tube will be red, white and blue, in layers, due to the diffusion of the chemicals and the reactions due to their mixing with one another.

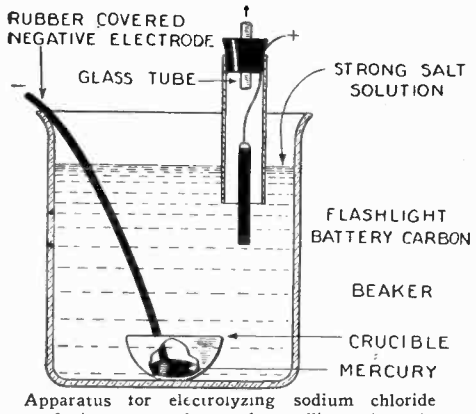




Experimenting on Electrolyzing Glass

By A. BERNARD WILLIAMS

UNDER normal conditions, notably that of temperature, glass is a non-conductor of electricity. At high voltages different types of glass behave variously as to breakdown characteristics. Certain types



Apparatus for electrolyzing sodium chloride producing an amalgam of metallic sodium, in the small vessel at the bottom of the larger one, for use in the experiments described.

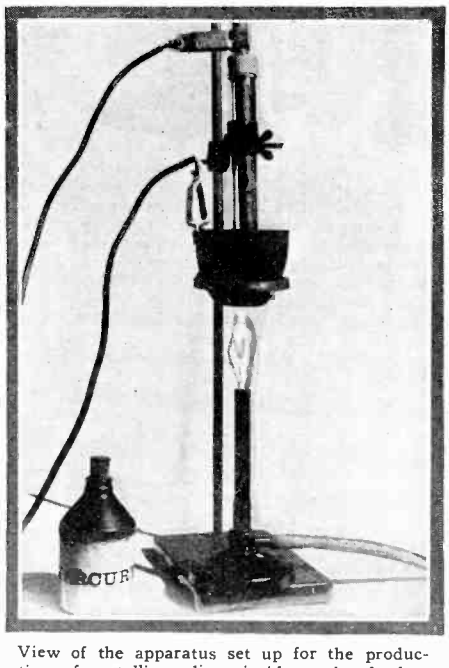
of glass insulators, such as Pyrex, are claimed to be far superior to other glasses for high voltages and for radio aerial insulation where very weak voltages are prevalent. But under certain conditions, glass can be made to be as conductive as copper. This is true at high temperatures.

If a short length of glass tubing is inserted in the circuit of a lamp with its 110-volt supply, in place of a length of copper conductor, of the length of the tubing, the circuit will not be completed and the lamp will not light. However, if a Bunsen burner be applied to the glass tube supposed to be fitted with conductive terminals adapted to withstand the temperature, the glass will become white hot and the current will pass. Platinum wire electrodes are especially suitable in this experiment, although copper wire electrodes, even though oxidizing rapidly at the temperature used, will serve if patience is had in holding them in place. Brass electrodes will not oxidize so rapidly. The current actually flows through the molten or plastic glass.

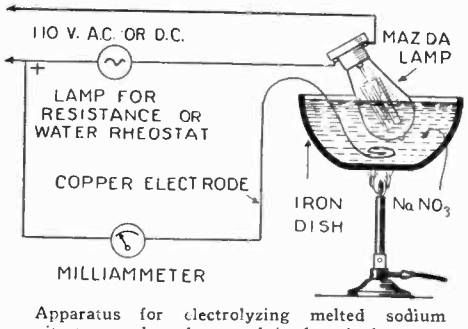
A very interesting experiment showing that glass can really be electrolyzed, or rendered transparent as to its ion-transporting powers, can be performed with some mercury, a test tube, an iron crucible or cup and a source of current actuated by low voltage.

In this experiment it is necessary to convert part of the mercury on hand into sodium amalgam, a mixture of metallic sodium and mercury. This can be done by cautiously adding bits of clean metallic sodium to warm mercury. Amalgamation will take place with, perhaps, a small explosion. The product should be kept in tightly-stoppered bottles, for, if water or moist air comes in contact with it, sodium hydroxide will be formed and hydrogen bubbles set free.

The experimenter can make his sodium amalgam by the electrolysis of a strong solution of sodium chloride (table salt), using the little apparatus pictured here. A porcelain crucible containing mercury is placed in a beaker of concentrated sodium chloride solution and made cathode of a storage battery. The anode or positive pole consists of a small flashlight battery carbon enclosed in a glass tube of about half an inch diameter. This tube is provided with a stopper carrying a glass tube through which one of the products of the electrolysis, chlorine, is evolved. It can be led away for other experiments or allowed to escape out of doors. About half an hour's passage of the current will leave the mercury thoroughly combined with sodium, which comes, of course, from the sodium chloride. The reason for using a porcelain crucible is to minimize the amount of mercury used, taking it for granted that the experimenter has not a good supply of this heavy metallic element.

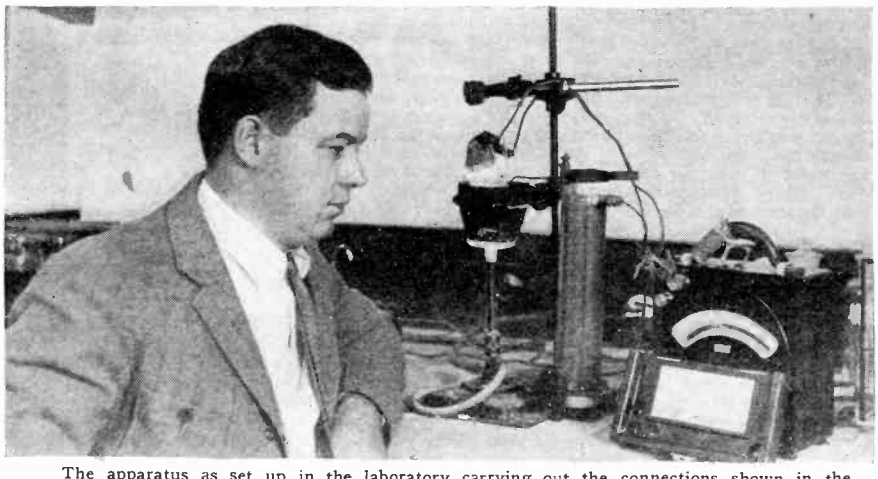


View of the apparatus set up for the production of metallic sodium inside a closed glass tube containing mercury. The mercury in the tube becomes charged with sodium as if the glass were porous.



Apparatus for electrolyzing melted sodium nitrate, so that the metal is deposited on the inside of an incandescent Mazda lamp, as a bright mirror.

The sodium amalgam so obtained is placed in an iron dish such as an iron crucible or top of a baking powder can, made anode (positive) with a storage battery and the cathode (negative pole) of the battery connected to a battery carbon which is inserted into several cc. of mercury in a test tube. This test tube is immersed in the liquid sodium amalgam as one photo shows. On heating the outer sodium amalgam to about 300° C. with the Bunsen flame, and passing the current for an hour or so, the mercury in the test tube will now be found to have become impregnated with metallic sodium, sodium amalgam having been formed. To test for the presence of sodium here, add several drops of water to several drops of the sodium amalgam and touch the water with red litmus paper. It will turn blue, owing to the formation of sodium hydroxide from the sodium and the water. Thorough washing of the sodium amalgam in fresh water will give us back pure mercury again, so no loss in mercury will result.



The apparatus as set up in the laboratory carrying out the connections shown in the diagram above. The incandescent lamp is seen immersed in the melted sodium nitrate. *Photo courtesy of Popular Radio.*

The next experiment, which was first carried out by Mr. Robert C. Burt, is very spectacular. It consists of *driving metallic sodium through the glass of an electric lamp bulb.* The sodium so driven through is deposited with a beautiful mirror-like appearance, exactly as if the bulb were plated with silver on the inside.

For this extremely interesting experiment, a source of 110 volts potential, to give either D.C. or A.C. current, is required; D.C. is far more preferable. An ordinary vacuum type incandescent lamp of about 60 watts

is connected as shown in the diagram. The glass of such lamps is a "soda" glass, in which the sodium ion is mobile. A socket is provided in the circuit so that by screwing lamps of different wattages into it, different resistances are inserted and the lamp to be experimented with is controlled in brilliancy. It is desirable, although not essential, that a milliammeter be inserted as shown in the wire which leads from the positive side of the D.C. line or from either side if A.C. is used. This wire electrode is essential, although the milliammeter can be omitted. The lamp under transformation or experimentation is immersed in an iron dish containing molten sodium nitrate and the current is turned on for several hours. When turned off and the lamp removed from the molten bath and allowed to cool a beautiful film of metallic sodium will be found to have been deposited upon the inner walls of the lamp which has cooled off.

In performing this experiment, make the connections as indicated, taking a copper wire lead off ahead of the lamp resistance and inserting this lead in the bottom of the iron cup or container used. Even a tin can will serve for the container if an iron vessel is not at hand. It must be clean! The lamp is lighted and lowered into the can or pan until the tip of the bulb is about a quarter of an inch from the bottom. It is best to have the lamp at about 45° to the vertical, as shown. Pulverized sodium nitrate is sprinkled in the container around the lamp and the dish is heated with the Bunsen burner. The sodium nitrate will melt at about 312° C. (593° F.). Fresh pieces of unmelted sodium nitrate can be pushed into the molten nitrate by means of a glass rod. It is important that wood or any carbonaceous substance be kept away from the sodium nitrate as it would probably be kindled and deflagration would follow. There is no danger attending the melting of the sodium nitrate and allowing the bulb to be immersed in the fluid. The glass will not soften and collapse at this low temperature. Water entering the molten nitrate will cause it to be spluttered out.

The sodium will soon be seen to be depositing upon the cooler upper walls of the lamp in the form of a dark mirror, when the current is on. This is noticeable in half an hour after the sodium nitrate has melted and electrolysis has gone on for that length of time. The current can be cut off at this point, the Bunsen burner taken away, the incandescent lamp lifted carefully from the liquid and allowed to cool. Any adhering crystallized sodium nitrate can be dissolved off in water. The beauty of the bulb can now be appreciated; but more particularly when it is realized that the silver film is metallic sodium and that it was originally present on the outside of the glass in the compound, sodium nitrate.

Arrangement of the iron dish containing sodium nitrate melted by a Bunsen burner and the incandescent lamp bulb partially immersed in the melted salt and supported by the same retort stand as shown.

The writer has observed fifteen milliamperes of current passing through the added electrode or take-off lead, as shown, using A.C. A telephone receiver placed in series here, using A.C., will hum, due to the interrupted flow of the current through this added wire electrode. This current which flows from the molten bath through the glass and then to the heated filament is the current carried across the streaming electrons from the filament by the Edison effect, like that transported from the filament to the plate in the "radio tubes."

The sodium will not deposit upon the filament because it is too hot, causing it to vaporize the sodium, whereby it condenses upon the upper, cooler portions of the bulb. The current can be continued for any length of time and perhaps with the formation of quite a quantity of the sodium.

Sometimes the filament will burn out; this is because too high a voltage is applied to the lamp. In this case, insert a higher resistance lamp to reduce the voltage in the next electrolysis.

After the experiment, it is best to pour the molten sodium nitrate upon clean concrete to crystallize, for once it crystallizes in the container, a cold chisel and a hammer is the only thing which will remove it. Melting is not safe, as a sort of volcano-like action will ensue.

What really happens in this electrolysis is this: The sodium atoms of the sodium nitrate are charged positively and they are attracted toward the negative side of the lamp which is at the filament; they appear to get in through the glass and, apparently, do so, and have their positive charges neutralized and become metallic sodium which deposits upon the glass.

Quadrant Electroscope

THE ordinary gold-leaf electroscope is regarded by many as a very sensitive instrument, but a properly made "quadrant type" is far more easily affected by minute charges of static electricity.

A simple form of this instrument can be made by sticking sectors of tin foil on a disc of bakelite, or any other insulating material, though bakelite is preferable, since good insulation is essential to sensitivity. Two of these discs are prepared as in Fig. 1, and a hole drilled through the centres. Mount them, separated at the edges by small pieces of bakelite, with the faces carrying the tin foil opposite one another. Fasten the pair together in this manner and to a base; shellac will do the work of holding it all together.

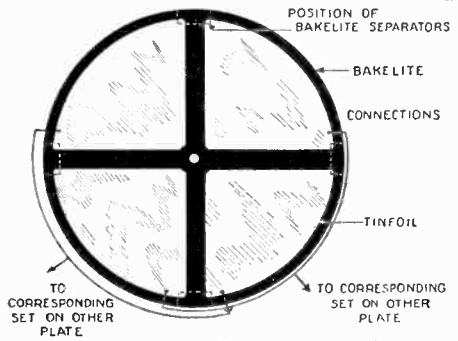


FIG. 1

The layout of the quadrants and discs and their connections for the quadrant electroscope. The apparatus is really a condenser, operating on the principle so familiar to all radio amateurs.

At one corner of the base fasten a large binding post and set in a ⅛-inch brass rod, bent as in Fig. 2. From the top point, a length of very fine wire is dropped, at the lower end of this is fastened, between the two discs, an armature of thin metal. The lighter this is the more sensitive the instrument will be, all other things being equal. No. 40 is not too fine for the suspending wire. Some sort of indicating device should be fastened to this wire, such as a needle swinging over a scale on the upper surface of the top disc, or a small mirror, such as many of the most sensitive instruments have. The lightness of all moving parts cannot be too greatly emphasized if the instrument is to be sensitive.

To use the instrument, the sets of foil sectors (each sector and the one directly above it form a set) are connected diagonally, as in Fig. 2, and the armature is raised to a high potential of 100 volts upward. If a charge is to be measured, one pair of diagonally connected sets is grounded and the other pair connected to the charged object. If the difference of charges is to be determined between two objects, one pair is connected to each object. A charge, or a difference of potential, if there are two objects, is indicated by a swing of the armature from the normal. The normal is the position shown in Fig. 2.

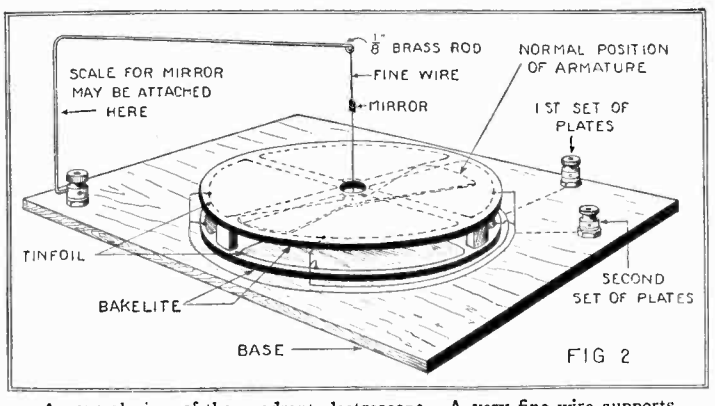


FIG 2

A general view of the quadrant electroscope. A very fine wire supports the rotating element, whose position is controlled by the potential of the charges on the quadrant, working against the torsion of the fine wire.

There are measuring instruments used in electrical work which possess a special interest. The tangent galvanometer is one of these, and has received due attention in the preceding issues of the various magazines published by us. The quadrant electroscope comes in a sense into the same class. Both give a reading which by proper standardization can be made direct, and it is in this obtaining a result from elemental features and one which at once tells the story, without any appeal to calculations. By using the looking glass indication the instrument becomes exceedingly sensitive, and various supporting fibres can be experimented with.

Glass can be drawn out as an experimental suspension but its fragility prevents its use in practical work.

Contributed by WM. CAPUNE.

A Miniature High Speed Motor

By A. BERNARD WILLIAMS

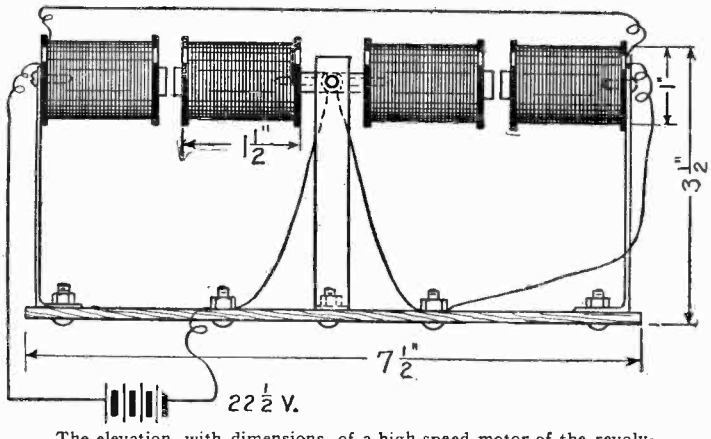
THIS motor can be easily constructed by an experimenter who will devote a little time and labor to it.

The magnets are wound with No. 24 or 26 cotton-covered wire, or they can be obtained from an old telegraph sounder. Each of the four magnets must have a threaded hole in one end. The two outside magnets can be supported by two short "Erector" spans or two short pieces of ¼-inch wood cut down to a workable size. The bottoms can be nailed to the base with small brads or bolted to a right-angle angle of an erector set, and this in turn bolted to the base.

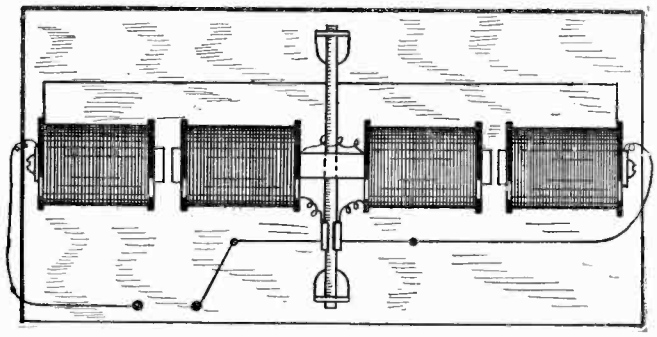
The armature magnets are two in number and are held together by a bolt with a hole in the center and a hole in each end. These bolts are found on telegraph sets, and are also used for connecting head-phones together on radio sets. Take a small bolt that will thread into both the magnet end and the center bolt, and cut its head off with a file. Thread this into the magnet and center bolt. Then do the same on the other side. A heavy wire is run through the center bolt. This can be supported on each end by small blocks of wood nailed to the base or 2½-inch "Erector" spans with angles bolted to the base.

Glue or thick shellac is applied in the hole in the center bolt; the center rod is quickly thrust in. String is quickly wound around the center rod and bolt and this is saturated with glue. The armature is now laid away to dry while work is done on the brushes.

A piece of bare No. 24 copper wire is doubled so that it is about 6 inches long as bent. One end is tacked down to the base while the other end bears directly on the commutator segments. The other brush is made in the same way and tacked down on the other side of the commutator. The armature should soon be dry and is placed in its bearings. About 1½ inches of the rod where the brushes are now touching is wound with friction tape so that the total diameter of the tape and center rod is ⅜ inch.



The elevation, with dimensions, of a high-speed motor of the revolving armature type. This type of motor is one of the earlier efforts in the direction of electric power-utilization or demonstration.



Plan view of the high-speed motor; for dimensions, the elevation above may be consulted and proportional measurements will give the plan dimensions which are not quoted.

Procure some discarded steel writing pens. The outside wire on one magnet is then run through the hole in the point of the pen and wound back on itself so that it is secure electrically. It may be soldered. The other pen is treated in the same manner upon the other side of the rod. Great care should be taken to see that the pens do not touch each other. They constitute commutator segments, and point in the direction of the center of the rod. String is then wound firmly around the pens, holding them firmly in place. Glue and paper strips may be substituted for the string. About ½ inch on the butt of the pens should be left clear for the wire brushes to bear on. The inside wires on the magnets are connected to each other. The armature coils should clear the field coils by ⅛ inch.

The circuit is as follows: The current enters the left-hand field magnet near the core and emerges at the last winding, then goes over to the other field magnet, entering at the top and emerging at the bottom of the coil. The current then goes to the brush, into the pen, to the outside of one magnet, to the core, then to the core winding of the other magnet, to the outside, to the pen, brush and battery binding post. In this way, no pair of magnets have like poles.

A high speed can be secured with this motor by using 15 or 20 volts from a radio "B" battery. The apparatus can also be used as a shocking machine, which the writer discovered after several strong shocks while making trial runs. Great care must be taken not to short-circuit the pens with each other or with the rod on which they ride.

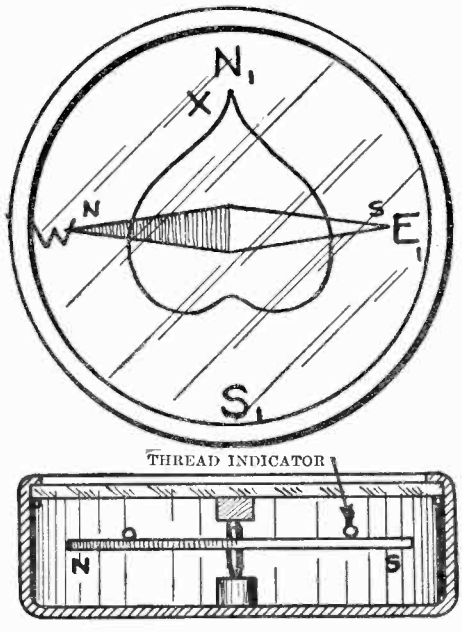
Current Indicator

THROUGH the center of a light steel bar, which may be a piece of a clock spring, or perhaps a heavier spring, a hole is made. With a hard centerpunch, a hole may be driven partly through the center, the spring resting upon an anvil or a vise. This, of course, will only make a little dent and it may be drilled through with a hard drill.

The process will be facilitated if the temper is drawn, which, of course, must be done very carefully so as not to decarbonize the metal, and when the hole is made the steel can be rehardened by heating to low redness and dipping in water. It is then remagnetized and is mounted as shown in the section. The shaft may be found, perhaps, in an old clockworks

The magnetic needle held above or below a wire tends to place itself at right angles thereto. Accordingly, on this needle there is secured by sealing wax or shellac a thread of the shape indicated. It will be seen now that as the needle tends to place itself at right angles to a live wire, the point of the thread will show the direction of the current. The thread may be stiffened by shellac.

One thing is to be noted; the thread must be so placed that it will point correctly, either when the compass is held above a wire or else when it is held below. It cannot point correctly in both positions. It is well to mark North, South, East and West on the glass, so that the compass can be used to determine compass bearings.



A current indicator, utilizing a stiffened thread made into a heart-shape as the index, so as to point at right-angles to the axis of the magnetic meter. The shaft has upper and lower bearings, to make it very substantial, because it will be acted on by relatively strong currents.

New Remote Control

THIS control can be used for many purposes, such as turning a motor generator off and on by pressing a button; or for connecting the aerial to the transmitting set and to the receiving set.

It can be of special use to the owner of a C. W. transmitting set. By pressing the button the aerial can be disconnected from the receiving set and the high voltage can be applied to the C. W. transmitting set, either starting the motor generator or turning on the voltage to the transformer, thereby lighting the filaments of both the transmitting tubes and the rectifier tubes and giving the high voltage to the C. W. set.

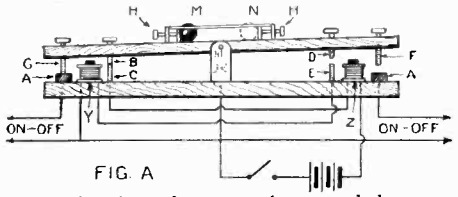


FIG. A

The elevation of a control operated by an oscillating balanced lever. The lever carries a ball on its upper surface, which balances down one end or the other of it, according to the position into which it is brought by the movements of the lever.

The operation is as follows: Pressing the button makes contact at (B) and (C), thereby making (Z) a magnet and pulling the armature down. When the armature is pulled down, the steel ball (M) rolls down to position (N), thereby breaking the contacts (G, A) and (B, C) and making contacts (D, E) and (F, A). Pressing the button again does the same operation to magnet Y as can be seen in the diagram.

The construction is shown in the diagram (A) and (A) are cups containing mercury. These cups were adopted instead of metal contacts, for metal contacts would be almost impossible to regulate, because of having to adjust both contacts on both sides.

FIG. B - TOP VIEW OF ARMATURE

This shows the top of the beam with the ball, this time, in the central position, and on the point of traveling toward one or the other end, actuated by the current received. This lever constitutes the armature.

It is absolutely necessary that thumbscrews be put on the armature as shown, (H) and (H), and that they are adjustable, as the adjustment of these two is necessary for the operation of the control. (M) is a steel ball which is nothing more than a ball for a large ball bearing; it can be obtained at any garage.

The armature should be drilled and tapped so that the contacts (G, B. D, F) are also adjustable.

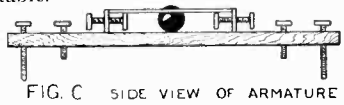


FIG. C SIDE VIEW OF ARMATURE

This gives the side view of the oscillating armature, showing the ball in the central position, as above, on the point of rolling to right or left.

Many other uses will suggest themselves to the experimenter; this control can be placed in the chicken house, and pressing the button in the home will open a small hole in a hopper containing feed in the chicken house to feed the chickens, and pressing it again will shut the feed off.

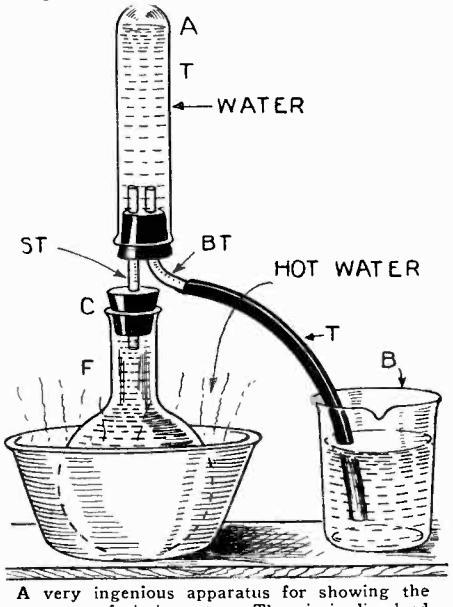
Determining Dissolved Gases in Water

IT IS surprising to the layman to be told that there are gases dissolved in the water he drinks. Even if it be distilled water, which is water from which the mineral matter has been taken out by distillation, there are sure to be some gases dissolved in it.

Here is a very simple piece of apparatus which the experimenter can rig up in a very few minutes which will enable him to ascertain the percentage of gases in any kind of water.

Flask (F) should be of about 500 cc. capacity. A smaller one will serve, but the accuracy of the determination will be lowered. It is filled with the water to be tested, the volume of the water being measured by means of a graduate. There should be no bubbles of air left under the cork (C) and it is to the bottom of this cork that the volume is measured. The test tube (T) should be filled with water, likewise the bent tube (BT), the rubber tube (T) and the beaker (B). In particular, there should be no air bubbles in the top (A) of the test tube (T). The experimenter will not find it difficult to entirely fill the entire apparatus with water, leaving no air bubbles in any part of it.

To make the determination, place the flask (F) in water (a water bath made as described in back issues of THE EXPERIMENTER serves very well) and heat the water to boiling, keeping it at the boiling point for several hours. This heating will expel the gas which is dissolved in the water to be tested in (F), and the gas bubbles will rise and pass up into (T), collecting at (A).



A very ingenious apparatus for showing the presence of air in water. The air is dissolved therein, is not in chemical combination, and is set free by heat.

The expansion in volume of the water due to the heat overflows into (T) through (BT) and (T) and then into (B).

At the end of the "run," or determination, the volume of the gases in (A) is measured by means of a rule or ruler, making a slight correction for the meniscus. The experimenter can note this reading of the rule and then remove the test tube and place several cc. of water in the tube to the same height as that of the gases collected. The number of cc. less, say, one, will be the number of cc. of gases evolved or which were contained in the water under examination. This figure, divided by the number of cc. of water taken for the test (the volume of the flask (F) up to the bottom of the cork (C)) and the result multiplied by 100 will give the per cent. by volume of gases dissolved in the water. If 490 cc. of water were used in flask (F) and 12 cc. of gases were collected in (T), there would be 2.44 per cent. by volume of gases dissolved in the water examined, for 12 divided by 490 equals .0244, and this, multiplied by 100, gives 2.44 per cent.

The water used for the test must be at 20 degrees Centigrade or a temperature correction would have to be applied to the observed volume, for 20 degrees is used in calibrating the flask used in measuring the sample of water to be analyzed.

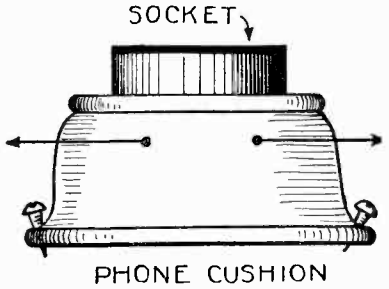
—Contributed by Raymond B. Wailes.

Tube Protection

A GOOD shock absorber for a vacuum tube can be made as shown in the diagram from a Goodrich phone cushion.

The cushion is mounted in the radio set, and the socket is nested in the center. The connecting wires can be run out over the top or through holes made as shown. The rubber is very resilient and gives just enough for proper cushioning effect.

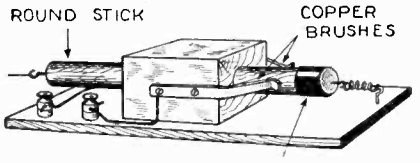
Contributed by LESLIE F. CARPENTER.



A telephone ear cushion is used to carry a tube socket to protect the tube from anything like violent shocks or jars, all such being annihilated by the India rubber.

Automatic Switch

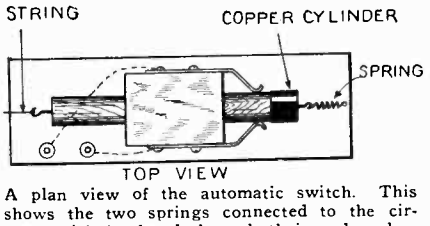
THIS switch is of pre-eminently simple construction. A block of wood is bored with a hole, through which a cylindrical piece passes with little or no friction. A piece of doweling will answer admirably for the round stick, or if a section of broomhandle with parallel sides can be obtained, it will do. Near its end is a brass or copper cylinder, and when the round stick is pulled in one direction, so as to draw the copper cylinder toward the block, it touches two spring contacts and closes a bell circuit or other alarm circuit, or, perhaps, a lighting circuit.



A switch operated by the pulling of a string and whose construction is so simple and substantial that it is highly to be recommended. It can be constructed to carry heavy currents. A round stick with a copper ring on its end drawn through a block opens and closes the circuit.

A spring, or even a rubber band, may be arranged to hold it out of engagement.

A string is attached to the end furthest from the brass plates; this string may be attached to a door, so that when the door is opened, it will pull the stick through, close the circuit and light a lamp. If to be used as a burglar alarm, it may be made to ring a bell when pulled upon by the motion of a door or window.



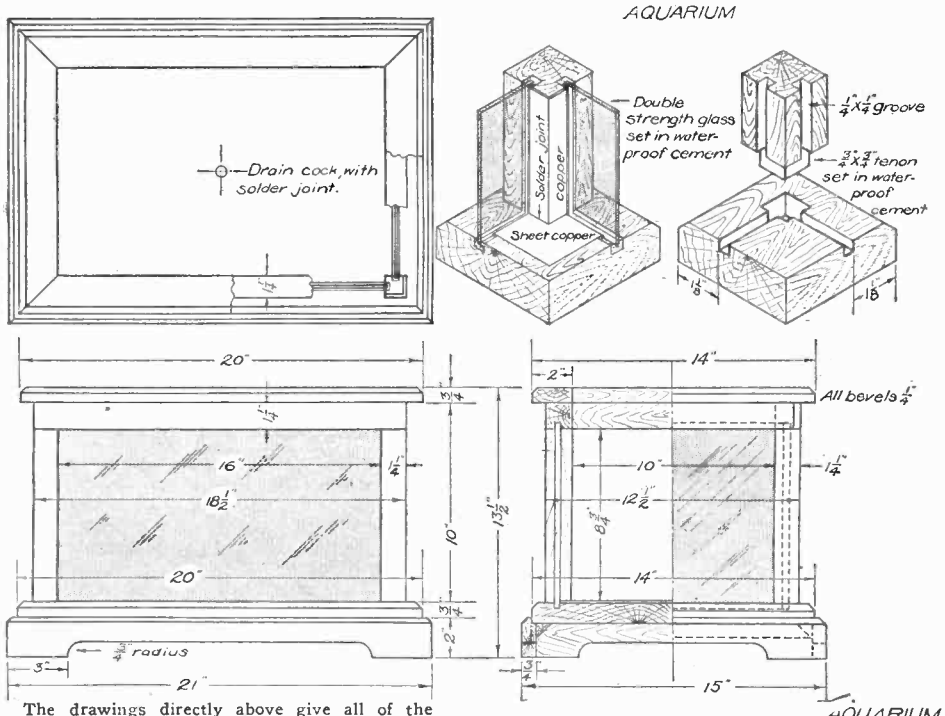
A plan view of the automatic switch. This shows the two springs connected to the circuit which is closed through their ends, when the non-conducting rod is drawn to the left, so as to bring the conducting ring on the right hand and between the two springs.

The merit of this switch consists largely in simplicity of construction.

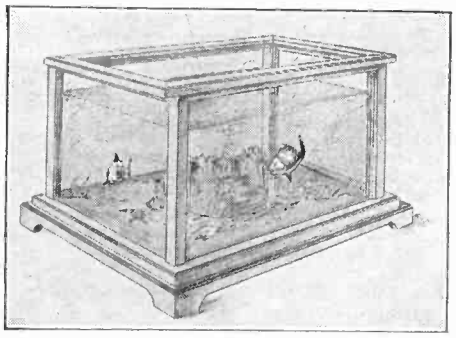
THE CONSTRUCTOR

Building an Aquarium

By H. L. WEATHERBY
Director of Manual Arts, Public Schools, Montgomery, Ala.



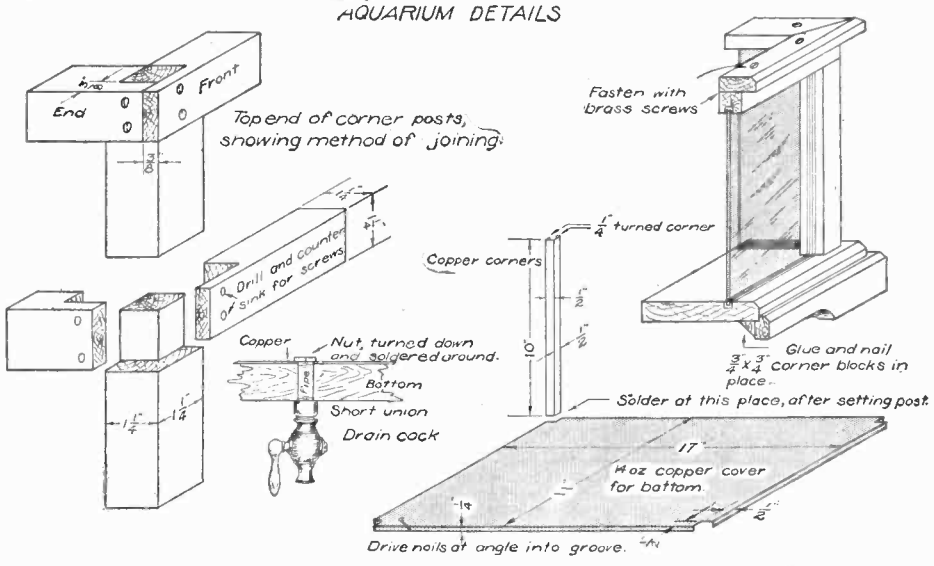
The drawings directly above give all of the necessary dimensions for the construction of this aquarium.

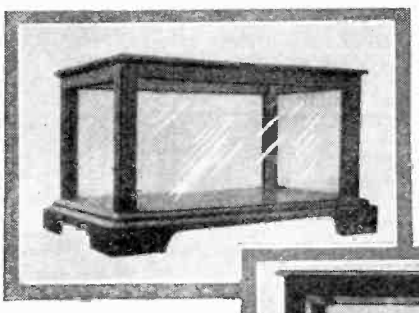


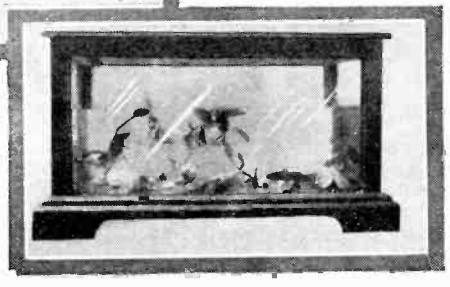
When completed, this simply made aquarium should appear as above. The design of the base can be changed to suit your taste.

THE aquarium described on this page is not difficult to construct and the average mechanic with ordinary tools can turn out a very fine specimen at a cost not exceeding $5.00.

In the material list the various parts will be found together with their finished dimensions. First cut the grooves for the glass and then do the remainder of the tool work such as cutting mitres and bevels, joints and finishing. Assemble the entire aquarium and fasten with screws. Mark all the joints and then take apart. Paint all the parts with asphaltum varnish, including the joints and grooves. Allow to dry and in the meantime, obtain a piece of sheet copper of the size shown and bend the edges at right-angles, the bent portion being ¼ of an inch wide. Tack this cover in place on the base, using brass nails and driving them in at an angle into the grooves as shown. Before applying this copper sheet, brush some asphaltum into the grooves. Do the same to the corner strips and slide the copper covering into place and nail in the grooves in the same manner as described before. Solder the metal joints at the bottoms of the posts as indicated.







The photographs above and to the right show the aquarium made by the author, both with and without water. When properly constructed, this aquarium is both beautiful and useful.

MATERIAL LIST			
1	1"x14"x20"	BOTTOM
4	½"x1½"x10"	CORNER POSTS
2	1½"x1¼"x18⅞"	SIDE TOP RAILS
2	1½"x1¼"x12½"	END TOP RAILS
2	¾"x¾"x13½"	CORNER BLOCKS

2	¾"x¾"x19½"	CORNER BLOCKS
2	¾"x2"x14"	TOP FRAME
2	¾"x2"x20"	TOP FRAME
2	¾"x2"x21"	BOTTOM FRAME
2	¾"x2"x15"	BOTTOM FRAME

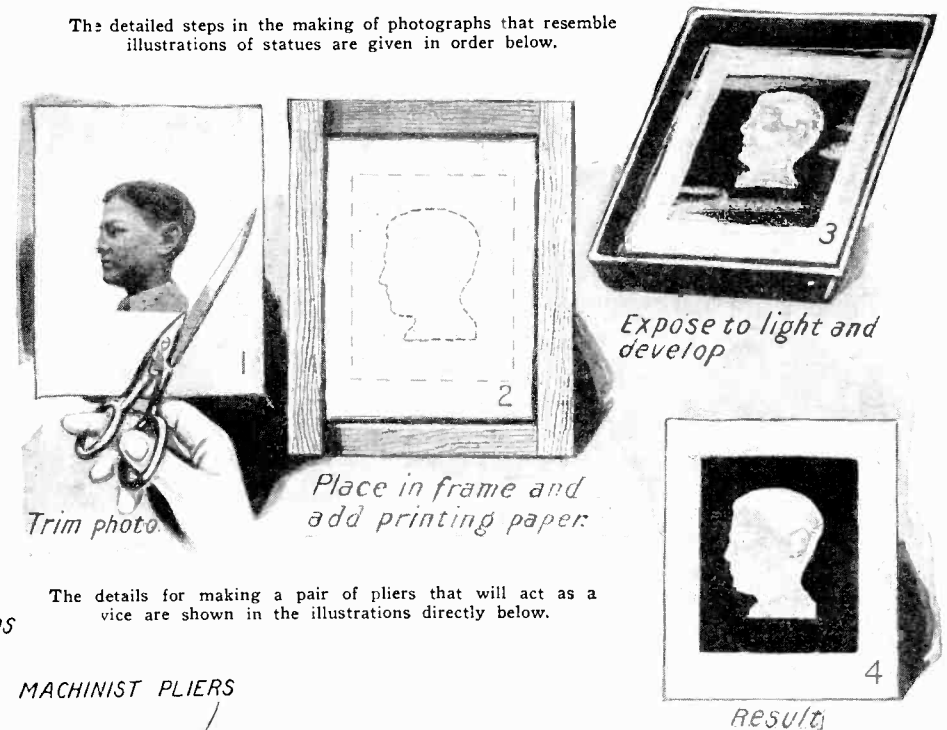
DRAIN COCK, PIPE, UNION AND NUT		
1	1"x17"	14 OZ COPPER
4	1½"x10¼"	14 OZ COPPER
2	9⅞"x10⅞"	DOUBLE STRENGTH
2	9⅞"x16⅞"	GLASS
SCREWS, NAILS, VARNISH, PAINT, ETC.		

More details on the constructional work are given directly above. Note how the corner posts are joined and then covered with beveled strips. The grooves should be cut on a circular-saw table in order to insure accuracy. The sides of the corner posts and the base are covered with copper.

For the glass, use double strength material, or better yet, plate glass free from imperfections. Melt together 1 pound of resin, 4 ounces of pitched tar and 4 ounces of linseed oil, making a water-proof cement. Pour into the grooves and slide the glass in place before the cement sets. Work the cement in carefully to insure water-tight, joints. Now finish the assembly and paint all of the wood work with marine paint. For convenience, a drain cock may be added.

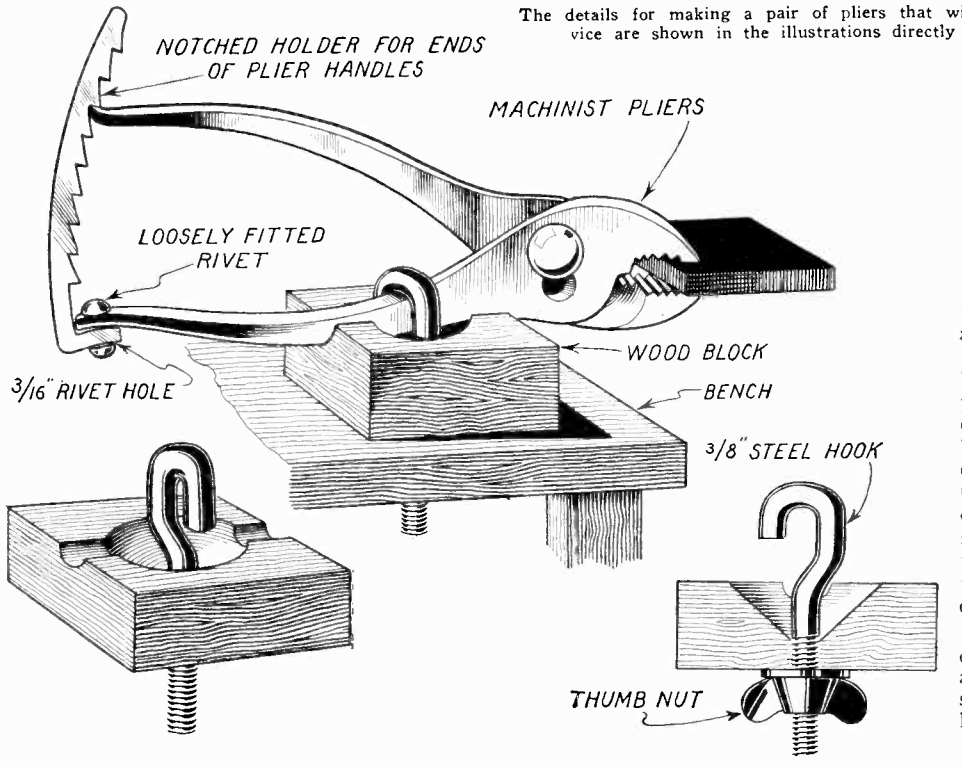
Statue Pictures

The detailed steps in the making of photographs that resemble illustrations of statues are given in order below.



PHOTOGRAPHS that resemble those taken of statues can be made in a very simple manner by following the process illustrated at the right. First a portrait is taken and the head of the person is cut out with a pair of sharp scissors as indicated at 1. This resulting silhouette is then used in a regular printing frame as though it were a negative. It is placed over a sheet of standard printing paper as shown in Fig. 2. This combination is then exposed to light just as though a regular negative were being printed, with the exception that a much longer exposure is necessary. About three times normal will be found satisfactory. The paper is then removed from the frame and developed in the usual way with the result shown in Fig. 4.—*A. A. Blumenfeld.*

The details for making a pair of pliers that will act as a vice are shown in the illustrations directly below.



Vice-Like Pliers

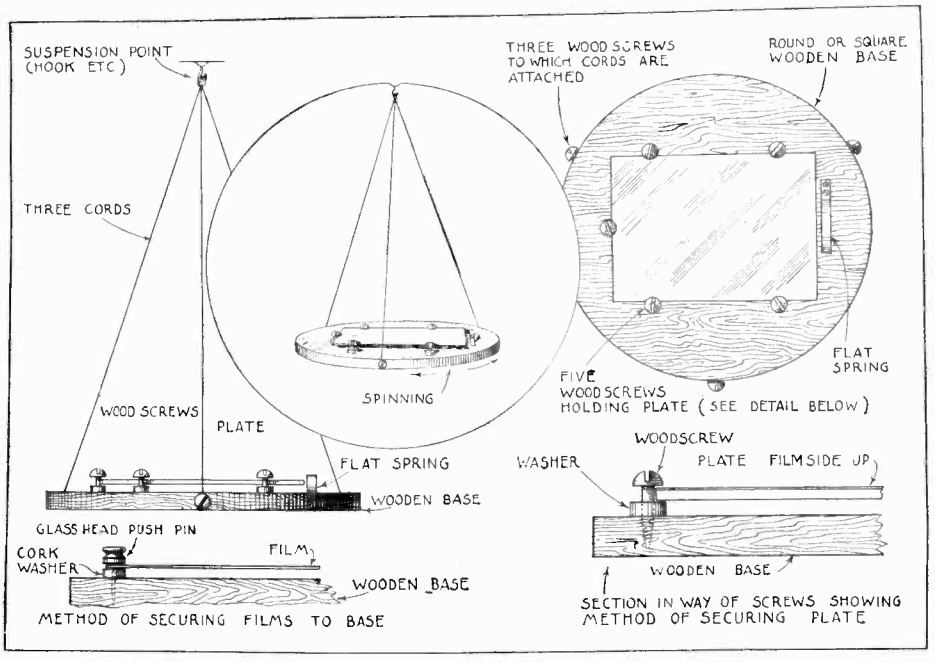
A PAIR of pliers that will retain their grip without the necessity of holding the handles and that can be used either as a stationary vise or as a portable one will be found very handy around any workshop. They can be easily made from a standard pair of machinist's pliers by following the details given in the drawings at the left. The only addition necessary to the pliers is a curved strip of metal with a serrated edge. One end of this strip is loosely riveted to one of the handles, and the other handle is sharpened slightly, so as to catch readily in the notches on the strip. A block can be made to hold the pliers to the bench when desired.

By employing a hook made as shown, the device can be clamped to a bench but is still available for instant removal when it is desired to hold the pliers in the hand. The hook is readily made from 3/8 inch steel rod.

—*George Arthur Luers.*

Quick Drying of Photographic Negatives

TO facilitate the drying of photographic plates or films, the apparatus illustrated at the right can be set up and the work can be accomplished in a much shorter time than usual. All that the apparatus consists of is a circular plate suspended by three strings. The negative to be dried is laid on this base and held in position by one of the methods shown. The wooden base is then revolved several times, twisting up the suspending cords and is released. It will keep on turning first in one direction, and then in the other, for some little time. The centrifugal force thus created throws the water off the surface of the negative and thus drying is quickly accomplished. If plates are used, wood screws and a latch consisting of a flat spring will hold them in position. In the case of films, glass-head push pins and cork washers are employed as indicated. An india rubber band will maintain a longer rotation than that produced by strings, but not so rapid a one.—*C. A. Oldroyd,* Rep. No. 4433.

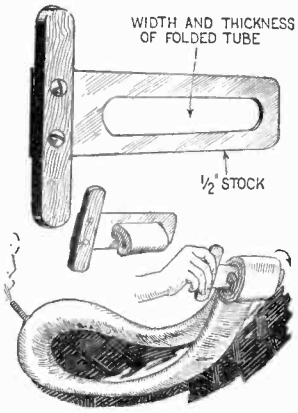


HOW TO MAKE IT

Trick Photography

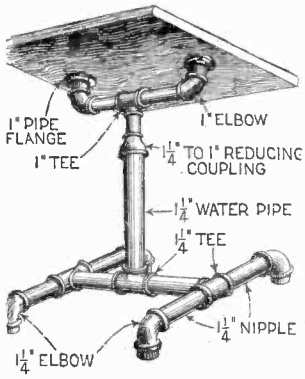
Realistic motion pictures of a charging bull are made by mounting a bull's head on the front of an automobile as at left and taking the pictures from the car as shown. This method was used in one of Buster Keaton's latest releases, entitled, "Go West." — Samuel M. Malkin, Rep. No. 19,022.

Tube Roller



When repairing a number of inner tubes, it is often a tedious task to roll them up and put them away. If, however, a simple tool or key such as that shown at the left is employed, the work will be greatly simplified. The slot in the tool should take the largest tube. — L. B. Robbins.

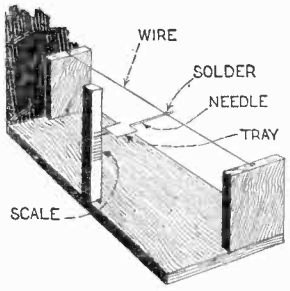
Drawing Table



A very handy drawing table that is most solid in construction can be made from standard pipe fittings as shown at the left. The necessary dimensions are given and the stand is to be fitted to carry a drawing board by means of pipe flanges. — F. E. Nasstrom.

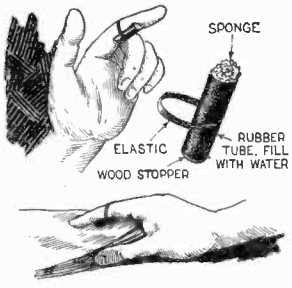
Scale

A very sensitive balance for the laboratory can be made as shown at the right. The scale on the upright is calibrated by employment of fairly accurate weights.—A. Vachan, Rep. No. 10,922.



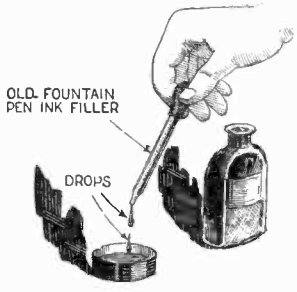
Moistener

When running through the pages of a book or magazine, a little moistener made as shown at the right will be found very handy. It is fastened to the finger by means of a rubber band. —Hubert Slouka, Rep. No. 7,110.

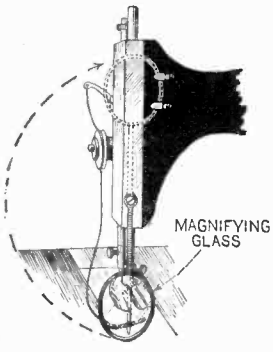


Liquid Measuring

Where liquids are to be measured by drops, a fountain pen filler or medicine dropper becomes most useful. It may also be employed for separating liquids from precipitates. William Fabry, Rep. No. 19,943.



Magnifier

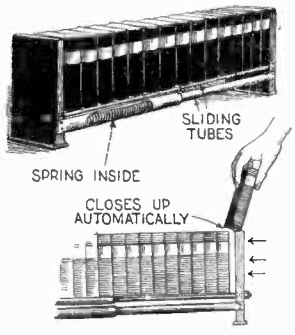


If a small magnifying glass is screwed to the head of a sewing machine as at the left, it will assist greatly in threading the needle and can then be swung up out of the way when not needed. It may be held by clips. — T. G. Wartin.

Drying Boots

When rubber boots become wet inside it is often a rather difficult proposition to dry them. A safe and sure way is to insert a lighted electric light bulb as shown and allow it to remain a few hours—L. B. Robbins.

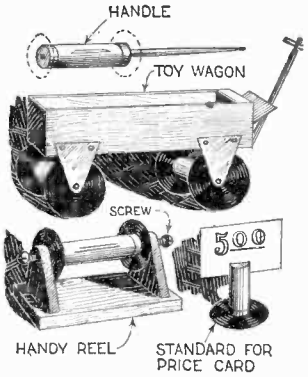
Book Rack



The book rack illustrated at the left will automatically shorten when a book is removed. This is because of the spring placed inside the larger of the two telescoping tubes. This rack can readily be made at home. — E. Elmes.

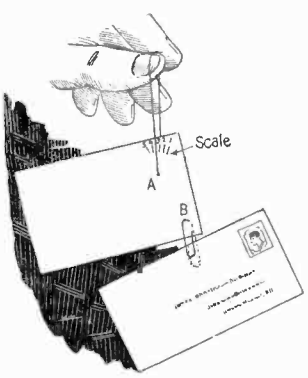
Spool Uses

Old film spools can be pressed into service as shown at the right. Cut off the ends and use the body as a handle. Use entire spools for making toy wagons. Reels for holding wire and cord are shown as is also a stand for a price card. — Beaumont Newhall.



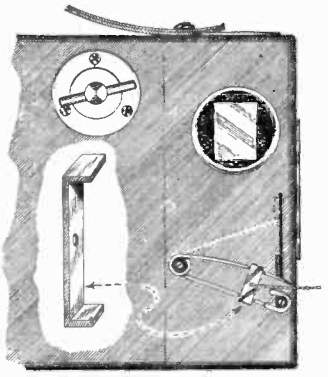
Letter Scale

A simple scale for weighing letters is made by pivoting a card at A and attaching the letter to the same card at B. Calibrate the scale indicated and hang the card by means of a loop of thread. The weight of the letter attached will be shown. —O. Glasser.



Shutter Release

A remote control shutter release for box cameras is illustrated at the right. The safety pin is fastened to the camera and held partly closed by means of the clip. When the clip is pulled off, the shutter is actuated. —Harold Jackson, Rep. No. 2,903.



Readers Forum

SCIENCE AND INVENTION desires to hear from its readers. It solicits comments of general scientific interest, and will appreciate opinions on science subjects. The arguments pro and con will be aired on this page. This magazine also relishes criticisms, and will present them in both palatable and unpalatable forms. So if you have anything to say, this is the place to say it. Please limit your letters to 500 words and address your letters to Editor—The Readers Forum, c/o Science and Invention Magazine, 53 Park Place, New York City.

BUILT SET WE DESCRIBED

Editor, SCIENCE AND INVENTION:

I built the Reinartz Standby exactly as specified in the January issue of SCIENCE AND INVENTION, except for the R.F. choke coil and the A.F. amplifier. The coil is just as you described it and I didn't even use low-loss condensers. I have only one tube and the results are unexcelled. Now for the results I obtained from this one-tube set:

The first night I had it, I logged forty-seven stations, some of them a thousand miles away from here. I can cover the entire broadcast range from 200 meters to 600 meters. It may seem impossible, but I got fourteen stations inside of ten points on the dial, and in one night got KHJ, KFI and KGO, which are about 2,000 miles from here. I will be busy in the next international test. I have built two of these sets for my friends and they work finely, but the users do not fish all the time as I do. I have logged 132 stations now. I recommend this set to anybody; it is 100 per cent. efficient in operation.

Signing off,

SIDNEY DUNN.
Flushing, Mich.

(We are always glad to hear from those of our readers who built the things we described. The editors try to make every article as accurate and authentic as is humanly possible, and are interested enough in their work to inquire as to the results others get with sets built according to specifications. These sets have all been tested in the laboratory of our Radio Editor and, consequently, their performance is always guaranteed. The results they bring in different locations are facts of which we would always like to be apprised. We appreciate your communication.—EDITOR.)

FROZEN FISH DO NOT SURVIVE

Editor, SCIENCE AND INVENTION:

As I am a reader of SCIENCE AND INVENTION, I noted two articles on the Readers' Forum page in the January issue of this magazine entitled, "Frozen Fish." I won't say either article is untrue, but my experience with fish differs from theirs. Some insects will freeze stiff all winter, and in the springtime will thaw out and come to life again. I fished on the lake at Fond Du Lac, Wis., several winters. We would cut a hole in the ice about two feet in diameter and sometimes the ice would be three feet thick. We would use a hook and line and bait same with a piece of meat. Some of the fish we caught we would cut up and use for bait. We have thirty to fifty degrees below zero in that country in some winter months. Most of the fish we caught were pickerel and perch. We would throw our fish on the ice after they were caught on our fish hook and they would flop about for five to six minutes and then become frozen stiff; yes, so stiff they would, or could, be broken in pieces. We used to sell these fish to town people. I would take some every day. My wife would place them in a bucket of cold water to thaw out, but never in hot water. After the fish had been in the bucket of water, say, twenty minutes, they would be thawed out so that they could be prepared and made ready for the pan. But, to tell the truth, never in my six years' of fishing, did I ever see a bit of life in any of these fish, after they were well frozen once and then thawed out. The authors of the two separate articles written for the Readers' Forum, on page 829, in the January issue, perhaps had a different fish to deal with?

AUGUST JEFFERS,
Bedford, Ind.

(It seems as though the editors ought to start two teams and let them argue this frozen fish business out to a finish. Every week we receive letters concerning the experiments in artificial hibernation which we made and the results of which were published. In that article we stated that fish or reptiles, when thoroughly frozen, do not come back to life.

About half of the letters we receive uphold the theory that fish can be frozen and brought back to life again. The other half state that such things cannot be done.

Our own experiments dealt with artificial freezing. We made sure that the fish were actually frozen and when we were positive on this point, any attempt to resuscitate them met with no success whatever. The fish were dead and, to paraphrase Dickens, we would say that they were "deader than a door nail."

We then received letters from science instructors stating that they have been able to freeze eels with liquid air and bring them back to life. When we told these science instructors to employ a second eel as a check and freeze both so brittle that one of them could be broken with a hammer; the other frozen simultaneously with the first, should be permitted to thaw out, and then the attempt to resuscitate should be begun. We received no letter of announcement of success with the experiment.

Then the editors received a great many communications claiming success for natural freezing of fish and an equal number disclaiming the possibility. If others of our readers have tried this experiment this winter, we would like to hear what their results were. They should, however, be positive in their assertions that the fish were actually frozen stiff and that a control fish frozen simultaneously with the one upon which the experiment is to take place, was actually frozen solid and could be broken by dropping it.—EDITOR.)

HIBERNATION

Editor, SCIENCE AND INVENTION:

In reference to the article in your September issue of SCIENCE AND INVENTION entitled, "Life Suspended in Ice." I don't know much of anything about it and have never studied it, but the little that I remember from my boyhood days might be of interest to you.

One day in the early fall some neighboring boys and myself were down along the creek and, seeing some minnows darting around at the edge of the water, we proceeded to capture some by means of hitting the water near them with a stick and knocking them out on the bank. We then put them in a tin can filled with water and proudly carried them home as pets. We put them in a big dish of water near the window of my home. Mother told us that they wouldn't live very long, but, as we insisted upon keeping them, she did the next best thing and helped us change the water regularly. Well, those minnows lived and were still going strong at Christmas time. One night their dish was forgotten and left in the window. The next morning I was heartbroken. My mother dumped the cake of ice out of the dish and I could plainly see the two or three little fish just as lifelike as always, but in solid ice. The ice was put back in the dish until the fire was built, and then we forgot about it. When I came home that evening from school my mother showed me my fish. They were swimming around just the same as usual. Those fish lived until the cat knocked the dish over one night.

I've never had a chance to try this stunt before, but I've always imagined that it was a natural affair with water creatures.

ARCHIE E. KNAPP,
Sioux City, Iowa.

(See answer to preceding letter.—EDITOR.)

MORE FISH

Editor, SCIENCE AND INVENTION:

Some weeks ago I read a syndicated article regarding experiments you had made on fish in an effort to freeze them and then thaw them out later. It interested me very much, as I have often thought something of the kind possible.

In the winter of 1894, we were living in Lincoln, Neb., and it was a bitter cold experience. Students —no money—and but little heat in our room, which was on the north. Our poor goldfish froze in a solid cake of ice each night and we thawed them out very carefully each morning by setting their dish in a pan of warm water. They were sluggish for an hour or so, but apparently none the worse for the experience.

If they could be frozen in a solid cake of ice for one night and then come out alive, would they be able to stand it two nights, or for a week or more? If the article is correct, you say not—but I wonder why not? I have often wished I had experimented a little more on those poor goldfish. I suppose you were trying to keep them frozen for some time, and it was not a success; but, still, I can't help thinking of those heroic little fish that were frozen solid each night and emerged from their icy prison to swim as gayly as ever.

W. A. ALTON, M. D.,
East San Diego, Calif.

(We have received a great many letters from our readers concerning their having seen fish frozen in ice, and also experiments with the liquid air freezing of animals. It seems strange that, when a control was employed in the liquid air experiments, none of the thoroughly frozen fish ever came back to life. Of course, with the natural freezing methods, we are never positive as to whether animation has been completely suspended or not. If completely suspended, no breathing takes place and there is no metabolism. Of course, a fish frozen in solid ice would find it difficult to breathe, because there is no circulation of water. There may be a slight blood circulation, due to the fact that the freezing point of the blood is considerably lower than that of water. Also note letter, "Frozen Fish Do Not Survive."

In attempting artificial experiments along these lines, we have never met with success.—EDITOR.)

LIKES S. & I. BUT——

Editor, SCIENCE AND INVENTION:

I am a boy 16 years of age, and wish to state that I enjoy your magazine very much, because it contains so many little practical items of interest, not only to scientific men but to the ordinary person. However, I do not see why magic should be included in a scientific magazine. The articles that Dunninger submits I believe, are needless exposés, as very few of the effects are practical for the ordinary person.

Take for instance, an illustration described in the October number. A person disappears from one glass tank, and reappears in another. I doubt very much whether this effect ever was performed, or if it could be performed. At any rate, it would cost a good deal of money to construct. *(It is being built now.—EDITOR.)*

In the September number there is an article describing a game, in which airplanes try to push a buoyant ball through a goal. I consider this game very impractical, dangerous and absurd. In the same number there is a description of an underground airplane shelter on a battlefield. From the location of the mines, I would like to know where the airplane would land, to again enter the shelter. The aforementioned are only a few of the ridiculous items found in some of the numbers.

On the other hand, however, I wish to state that most of the articles are vastly interesting. A few articles in the last few numbers that I liked were the making of motion pictures, magnified photographs of insects, scientific problems and puzzles, etc. Furthermore, I wish to say that I like science and the magazines dealing with it, but when it comes to a choice of scientific magazines, I take SCIENCE AND INVENTION.

PAUL DOERING,
Philadelphia, Pa.

(If you will refer to Prof. Dunninger's series of articles, you will find that he always gives one trick for the stage, one for the lyceum entertainer, one for the amateur magician and one parlor magical trick. The glass tank effect for the stage is not difficult to produce and will not cost a large sum of money. As a matter of fact productions much more expensive have been developed by most of the well-known magicians.

With reference to the aerial golf, we would state that this game is not as absurd as it may seem. We had horse polo, and then came bicycle polo, motorcycle polo and finally automobile polo. Why not a game in which airplanes could partake and which would teach pilots more maneuvers in a simple way. This game has actually been tried out, and movies of the same were taken. As to the airplanes getting into an underground shelter, that is a simple matter when the mines are electrically controlled.—EDITOR.)

LIVING DEATH

Editor, SCIENCE AND INVENTION:

I have been a reader of your magazine for five years now and have never missed an issue. I have never had any occasion to be disappointed, as I have thoroughly enjoyed the interesting scientific knowledge contained in each issue.

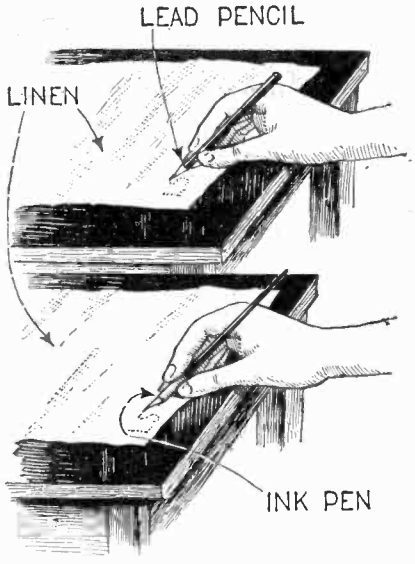
I particularly liked John Martin Leahy's story, "The Living Death," but the ending only made me more curious to hear the sleeping beauty's story. I am sure I am not the only reader who is anxious to hear more about it. Is there going

(Continued on page 1056)

WRINKLES
RECIPES & FORMULAS

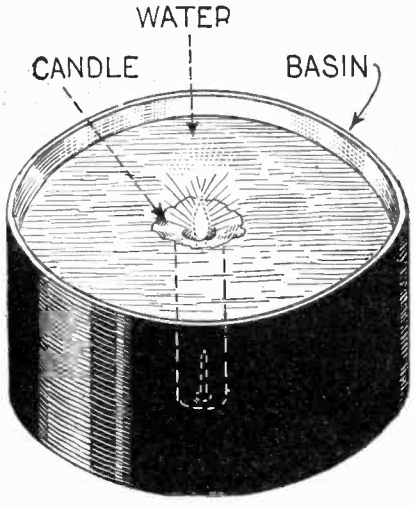
Edited by S. Gernsback

MARKING LINEN



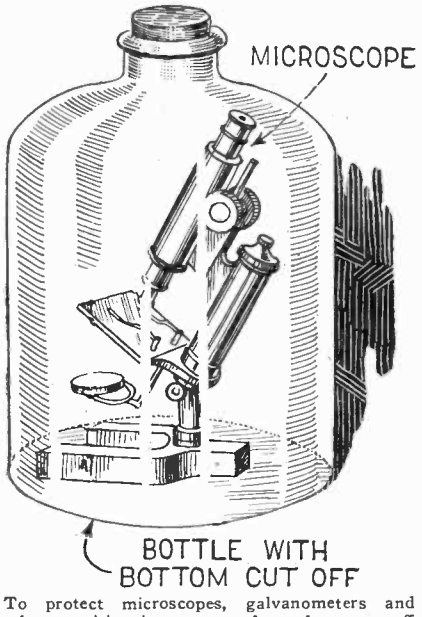
To successfully mark linen for any particular purpose, use a rather blunt pencil for first inscribing the design and then follow over the pencil marks with pen and ink. The ink will not run. —Mrs. Nina Jeffers.

SAFETY LIGHT



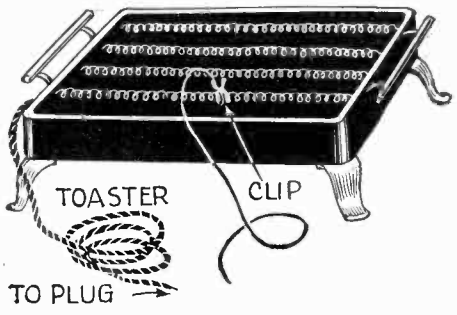
If a candle is weighted at one end so that it sinks but so that no water reaches the wick, the latter can be lighted and the candle will burn until consumed. As the wax is used the candle rises. —S. G.

MICROSCOPE SHIELD



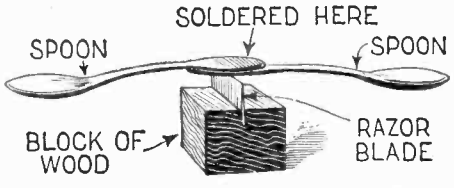
To protect microscopes, galvanometers and other sensitive instruments from dust, cut off the bottom of a large glass bottle and use the remainder of the bottle as a cover as shown above. —Raymond B. Wailes.

VARIABLE RESISTOR



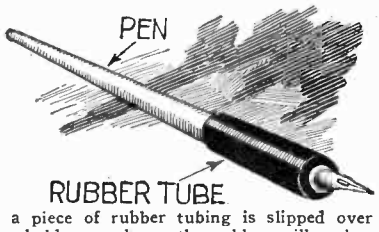
The heating element of an electric stove or toaster is often used as a resistance and it can be made variable if a clip is employed as shown. —Hugo E. Anderson, Rep. No. 10,142.

BALANCE



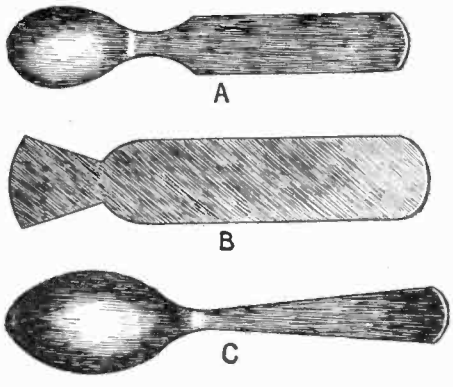
A small scale that will prove quite sensitive can be made from two spoons and a razor blade as above. The spoons are soldered together and then balanced on the edge of the blade which has in turn been inserted in a wooden block. —W. B. Cowan.

PEN GRIP



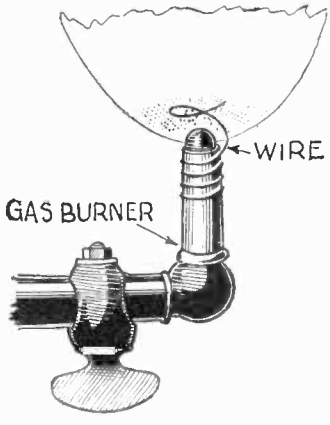
If a piece of rubber tubing is slipped over a pen holder as above, the rubber will make an excellent grip and will enable the user to work for long times without tiring. The rubber provides a soft holding surface.—B. G. Switzer.

CELLULOID SPATULAS



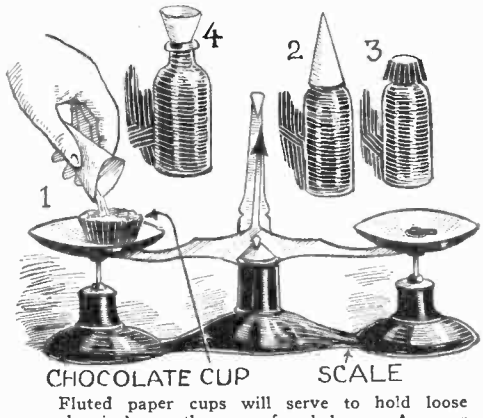
To make a spatula of any desired size or shape for some particular purpose, cut a piece of cardboard to the form desired and coat it with a solution made by dissolving sheet celluloid in acetone. Apply several coats. —E. A. Daansen, Rep. No. 17,657.

BURNER RELIGHTER



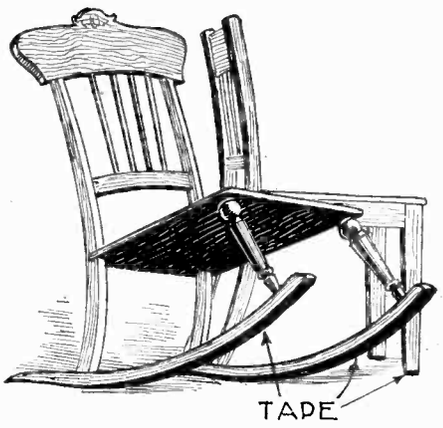
When gas flames are turned down very low, they often go out. If a coil of fine copper wire is placed as above, it will be heated to incandescence and will immediately ignite the gas again. —Louis Strange.

PAPER KINKS



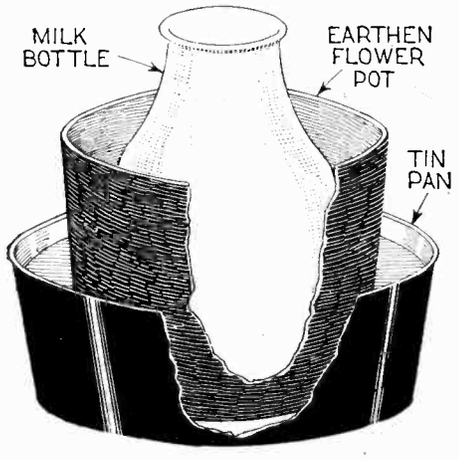
Fluted paper cups will serve to hold loose chemicals on the pan of a balance. A paper cone, 2, make an excellent dust cap for bottles of chemicals. Fluted cups, 3, serve the same purpose. A cone of paper, 4, serves as funnel for dry chemicals. —A. Daansen, Rep. No. 17,657.

SCRATCH PREVENTATIVE



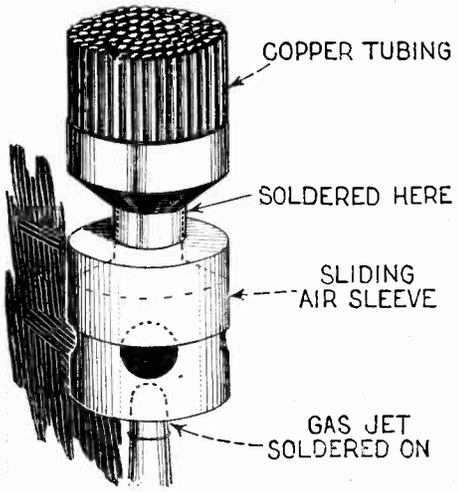
Often the legs of rockers or chairs tend to scratch hard wood floors but if pieces of adhesive tape are applied as above, this will be prevented. Surgeon's tape that is adhesive on only one side is to be recommended for this work. Use long strips for rockers or small squares for the legs of ordinary chairs. —Homer E. Black.

COOLING MILK



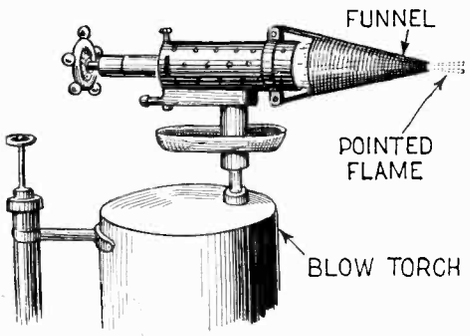
To keep milk cool without ice, place the bottle in the center of an earthen flower pot and the flowerpot in a tin pan nearly full of water. The flowerpot being porous, absorbs water which in turn evaporates and keeps the surrounding atmosphere and contents of the bottle cool.
—K. Yenari.

MEKER BURNER



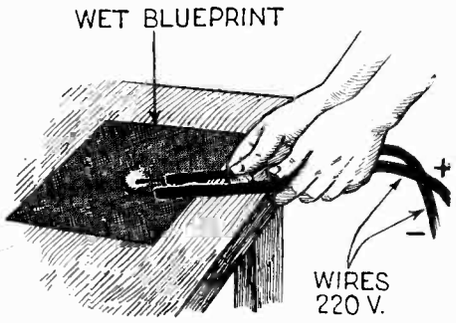
This type of burner is often desirable and can be made from an ordinary gas jet with the accessories shown above. Use hard solder on all parts. The sizes of the various components may be made to suit the material at hand.
—Edward Mazone.

POINTED FLAME



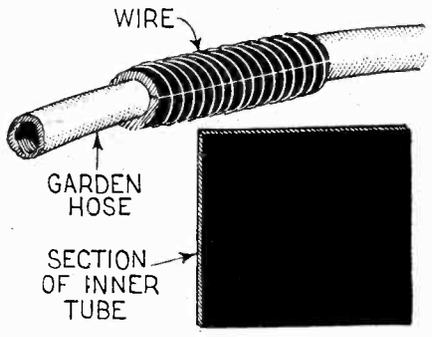
A pointed flame is often desirable and if a sheet metal or asbestos funnel is attached to a gasoline blow torch as above, the effect will be all that can be wanted.
—C. Wallon. Rep. No. 12,555.

POLARITY INDICATOR



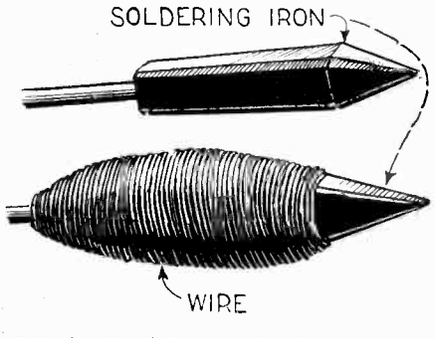
If a piece of blue-print paper is moistened and two electric terminals or ends of wires, the polarities of which are to be found, are touched to the surface, the area around the negative wire will turn white. —James Noble.

REPAIRING HOSE



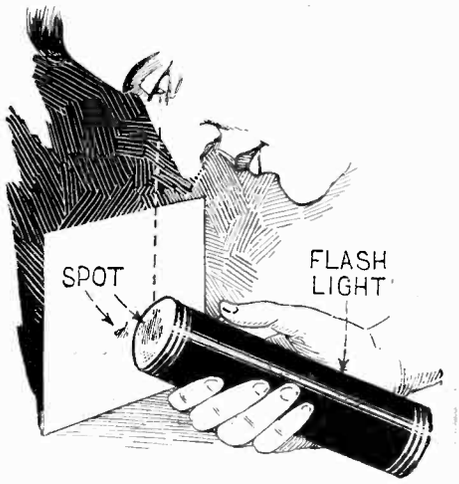
When a garden hose breaks, cover the rupture with a piece of inner-tube rubber and bind tightly in place with wire as shown above.
—B. G. Switzer.

SOLDERING IRON



It is often found that a small soldering iron will not hold heat long enough to permit satisfactory workmanship, but if the tip is wrapped with several layers of copper wire as shown above, this difficulty will be found to be overcome to a very great extent. Fasten by overlapping turns.
—Albert Staehle.

MAGNIFIER

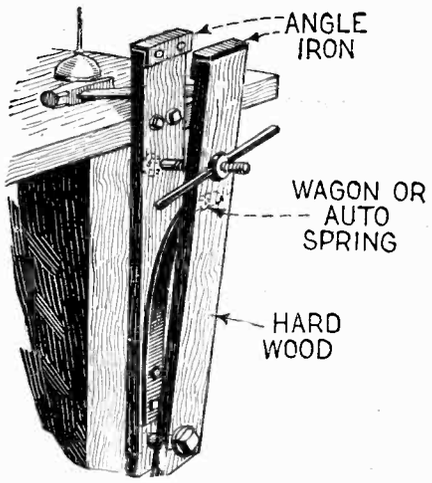


The lens of a flashlight can be used for magnifying small objects without removing it from its assembly, if the object to be examined and the lens are placed in the relative positions shown in the above illustration. View from above.
—W. S. Reynolds.

POISON PROTECTION

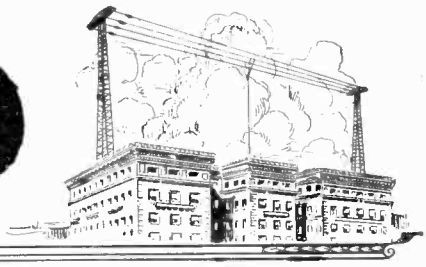
To prevent possible tragedy, label all poison bottles with a luminous inscription. The luminous ink is made by corking tightly in a bottle 1 dram of phosphorous and 1 ounce of oil of cinnamon and place in hot water until dissolved.
—Homer E. Black.

VISE



A very satisfactory vise for the work shop can be made from odds and ends as shown above. The metal spring tends to keep the vise open, and it is closed by means of a threaded rod and arm shown. Protect the faces with angle iron. The lowest holding bolt is to be quite loose.
—Auguste Mathieu.

RADIO



WHEN AN S O S CALLS!

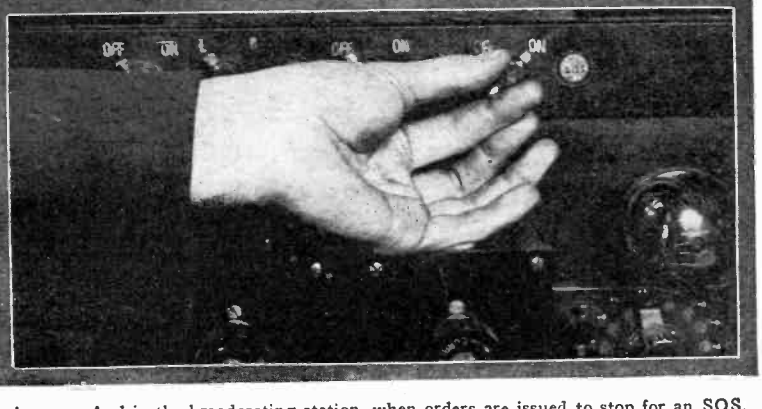
• • • — — — • • •

What Happens When This Plaintive Call Is Heard? Why Do the Broadcasters Clear the Air?

Left: A vessel is sinking: In the radio room, its operator is frantically sending that most dreaded of all radio signals—SOS. Will it be heard? Will assistance arrive in time to aid? Will the ship founder before all can escape? These are the questions that flash across the mind of radio operators everywhere who intercept that electrifying combination of dots and dashes.

This is the "600 meter watch" in a broadcasting station where instructions are received for stopping transmission when SOS is heard.

Above: Here is the room where all of the radio traffic of a seagoing vessel is handled. Here is where the operator, among the last to leave a sinking ship, cooly pounds out SOS though death be near at hand.



And in the broadcasting station, when orders are issued to stop for an SOS, a snap of the switch shown in the photograph above immediately takes the station off the air and clears the way for rescue messages.

"SIGNING off on account of an SOS." The last time you heard this announcement by your favorite broadcasting station, what did you do? Did you lose your temper and fuss and fume about the "darn interruptions that always come along just when the program is at its best," or did you sit back in your chair and give a few thoughts to the meaning of that cryptic announcement? If you acted as mentioned last, you may have visualized a scene such as that shown in the upper left-hand photograph on this page. Here is shown an actual photograph of the saving of the crew of Italian freighter *Ignacio Florio* by the American steamship *President Harding*.

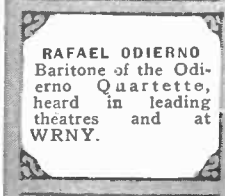
The next time that your program is interrupted by an SOS, remember this photograph and think of how cold and dreary it must be somewhere out in the ocean with only a frail lifeboat between yourself and death by drowning. Then you will begin to realize what lies back of an SOS signal. If you are at all religiously inclined, offer up a little prayer for the salvation of those helpless people who are in great danger of their lives and whose only link with assistance is radio. Your broadcasting program has been stopped in order to clear the way for communications between the ship in distress and other nearby ships or shore stations, so that rescue can be effected as speedily as possible. If broadcasting were to be continued at a time such as this, the programs might seriously interfere with the most necessary traffic that any radio wave ever carried. Therefore, all coastal stations are shut off at times of distress and the speedy handling of communications with the hapless vessel is expedited.

Broadcasting stations further inland may still be operating, so tune in for them.

When Nations Listen In

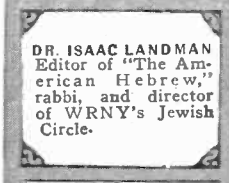
By CHARLES D. ISAACSON

'SVANHILDE" The radio name of a brilliant soprano, Astrid Fjelde, who broadcasts Norse songs over WRNY.



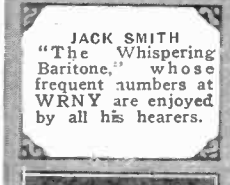
RAFAEL ODIERNO Baritone of the Odierno Quartette, heard in leading theatres and at WRNY.

ANITA SELF A charming soprano, who is heard always with Miss Callow at WRNY.



DR. ISAAC LANDMAN Editor of "The American Hebrew," rabbi, and director of WRNY's Jewish Circle.

JUNE LEE "The Singing Vagabond," whose popular songs through WRNY run the gamut from comedy to pathos.



JACK SMITH "The Whispering Baritone," whose frequent numbers at WRNY are enjoyed by all his hearers.

FRANCES MARIE CALLOW This distinguished harpist appears fortnightly at WRNY, together with Miss Self.

ANAGARIKA DHARMAPALA The first Buddhist teacher to put his message on the radio, spoke recently from WRNY.

YOU have elsewhere had recounted to you how WRNY on Christmas Day gave Germany's greetings to America, in the words of the eminent leaders of the German republic, speaking exclusively and specifically through this station to the people of America. I shall not attempt to do more than remind you of it at this time.

Georgette Nyrelle will be in Paris in February as the special representative of WRNY, broadcasting a message from America to the people of France, from the important stations of that country. She will speak in English and French, and will sing a program of French songs as a symbol of American friendship for France, and as a forerunner of future possibilities of intercommunication.

John St. Loe Strachey, the famous English journalist, at the close of his visit to the United States, gave a farewell greeting of amity between the English-speaking nations through WRNY.

Radio is cementing, not only the cities and regions of the United States, but the nations of the world in the bonds of a better common understanding.

WHERE ALL RUB SHOULDERS

Speaking of cities, perhaps you heard WRNY when Mayor Kendrick, of Philadelphia, and Mayor-Elect Walker, of New York City, exchanged felicitations in connection with the coming Sesquicentennial celebration in the City of Brotherly Love?

Or, speaking of religions, perhaps you have heard the great Jewish and the great Catholic leaders sending their messages upon the air through WRNY?

Or, speaking of the mingling of past and present, perhaps you heard Governor Henry J. Allen, of Kansas, speak at the unveiling of the Roosevelt plaque at The Roosevelt, the home of WRNY?

Speaking of arts, perhaps you have followed the talks on painting, sculpture, architecture, at WRNY? Now, think of it, there has been an exhibition of the works of Zeitlin, Dugas, Gibson, Musgrove, March, Essman, Blume, and of the floral designs of Irene Hayes and other artists, at The Roosevelt, expressly for the radio listeners of WRNY.

RELIGIONS OF THE WORLD

AT WRNY, the venerable Anagarika Dharmapala, one of the foremost teachers among the hundreds of millions of Buddhists of the world, met with Jewish cantors, Mohammedan muezzins, Arab chanters, and many others, in their native costumes and singing their own religious music. For the first time in the 2,500 years of Buddhism, one of their teachers has spoken by radio. Carl L. Bemies has arranged these wonderful meetings of Musics of All Religions. Regularly, Dr. Christian F. Reisner, of the Chelsea Methodist Episcopal Church, addresses WRNY listeners each Sunday.

FROM STAGE TO MICROPHONE

At WRNY, one night, were Harry Kemp, "the tramp poet," and Harold Vinal, editor of *Voices*, the magazine of modern poetry. Here were, one night, Rollo Peters, Estelle Winwood, Ann Harding, and others from the production of "The Taming of the

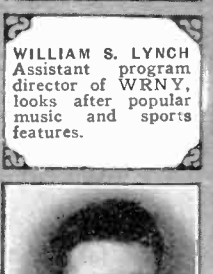
(*Continued on page* 1043)

PIETRO SOLDANO "The Ballade Minstrel," a fine young American baritone of operatic and concert popularity, who sings winsomely through WRNY.

LOUISE STALLINGS Prominent American soprano, who appeared with Maestro Sapio in a grand opera recital at WRNY.

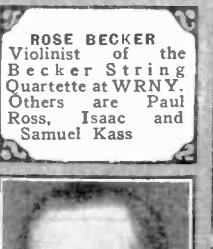
CHEVALIER De LANCELLOTTI Director of a song series at WRNY, has been honored by the British, French and Italian governments.

BELLE BENNETT Creator of "Stella Dallas" gave WRNY fans a genuine thrill by her recent appearance in person.



WILLIAM S. LYNCH Assistant program director of WRNY, looks after popular music and sports features.

GIUSEPPE ADAMI WRNY's "Crooning Violinist," plays with soulful, tender, lilting style.



ROSE BECKER Violinist of the Becker String Quartette at WRNY. Others are Paul Ross, Isaac and Samuel Kass

CARL L. BEMIES Director of "Music of All Religions," the picturesque Sunday afternoon feature of WRNY programs.

The Radio Constructor

How to Build An Extremely Selective Tuned R.F. Receiver, Using a Regenerative Detector, But No Neutralization. This Set Will Not Radiate

By A. P. PECK, Assoc. I.R.E.

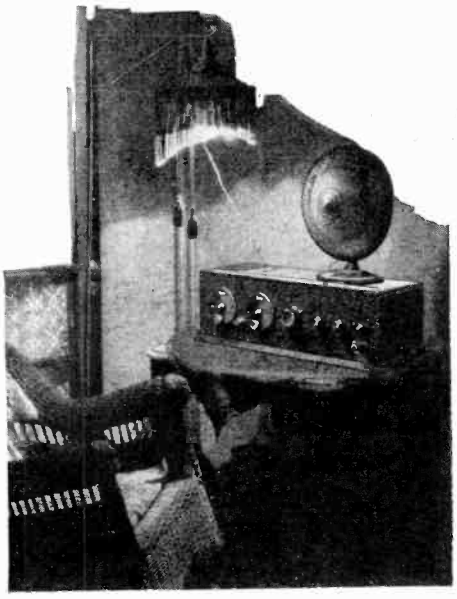


Fig. 1. How does this impress you for comfort? We might even paraphrase two old sayings thusly. "A woman is only a woman but a good radio set is a thing of joy forever." If you would enjoy radio to its fullest, here is the set that will assist you most ably.

IN THE search for a home-made radio receiver that can be built and then used day in and day out with absolute regularity and with satisfactory service, there are several things that must be taken into consideration. First, the set must be stable in operation and must be capable of being logged. In other words, stations of a given wave-length must always come in on the same points on the tuning dial. Therefore, if regeneration is used, it must be some system that does not affect the tuning to any appreciable extent. Secondly, the set must not radiate. If it does radiate, it will interfere with neighboring receivers and you will at once become a bad "radio neighbor." Third, the set must be selective, so that nearby powerful stations can be tuned out. Fourth, it must be economical in operation and must have a low first cost. Fifth, it must give ample volume for ordinary home use, and sixth, it must be so designed that its appearance will harmonize with the home. These are merely some of the qualifications that it should possess, and there are others, such as capability to receive DX, ease of tuning, and more that will be obvious upon the study of the situation.

DISCOVERING THE SET

The writer has been looking for a set that will give all the results mentioned above, and finally has hit upon the one described and illustrated in these columns. A good many sets have been built in the course of time, but this one seems to fulfill all of the requirements to a greater extent than any other. It worked the first time that it was tested out, after assembly, and there was no necessity of changing any parts or connections in order to make it operate just as it should. This is contrary to the usual process of making a set, wherein certain leads have to be put in temporarily and then switched around under test, until the best operating positions for them are found. Therefore, a set of this type is to be heartily recommended to the amateur builder, who does not know the finer points of radio construction.

The apparatus that is described here comprises one stage of radio frequency amplification placed in front of a unique type of regenerative detector, and with two additional stages of audio frequency amplification. The radio frequency amplifier performs two main functions in this set. First, it increases sensitivity and signal strength by amplifying the incoming currents so that they are better adapted to actuating the detector tube. Second, the radio frequency tube effectively acts as a block to any oscillatory currents set up by the regenerative detector that otherwise would be fed into the antenna and radiate out, causing interference with nearby receiving sets. With the loosely-coupled R.F. amplifier, this radiation effect is impossible, and by using a set of this type, you immediately become a good "radio neighbor."

By employing regeneration in the detector circuit, the sensitiveness of the set is still further increased, and it becomes possible to pick up DX stations and tune them in on the squeal without causing radiation. The squeal method of tuning is acknowledged by experts to be the very best possible, and using it, stations can be heard and brought up to the greatest obtainable volume, whereas otherwise they might be passed over and never be heard if the squeal method of tuning was not employed.

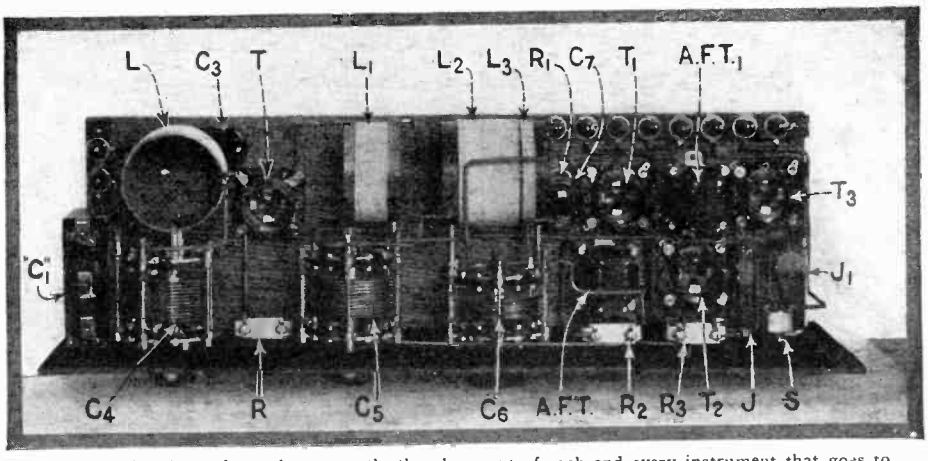


Fig. 3. The photo above shows exactly the placement of each and every instrument that goes to make up this exceptional radio set. The numbers and letters are carried throughout.
Photos courtesy Martin-Copeland Co., Allen-Bradley Co. and Radio Specialty Co.

REGENERATION

The regenerative feature of this set is one that deserves special mention. The control of regeneration is accomplished by means

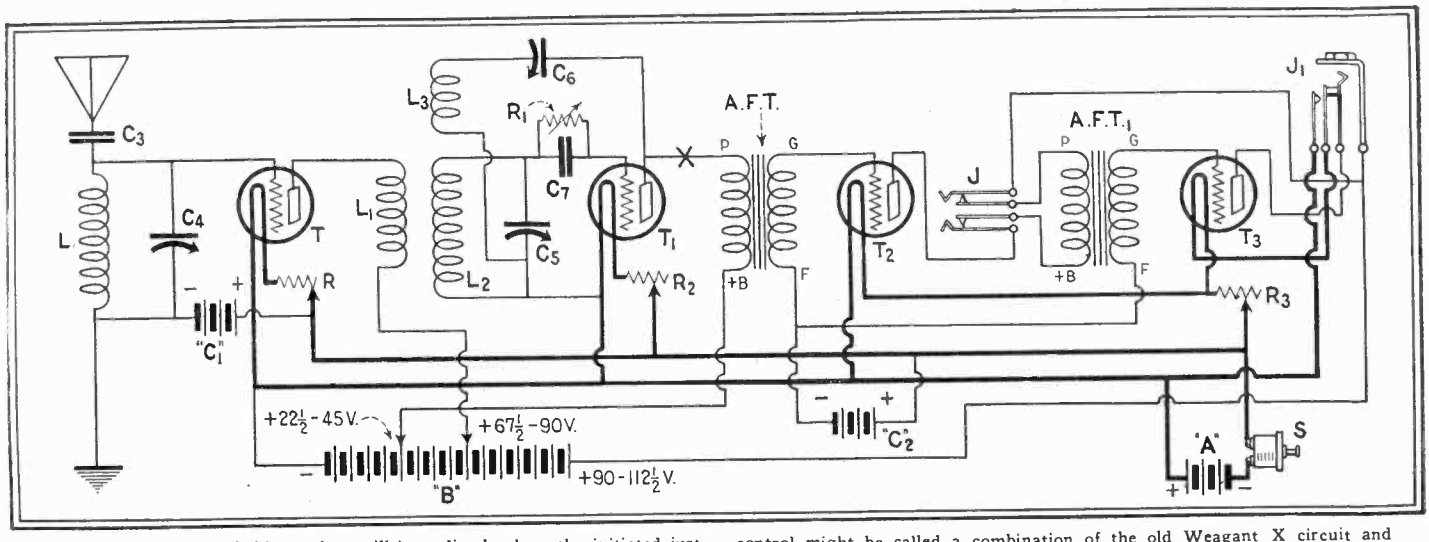


Fig. 5. The circuit of this receiver will immediately show the initiated just the type of control that is employed. The first tube constitutes a standard stage of tuned radio frequency amplification and regeneration in the detector circuit is controlled by the variable condenser, C6. This regeneration control might be called a combination of the old Weagant X circuit and the well known Reinartz system, incorporated in a receiver in such a way as to render the result a most capable set for all around use, yet one that is simple to control. Selectivity and volume are also features.

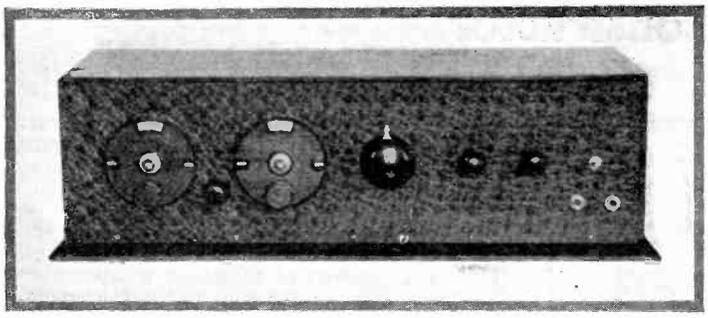


Fig. 2. The panel view of this receiver shows the simplicity of control. The knob in the approximate center is the regeneration control.

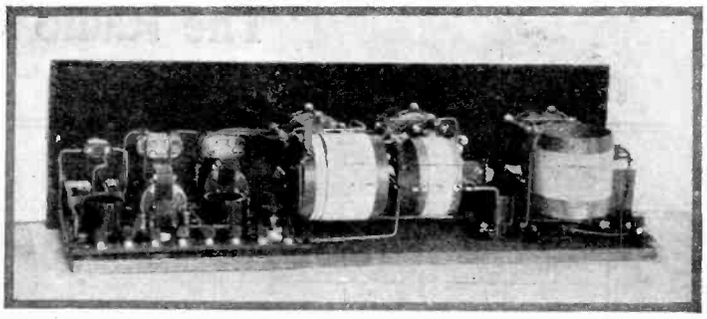


Fig. 4. The rear view of this set again shows the placement of the various instruments. Note the position of the antenna tuning coil.

of a small variable condenser of .00025 mf. capacity. This control is far more sensitive and stable than any tickler coil ever could be made and, furthermore, the control is smoother. The set can be brought very close to the oscillation point without "spilling over," and thus greater amplification, by means of regeneration, is obtained. The exact position of the regeneration condenser in the set can be seen in the various photographs and diagrams given on these pages. It is connected in series with a small feedback coil which is placed in fixed inductive relation to the grid coil of the detector tube and is wound in the opposite direction to that coil. The details of these two coils, as well as the one connected in the antenna circuit of the R.F. tube and that connected in the plate circuit of the same tube, may be seen in Figs. 10, 11 and 12.

List of Parts

L	Antenna coil.
L1	R.F. plate coil.
L2	Detector grid coil.
L3	Detector plate coil.
C1	R.F. "C" battery.
C2	A.F. "C" battery.
C3	.0001-mf. antenna condenser.
C4	.0005-mf. variable condenser.
C5	.0005-mf. variable condenser.
C6	.00025-mf. variable condenser.
C7	.00025-mf. grid condenser.
R	Carbon pile rheostats.
R2	Carbon pile rheostats.
R3	Carbon pile rheostats.
R1	Carbon pile grid leak.
AFT	First A.F. transformer.
AFT1	Second A.F. transformer
J	Two-circuit jack.
J1	Single-circuit filament control jack.
T	R.F. tube.
T1	Detector tube.
T2	A.F. tube.
T3	A.F. Tube.
B	"B" battery of 90 to 112½ volts.
S	Filament switch.
A	"A" battery.

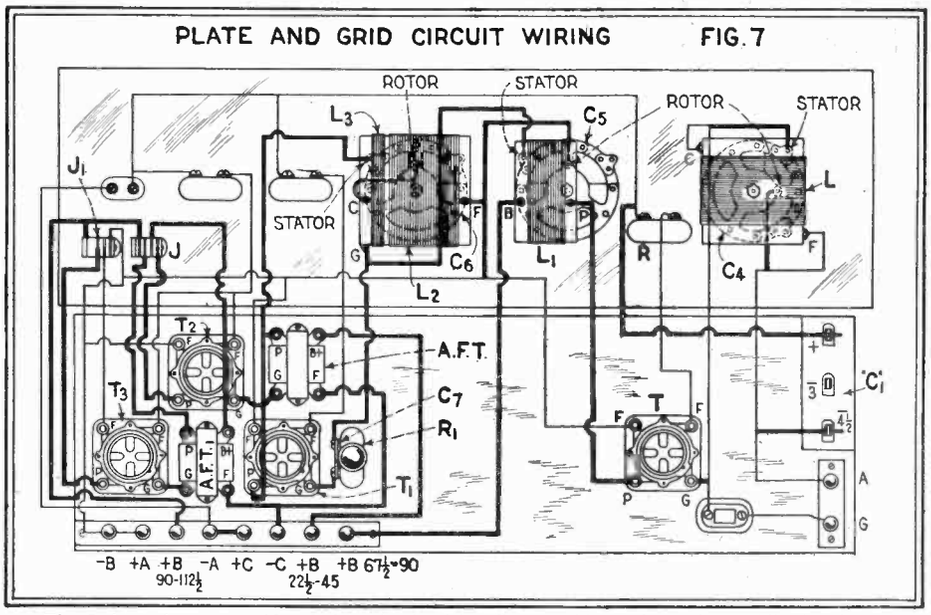


Fig. 7 above shows the grid and plate circuit wiring diagrams in very heavy lines while the filament circuits shown below are included in this drawing in very light lines.

COIL DATA

These coils are exceedingly simple to make, inasmuch as they are all single-layer solenoids, and they are all wound on the same diameter tubing. The tubes are of the diameter shown, and one tube 3⅛ inches long will be required for the antenna coil. Another one 1¾ inches long is used for the R.F. plate coil, and a third one 3¼ inches long is used for the detector grid and plate coils. The tubing may be of any good insulating material. For the antenna coil, 47 turns of No. 20 D.C.C. wire are required, and the ends should be fastened by passing through holes in the tubing and then soldering them to lugs or to small binding posts mounted on the ends of the tube. The same method of construction is used in the other coils and the R.F. plate coil consists of 25 turns of No. 20 D.C.C. wire. On the third and remaining piece of tubing, 45 turns of No. 20 D.C.C. wire are wound, and these constitute the secondary coil. Spaced one-eighth of an inch from this winding is the plate coil, comprising 20 turns of No. 30 D.C.C. wire, wound in the opposite direction to the secondary. This completes the coil-winding data.

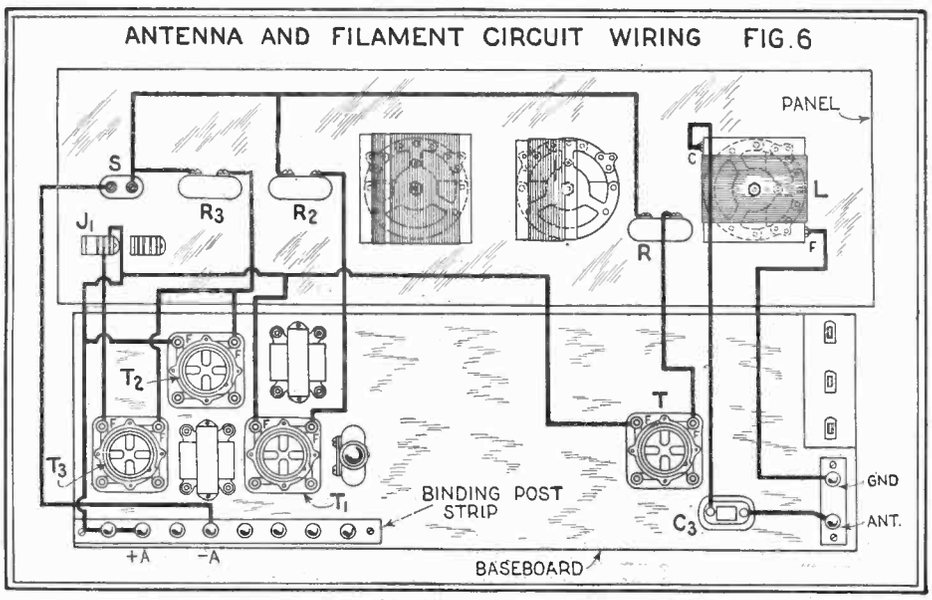


Fig. 6 is the first of the progressive wiring diagrams of this receiver. Here the antenna and ground connections and those wires that hook up the various filament circuits are shown in detail so as to save you trouble when constructing this efficient receiver.

As can be seen in the various drawings, the layout of the set is extremely simple. Anyone should be able to wire up the instruments by following either the schematic circuit shown in Fig. 5, or the progressive diagrams shown in Figs. 6 and 7. A specially-made binding post strip is used with this set and is shown in detail in Fig. 9. This does not include the antenna and ground posts, which are mounted on a small strip placed in the left-hand end of the set. However, it does include all external battery connections. Notice that a separate terminal is used for the positive lead from the "B" battery to the radio frequency amplifying tube. It is quite necessary that this provision be made, as the average tube operating as a radio frequency amplifier requires less voltage for best results, than it would when being used as an audio frequency amplifier. For all general purposes, and considering the use of UV-201A tubes throughout, 22½ volts should be used on the detector, 67½ volts on the radio frequency amplifier, and 90 volts on the audio frequency. Try varia-

(*Continued on following page*)

The Radio Constructor

(*Continued from preceding page*)

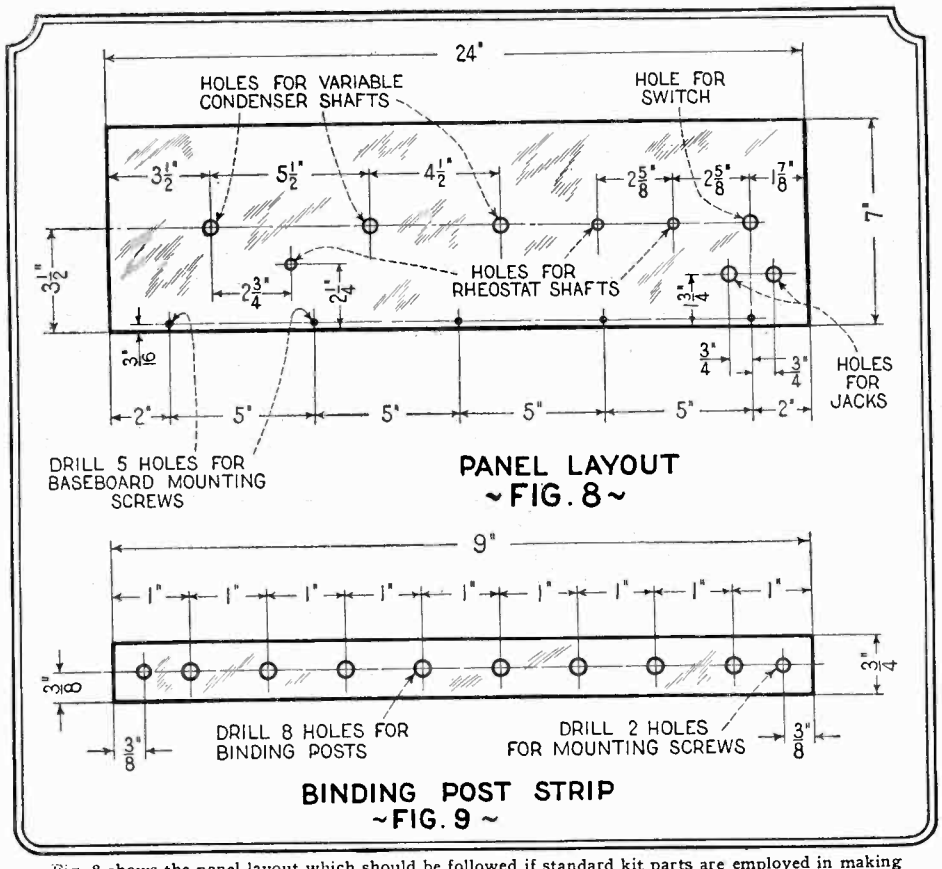


Fig. 8 shows the panel layout which should be followed if standard kit parts are employed in making up the set. This should be done so that the R.F. plate coil and detector grid coil will be correctly placed. Fig. 9 shows special binding post strip.

tions to determine the best voltages for tubes used.

"C" BATTERIES

Note that two 4½-volt "C" batteries are used in this set. One furnishes the grid bias for the A.F. amplifier tubes and is located outside of the set. Two terminals are provided on the binding post strip for the connections to this battery. The other "C" battery is enclosed in the set and can be plainly seen in the photographs. Its key number is C1. It is not always necessary to use this additional "C" battery, but it is wise to try the set both with and without it. In most tubes, it will be found of assistance in stabilizing the set and in rendering the production of received signals better and clearer.

The set that is shown in the various photographs was built from a kit of parts, but the reader should have no trouble whatsoever in making up his own coils and building the completed set from ordinary parts that can be obtained in any radio store. In such an event, it is not advisable to attempt to mount the coils on the backs of the condensers, as shown in the photographs, but, instead, brackets should be made up as shown in Figs. 13A and 13B. By means of these brackets, the coils are mounted on the baseboard. Regardless of what type of coils are used, however, the wiring and other details will apply in all cases.

OSCILLATION CONTROL

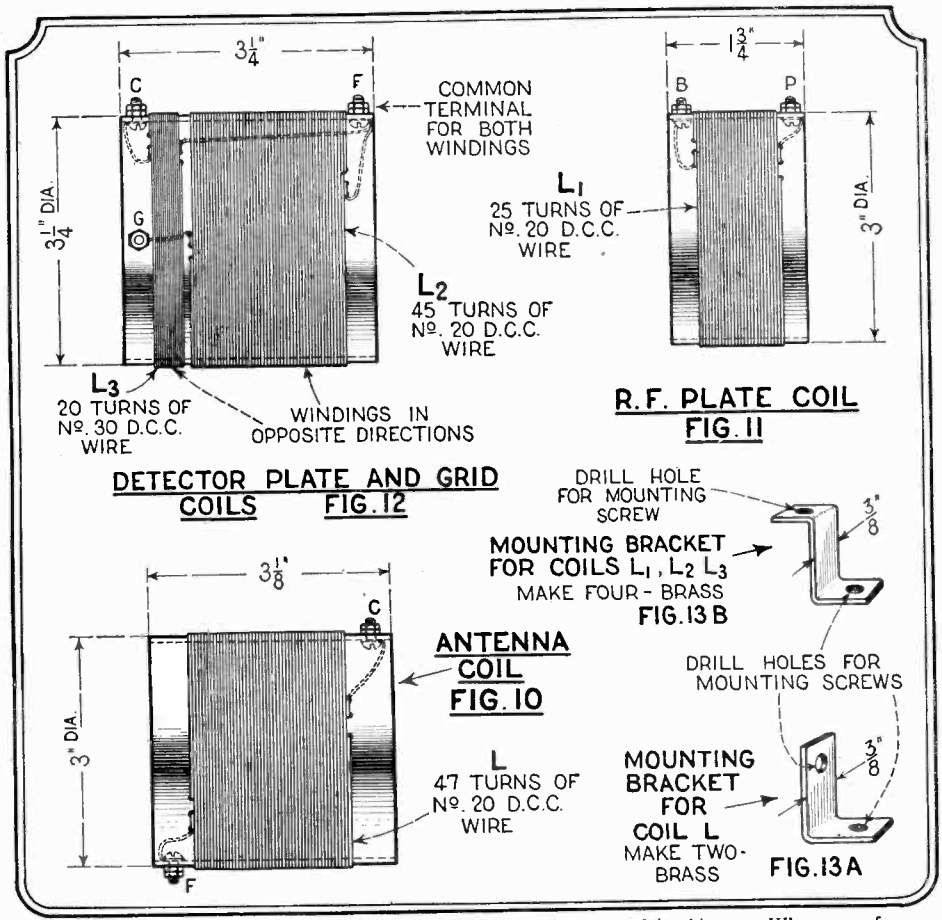
The secret of the oscillation control in the radio frequency stage of this set lies in the extremely loose coupling between the plate coil of the R.F. tube and the grid coil of the detector tube. This coupling must be on the order of two inches, or even more, if the R.F. tube is to be kept out of oscillation. By using this loose coupling, selectivity is increased enormously and no neutralizing method is required to prevent radio frequency oscillations. This system is also applicable to other types of receivers.

The set as shown was assembled on a 24-inch panel with a 23-inch baseboard, but if the reader does not desire to spend a little time and trouble in wiring up the audio frequency part of the set, it is advisable to use a 28-inch panel with a 27-inch baseboard. Much trouble and difficulty in wiring will be avoided if this size is employed, although the 24-inch panel will make a more compact and neater layout if carefully made. In such an event, all the instruments should not be mounted before the wiring is started, but the coils, condensers, rheostats, jacks and filament switch should be mounted on the panel, and the radio frequency amplifying tube socket and the first amplifying transformer should be mounted on the baseboard. Wire up as much of the set as is possible and then place in position the detector tube socket and the grid leak and condenser. Continue with the wiring and then put the first amplifying tube socket, the second transformer and the second audio frequency amplifying tube socket in place successively, wiring as much as possible between each step. In this way, the shortest and neatest leads possible will result. The terminal strip is placed in position last and the wires are connected to it. Place soldering lugs under the binding post bolts.

R.F. CHOKE COIL

Because of the type of regeneration control used in this set, it may be necessary to insert an R.F. choke coil in the plate circuit of the detector. This coil should be placed at the point indicated by X in Fig. 5. It may consist of about 300 turns of No. 28 or 30

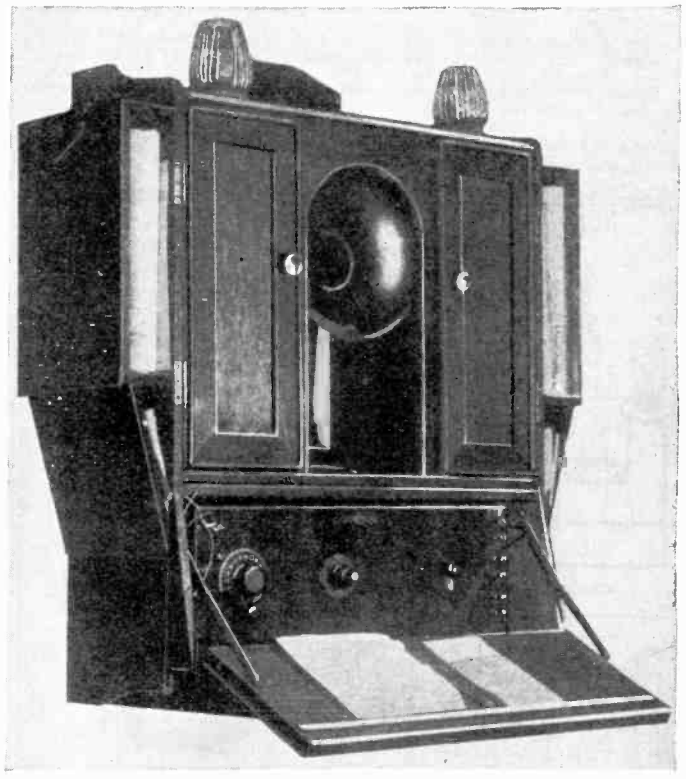
(*Continued on page* 1055)



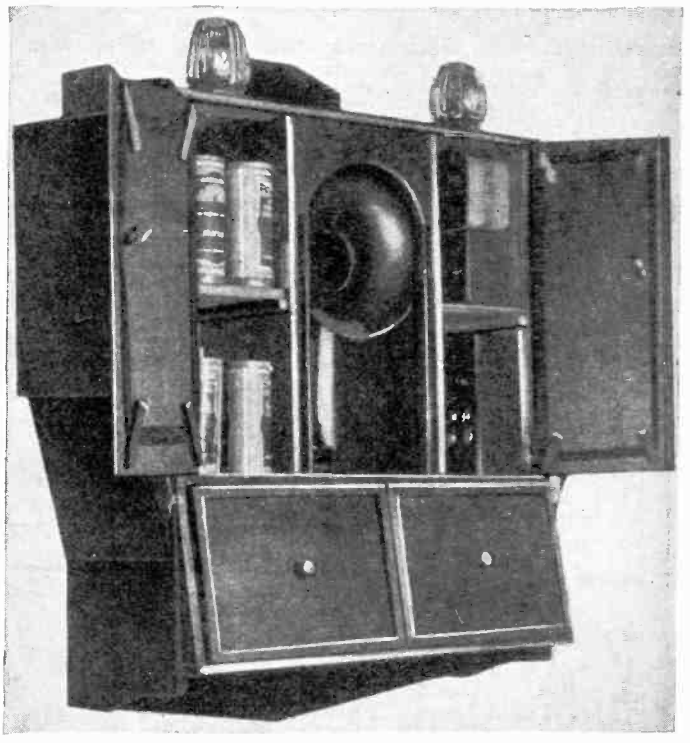
Figs. 10, 11 and 12 show the details of the various inductances used in this set. When manufactured coils are not employed, the home-made ones can be mounted on brackets such as those shown in Figs. 13A and 13B. In this case, wind coils on longer tubes to allow for brackets.

A Different Radio Cabinet

By Dr. ERNEST BADE

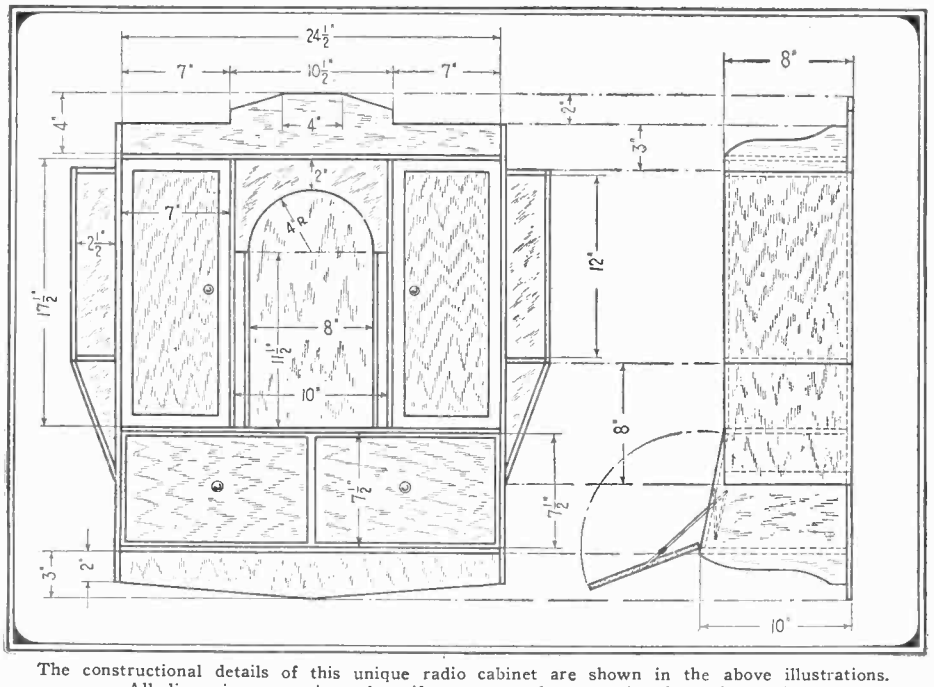


The writing shelf lowered, exposing the front of the radio receiving set. Notice the magazine racks at the sides of the cabinet.



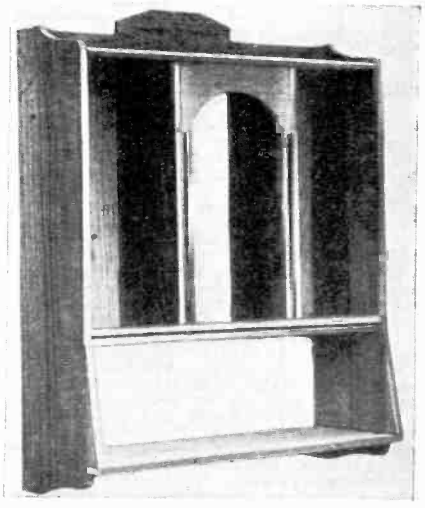
Here the doors are open, disclosing the battery compartments and the loop aerials wound on the doors. The latter are held in place by means of four wooden strips as shown and about sixteen turns on doors of the size shown will be found satisfactory.

WHY must every radio receiving set be placed on the table and thus take up valuable space that could be devoted to other purposes? There is no reason at all why this should be so and, therefore, the writer set out to design something new in the line of a cabinet. The result was the unique arrangement illustrated on this page which takes the form of a hanging Dutch shelf. The entire cabinet is not at all difficult to construct and it houses everything necessary for operation. Two compartments on either side of the center take care of the batteries and, if necessary, of the charger. In the center is the loud speaker and on the extreme ends are racks for magazines and log books. The radio set proper is in the lower section and, when not in use, is covered by a hinged door. When the latter is lowered, it serves as a writing desk.

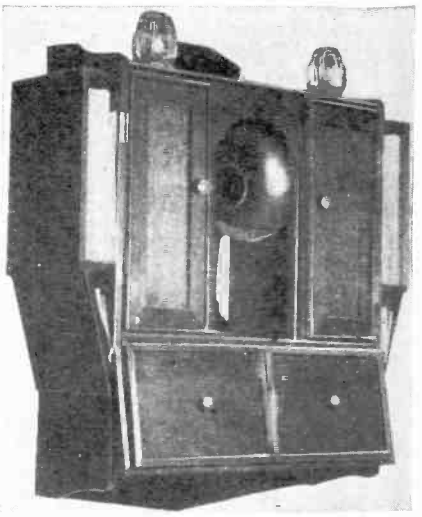


The constructional details of this unique radio cabinet are shown in the above illustrations. All dimensions are given, but, if necessary, they may be changed to suit.

In making this cabinet, any wood that may be at hand can be employed, but it should be smoothly finished and stained with some dark color. The entire assembly can then be varnished or given any treatment that may be desired.



The photo above shows the cabinet partially completed. Complete cabinet below.



RADIO ORACLE

In this Department we publish questions and answers which we feel are of interest to the novice and amateur. Letters addressed to this Department cannot be answered free. A charge of 50c is made for all questions where a personal answer is desired.

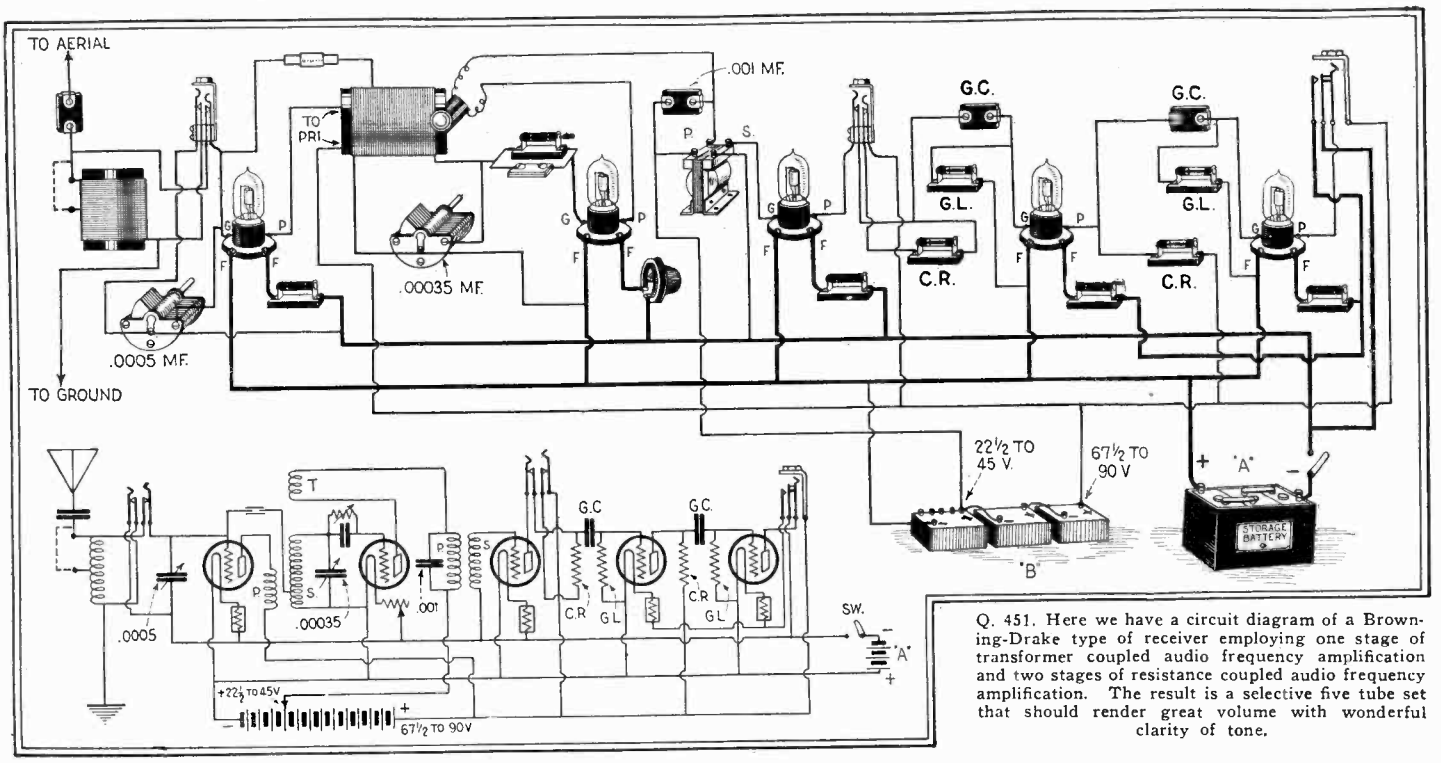
BROWNING-DRAKE WITH AMPLIFIER

(451) Q. 1. J. C. Reeves, Milwaukee, Wis., says that he has built the Browning-Drake receiver described in the September, 1925, issue of this magazine and desires to add one stage of transformer-coupled audio-frequency amplification and two stages using resistance coupling. He asks how this can be accomplished, using a jack between the third and fourth tubes and another jack in the plate circuit of the fifth tube.

A. 1. The circuit in these columns gives all the necessary connections. For the benefit of the rest of our readers, we would advise that specific details on the construction of the tuning coils used in this receiver were given in the September, 1925, issue of SCIENCE AND INVENTION Magazine.

We have simplified this set to as great an extent as possible by using fixed filament control resistances in the filament circuits of the four amplifier tubes. The only rheostat necessary is that in the detector circuit. An ordinary two-circuit jack is used in the plate circuit of the first audio frequency amplifier and a filament control jack, connected in the filament circuits of the last two tubes is employed in the plate circuit of the fifth tube. In this way, it will not be necessary to turn off the filaments of the fourth and fifth tubes when it is desired to use only the first three.

In the circuit diagram, G C indicates grid blocking condensers, C R coupling resistances and G L amplifier grid leaks. All of these are of the standard types used in resistance coupled amplifiers.



Q. 451. Here we have a circuit diagram of a Browning-Drake type of receiver employing one stage of transformer coupled audio frequency amplification and two stages of resistance coupled audio frequency amplification. The result is a selective five tube set that should render great volume with wonderful clarity of tone.

BATTERY CHARGER

(452) Q. 1. Ross L. Douglas, Bellflower, Calif., asks why taps are arranged on the primary coil of the transformer used in connection with a tungar rectifying bulb.

A. 1. In the battery charging transformer that you mention, the taps on the primary are to compensate for line voltage changes. The transformer is designed to operate on ordinary 110 volt 60 cycle line, but since the voltage is slightly different in different locations, taps are taken off the coil.

Q. 2. Do both "A" and "B" batteries give off the same type of current?

A. 2. There is no difference between the type of current given by "B" batteries and that given by "A" batteries.

Q. 3. How can I place an ammeter in my battery charger circuit so as to show the rate of charge?

A. 3. You can connect an ammeter in the circuit of this battery charger in series with one or the other lead to the battery.

BATTERY CHARGER

(453) Q. 1. C. D. Bowie, West Haven, Conn., refers to the battery charger described in the Radio Oracle Department in the March, 1925, issue of this magazine and asks whether the filament winding should be under or over the secondary winding.

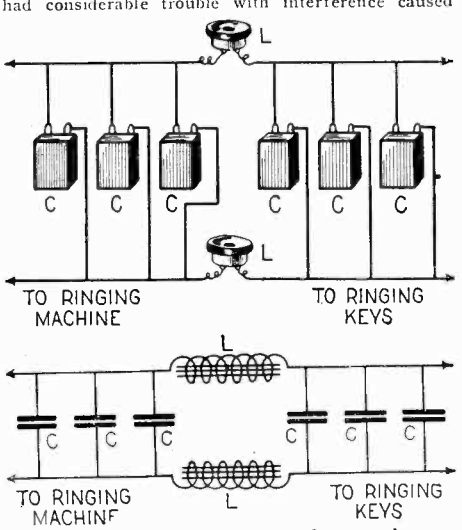
A. 1. In regard to the battery charger you mention, we would advise as follows: The filament winding may be either over or under the secondary winding or placed directly alongside of it. Less wire is used if it is placed under the secondary.

Q. 2. What voltage is supplied to the filament and to the plate by the transformer described for use in connection with this battery charger?

A. 2. The voltage of the filament supply secondary is 2½ and of the plate supply secondary 30. The amperage is 6 for the filament and 5 to 8 for the plate.

FILTERING INTERFERENCE

(454) Q. 1. John Pease, Monmouth, Ore., has had considerable trouble with interference caused by nearby telephone ringing machines and asks us how this trouble can be overcome.



Q. 454. It is often possible to filter out interference caused by telephone ringing machines, using a circuit such as that shown in the above illustration.

A. 1. Usually this can be eliminated to a more or less extent by eliminating sparking at the commutators of the ringing machines. This is accomplished by truing them up. In any event, some interference will be encountered and this can be eliminated by means of a filter. It should be connected in the circuit very close to the terminals of the ringing machine and should consist of six condensers, C, and two choke coils, L. The condensers should each have a capacity of 2 mf., and the two choke coils can be ordinary 75-om telephone receivers. The installation of a system such as this will usually eliminate every vestage of trouble.

LOW-LOSS WINDING

(455) Q. 1. Stanley Tucker, Brooklyn, N. Y., asks: What, in your opinion, is the most effective type of low-loss winding, particularly for short-wave inductance coils?

A. 1. Undoubtedly a spaced solenoid type of winding holds the honors for this type of work. A comparatively large wire, about No. 14 or No. 16, should be used and the space between turns should be at least equal to the thickness of the wire. This type of winding is far superior to any of the so-called basket-weave or spider-web types, particularly for short-wave work. Its disadvantage on the broadcast waves is its bulk.

"B" ELIMINATOR

(456) Q. 1. E. B. Harris, Galveston, Texas, says that he has built a "B" eliminator of the type described in this magazine and that "everything seems to work well with the exception of the transformer which has a hum and when same is connected to second or third stage in set, the hum is so loud that no music can be heard. He asks how this can be remedied.

A. 1. You do not quite make your trouble clear in your letter of recent date. It is quite possible that you have placed your "B" eliminator unit too close to your receiving set. In such a case, the magnetic fields set up by the windings of the transformer would interact with the coils in your receiving set and cause a hum.

If you have constructed your filter circuit consisting of the choke coil and condensers properly, there should be no hum in your receiver at all. Possibly you have not done this and we would advise you to check it over.

The fact that the core of the transformer itself hums somewhat does not have any particular bearing on the actual results. However, be sure to place all of the instruments of the "B" eliminator unit at least four or five feet away from the receiving set proper.

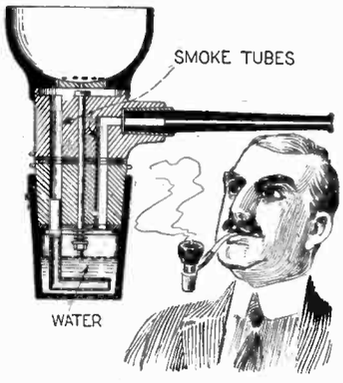
MATCHING CONDENSERS

(457) Q. 1. D. McGurk, Montreal, Canada, desires to match and test some small fixed condensers for use in radio receiving sets and asks how this should be done.

A. 1. It would be very expensive indeed to install apparatus for the matching and testing of various condensers. Unless you have many condensers to test and match, it is not advisable to make this installation. Rather we would advise that you get in touch with some experimental laboratory where this can be done for you at a nominal charge. We will send name and address of such a laboratory upon receipt of stamped addressed envelope.

LATEST PATENTS

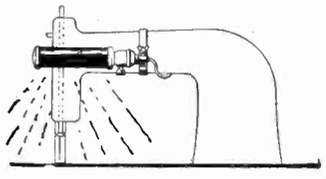
Pipe



No. 1,563,460 issued to William Walker protects a type of pipe that is illustrated above and which might be likened to a combination between a standard tobacco pipe and the hookah of the Turk. The liquid containing reservoir is removable for cleaning and replenishing.

Light

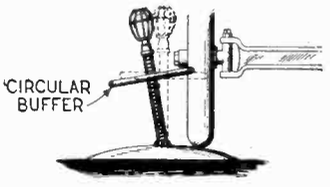
No. 1,555,820 issued to Frank E. Becka describes the portable lamp for use with sewing machines that is



illustrated in this column. The lamp housing is equipped with a clamp so as to be adaptable to any type of machine. The bulb employed is to be of the type necessary for the current that is available.

Traffic Post

No. 1,560,572 issued to Philip R. Hatton covers the type of traffic post and light shown here. It is to be ar-

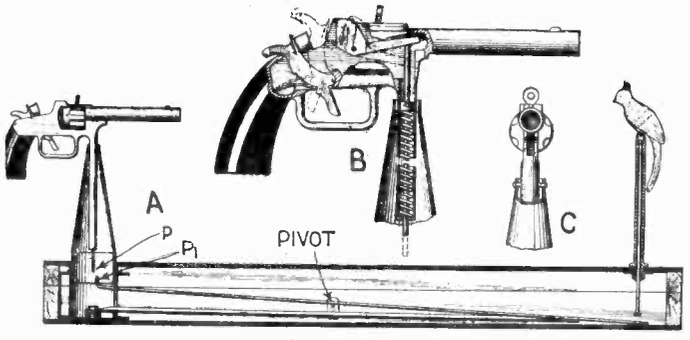


ranged so that current is supplied to the electric light bulb in the housing. When the post is struck accidentally, the upright shaft, being flexible gives way and does not injure the vehicle that hits it.

Powder Brush

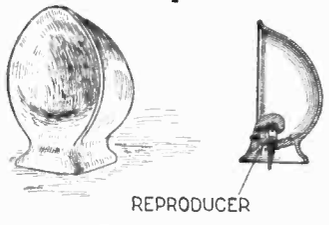
No. 1,506,292 issued to Salvator Corsello covers the so-called magazine powder brush illustrated directly above. It is designed for use in barber shops and is so arranged that as the back of the neck is brushed, powder is applied with the same application.

Mechanical Target Range



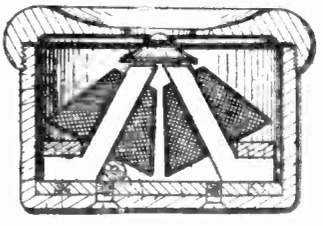
No. 1,546,284 issued to Charles H. Helling describes the mechanical target practice device illustrated directly above. From the drawings A, B and C it can easily be seen how this device functions. The pistol is pivotably arranged so that it can be moved in any direction and when it is properly aimed at the imitation bird shown in A, the points P and P1 are lined up. When the trigger is pulled, point P strikes P1, actuating the lever about its pivot, causing the bird to move.

Loud Speaker



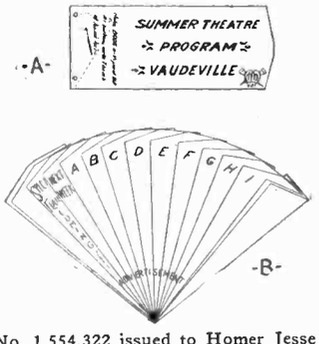
No. 1,560,684 issued to Hugo Gernsback protects a novel and ornamental type of loud speaker horn shown in the above illustration. The reproducing unit is located at the base of a bowl-shaped sound chamber and the result is excellent

Receiver



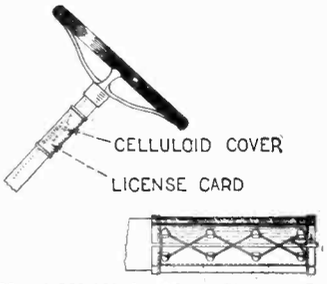
No. 1,546,505 issued to J. H. Muth protects the novel arrangement for the interior of a sound producing device such as that shown above. It is claimed that with this disposition of the integral parts, manufacturing is reduced to the simplest possible form and the receiver is made as efficient as possible. That hysteresis losses are reduced to a minimum is another one of the claims made.

Program



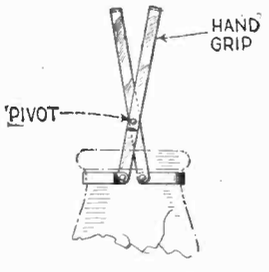
No. 1,554,322 issued to Homer Jesse Banta covers the design of a novel theatre program shown at A above. This can be fanned out to the shape shown at B so that the result can be used as a fan, while the advertising is still visible.

License Holder



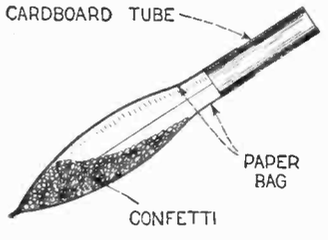
No. 1,563,139 issued to Clarence S. Applas describes the novel holder for an automobile registration card shown above. It consists of a flexible container having a celluloid or other transparent section in which the card is to be placed and which is to be tied to the steering column of an automobile as shown.

Bottle Carrier



No. 1,561,453 issued to Frederick C. Althen protects a very simple yet efficient handle for conveying bottles of the type that are universally used for containing milk. As shown, it consists of a few strips of metal suitably arranged and pivoted so as to accomplish the purpose in the way shown above.

Confetti Gun



No. 1,560,326 issued to Grace G. Rutherford has as its object the protection of the so-called confetti gun or distributor illustrated. By pressing the sides of the paper bag, the confetti is distributed.

NOTICE TO READERS. The above illustrated and described devices have recently been issued patent protection but are not as yet to our knowledge available on the market. We regret to advise that it is impossible to supply the names and addresses of inventors of the above devices to any of our readers. The only records available, and they are at the Patent Office at Washington, D. C., give only the addresses of the inventors at the time of application for a patent. Many months have elapsed since that time, and those records are necessarily inaccurate. Therefore, kindly do not request such information.

—EDITOR.

Scientific Humor

THIS IS A PRONOUN NOT A PROTOWN

MAN IN SPEEDING CAR (to driver): "Say, this is a pretty town, wasn't it?"—*F. J. Wilhelm.*

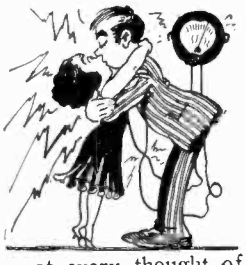
DEPENDS ON THE LIP STICK

SHE: "What's the shape of a kiss?"
HE: "Elliptical!—*George McLaughlin.*

THE LONG AND SHORT OF IT

Boss: "What's Mrs. Flynn complaining about now?"
BUTCHER: "The long wait."
Boss: "That's funny! Yesterday it was the short weight!—*George McLaughlin.*

AN E. E. PROPOSES



"Mazda, darling," he wrote, "be mine. Incandescent one! Watts life without you? Ohm is not ohm without the light of your presence. My heart is a transformer that steps up at every thought of you. I would lay my head alongside your switch; the touch of your hand is like a live wire. Marry me, and let us have a little meter in our home."—*R. W. Hicks.*

ONLY TWELVE MEN UNDERSTAND IT

"Aren't you afraid, Professor, that your theory will be disproved?"
"How can it be, my boy, when no one understands it?"—*J. J. O'Connell.*

GENERATOR PIG TAILS

CUSTOMER (testing out car): "What makes this car squeak so?"
DEALER: "Don't mind that, its just the bearings, they're made of pig iron."—*R. E. Shumaker, Reporter No. 9831.*

NO—HE REMOVES THE HOOD

MCNATT: "Does your gal know much about cars?"
MCNUTT: "Heavens, no, she asks me if I cool the car by stripping the gears."—*Alvin G. Moffatt,* Rep. No. 22620.

ALAS—TOO TRUE

BILL: "I've got a perpetual motion machine."
PHIL: "I'm married, too!"—*Aaron E. Glasser.*

IT ISN'T FRUGAL ANYHOW

PROF.: "Explain centrifugal force."
FROSH: "Anything on a round object which is rotating is thrown out from it."
PROF.: "Can you give an example?"
FROSH: "On a talking machine the notes are thrown out from the record."—*Samuel Steinman.*

A STICKER

FIRST GERMAN WOMAN: "I can always tell when it is going to rain because this door sticks then."
SECOND DITTO: "Yes, and in Washington they have a Bureau which tells.—*Edwin Beal.*

First Prize---$3.00

WELL—SILENCE IS GOLDEN

JASON: "What type of radio is yours?"
MASON: "The Tightwad."
JASON: "Tightwad?"
MASON: "Yes, you can't get a darn thing out of it."—*J. B. Dillon.*

YOU SUBMIT 500 FOR THAT!

PROF. (as punishment for talking): "Now each of you will prepare me a list of fifty kinds of birds for every time you have talked."
STUDENT: "I didn't know there were but two kinds of birds."
PROF.: "Why, what do you mean, what are they?"
STUDENT: "Male and female."—*W. R. Estes.*

WE receive daily from one to two hundred contributions to this department. Of these only one or two are available. We desire to publish only scientific humor and all contributions should be original if possible. Do not copy jokes from old books or other publications as they have little or no chance here. By scientific humor we mean only such jokes as contain something of a scientific nature. Note our prize winners. Write each joke on a separate sheet and sign your name and address to it. Write only on one side of sheet. We cannot return unaccepted jokes. Please do not enclose return postage.

All jokes published here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best joke submitted each month. In the event that two people send in the same joke so as to tie for the prize, then the sum of three dollars in cash will be paid to each one.

MUST MEET EVENTUALLY—ASK EINSTEIN

HE (after a little quarrel): "I think our lips are parallel, don't you?"
SHE: "I don't know. Why?"
HE: "Because they never meet."—*Opie Allred.*

THIS JOKE VERGES ON THE SILICIDE

"*Telluride* like to give her the *nitrate* on this message," said the telegrapher, "but it's not *quinine* o'clock yet, and it's against the rules *ferrous* to do it."—*Forrest K. Green.*

BETTER THAN AQUA REGIA

CHEMISTRY PROF.: "What is the best solvent for gold?"
MARRIED STUDENT: "Matrimony."—*Peter P. Udre.*

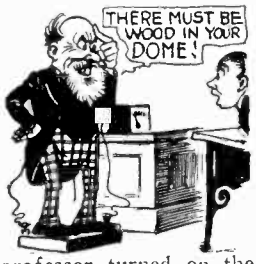
A CREEPY FEELING

JIM: "I love to hear the Professor lecture on chemistry. He brings things home to me that I have never seen before."
JACK: "That's nothing; so does the Student Laundry Agency."—*R. Rowe.*

CAUSE FOR DIVORCE

SWEET YOUNG THING (reading advertisements in SCIENCE AND INVENTION): "Why, the very idea! Look here, Jim, baby detectors are advertised in this magazine. As if any baby needed to be detected."—*M. Louise Boggs.*

A POOR CONDUCTOR



The other day we were performing an experiment to test the resistance of the human body to an electrical current. There was a voltmeter in the circuit and no voltage was recorded on this when the professor turned on the current and placed himself in the circuit.

He turned to ask the class, "Why doesn't the voltmeter register?" (Of course, the resistance of his body was too high.) But one of the bright students loudly answered, "There's no iron in your blood!"—*John F. Larsen.*

DID YOU KNOW THAT—

There is no use in breaking open a vacuum tube to get the plate, because it is too small for table use anyway?

Grid leaks cannot be mended by riveting?

It is much easier to C.Q. above 200 meters but it costs more in court?

A flea was the original oscillator?

Arlington time signals are not sent by means of an Ingersoll?

If you touch the terminals of a rotary gap while operating you will immediately receive a high frequency treatment?

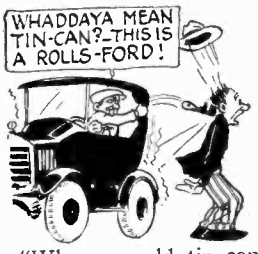
Ninety-nine out of one hundred amateurs in your home town are air hogs—and you're the other one?

Gas cannot be used to light the filaments of vacuum tubes?

If all the Nations in the world went dry, we'd still have damped waves?

Radio frequency has nothing to do with how many times a man listens in or raves about his set?—*Harold F. Pitzer.*

THEN HE SAW RED



BILL: "Well, John, got to paint your car red."
JOHN: "Who said so?"
BILL: "It's the law."
JOHN: (very angry): "What's the new idea now again?"
BILL (smiling): "Why, any old tin can that carries gasoline has to be painted red."—*Jerome Kukla.*

WHY SWALLOWS HOMEWARD FLY

"Where is the home of the swallow?" the teacher asked. A long silence, and then a hand waved.
"You may answer, Robert."
"The home of the swallow," declared Robert, "is in the stummick."—*Elsie Koester.*

THE ORACLE

The "Oracle" is for the sole benefit of all scientific students. Questions will be answered here for the benefit of all but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only 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 addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 50 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.

DISSOLVING WOOL

(2001) Q. 1. R. L. Atwood, New York City, asks: What chemical when applied to cloth will dissolve the wool contained therein and leave the cotton?

A. 1. In regard to your query of recent date, we would advise that a caustic alkali solution, sodium hydroxide or potassium hydroxide will dissolve wool and leave the cotton.

On the other hand, cotton can be dissolved in zinc chloride solution acidified with hydrochloric acid. An ammoniacal solution of copper hydroxide made up as follows will also dissolve cotton. Add ammonia to a copper sulphate solution until the result is a very deep blue color.

SPARK COILS

(2002) Q. 1. Paul Atkins, New Dayton, Alberta, Canada, asks: Why is it that a Ford spark coil has only three terminals, whereas ordinary spark coils have four?

A. 1. In a Ford spark coil, one of the terminals is common to both primary and secondary.

Q. 2. What are the faint blue streaks of light which appear between the secondary terminals of a spark coil when they are a little too far apart to enable the spark to jump?

A. 2. The phenomenon mentioned is that known as a brush discharge and consists of very fine streamers of sparks which are not concentrated or strong enough to cause a solid spark to jump across the gap.

MAGNETIC INSULATOR

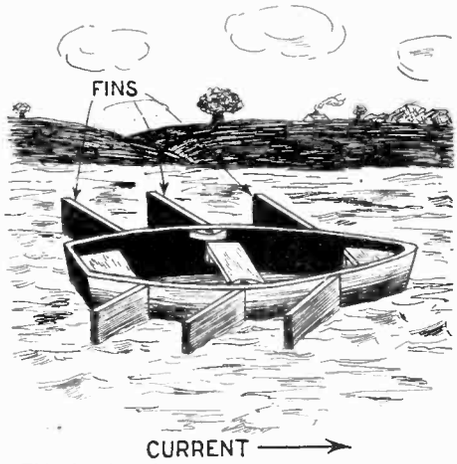
(2003) Q. 1. H. H. Dickson, Montauk, L. I., asks if a magnetic field from a permanent or an electro-magnet can be insulated or counteracted:

A. 1. There is no such thing as a magnetic insulator. One of the best ways to counteract magnetism is by means of another magnetic field of the same strength, but with opposite polarities.

BOAT PROBLEM

(2004) Q. 1. James C. Corn, Detroit, Mich., submits a diagram which is reproduced in these columns and asks our opinion on the following problem:

A boat equipped with fins on the sides as shown is placed in the center of a river but no motive power is used. Another boat of exactly the same



This drawing shows the salient features of the problem discussed in detail in this column.

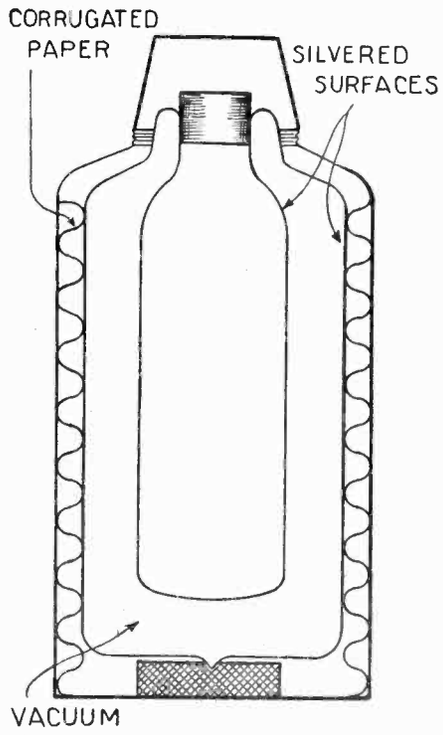
size, shape and other general characteristics, but without fins, is also placed in the current. Will the boat that is equipped with fins attain a greater speed than the other one? No motive power is used in either case.

A. 1. After the boats have been in the river for a short period of time, their speed will be the same regardless of whether or not there are any fins such as you mention. Possibly a boat equipped with fins will attain this maximum speed quicker than one not so equipped, but in any event, when the maximum speed has been reached, that speed will be the same for either type of boat.

THERMOS BOTTLE

(2005) Q. 1. Benjamin L. Cross, Atlanta, Ga., asks: What is the internal construction of a so-called thermos bottle?

A. 1. The drawing in this column will illustrate the principle very well. Inside of a steel



Above we see a cross-sectional view of the thermos bottle. This is described in the text.

or metal container is a thin double walled bottle, the space between the two walls being evacuated to prevent heat losses. This glass bottle is usually protected from mechanical shocks in some way such as that shown. The inner surfaces of the two glass walls are silvered so as to prevent radiation losses. There is available today an unbreakable all-steel vacuum bottle.

RIFLE SILENCER

(2006) Q. 1. William Tell, Eagle Pass, Texas, asks for a general description of the principle upon which a Maxim silencer for rifles operates.

A. 1. In general, the principle underlying the operation of a Maxim silencer such as used for rifles or revolvers is as follows: The device consists of a series of circular plates through the centers of which holes are pierced, large enough to allow the passage of the bullet. There are also other holes pierced through the peripheries of the rings and the plates are so arranged that they impart a whirling motion to the gases. The latter are then retarded in their progress and do not burst from the barrel of the gun with the rapidity that they do when no silencer is used. In other words, after the bullet has reached a certain place in its travel, that is, some point in the silencer itself, the explosive force of the gases is reduced by means of this whirling motion and, therefore, the noise that would otherwise be generated is also reduced.

LEAD-TETRA-ETHYL

(2007) Q. 1. O. L. Murphy, Tujanga, Calif., asks for some chemical details regarding lead-tetra-ethyl.

A. 1. The formula for lead-tetra-ethyl is as follows: $Pb(C_2H_5)_4$. This substance is a liquid having a specific gravity of 1.62 and has a boiling point between 198 and 202° C. It is insoluble in water and very poisonous.

HORSEPOWER-HOUR

(2008) Q. 1. Don C. Edwards, Jr., Lexington, Kentucky, refers to an editorial appearing in RADIO NEWS entitled, "Power by Radio," in which, near the top of the second column, a statement is made as follows:

"In Egypt and out west we now have sun-power motors which deliver quite a good deal of energy per square foot, .67 horsepower per hour to be exact."

Is not horsepower to be defined as the power that does 550 foot pounds of work per second or 33,000 foot pounds of work per minute? If we can accept this definition, your statement would mean .67 horsepower per hour or 22,110 foot pounds of work per minute per hour, which would be rather ambiguous of interpretation. Is the statement as made in the magazine correct?

A. 1. The usual way of expressing such a term as .67 horsepower exerted for a period of an hour would be .67 horsepower-hour or else .67 horsepower for one hour. The word *per* is perhaps a little broader than the use of the word "for," which you find in all engineering text-books, where the definition of one horsepower-hour or one kilowatt-hour are given.

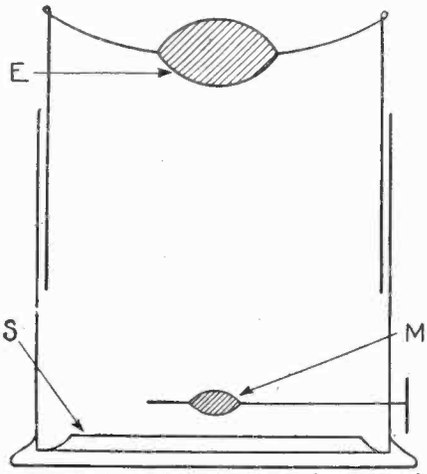
The definition of one horsepower-hour means that one horsepower is exerted for a period of one hour and, of course, .67 H. P. hour is about two-thirds of that power.

Expressed in another way we can consider a one horsepower electric motor which is operated for one hour. In paying for electrical energy used by this motor in an hour you pay for one horsepower-hour or .74 kilowatt hour. If we stop to analyze this situation a little closer, we find, of course, that at the end of one minute 33,000 foot-pounds of energy have been exerted by the motor, generally speaking, and at the end of sixty minutes or one hour, 1,980,000 foot-pound-minutes have been developed by the motor. These figures consider of course 100% efficiency in the motor, but the highest we realize in actual practice is about 90% efficiency for the conversion of electrical into mechanical energy.

SPINTHARISCOPE

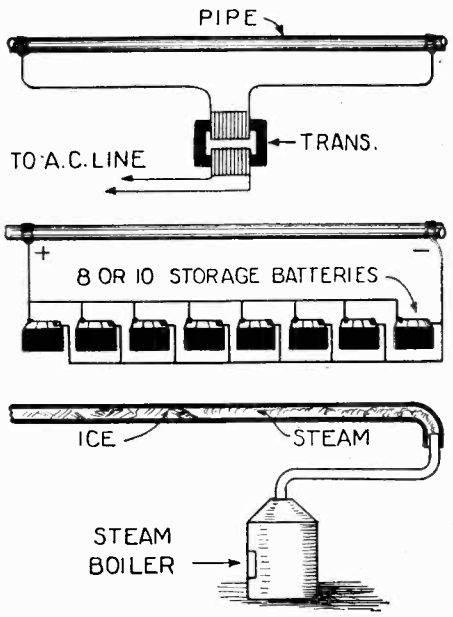
(2009) Q. 1. Raymond Wiley, Newark, N. J., asks: What is a spinthariscone?

A. 1. This is a little device by means of which



A spinthariscope is an instrument by means of which the effect of radium radiations can be seen. It is shown in cross-section above.

the fluorescent effect of radium radiations can be seen in a most striking manner. A simple spinthariscope is illustrated in these columns. E is an eye piece, usually consisting of a glass lens. S is a small sheet of paper coated with zinc sulphide and M is a small strip of metal which has been dipped into a solution of radium bromide and allowed to dry. The radiation from M causes the screen S to scintillate in a very brilliant manner. Usually this entire apparatus is enclosed in two telescoping tubes.



The three methods of thawing out frozen water pipes that are discussed in this column below are shown in detail in the drawing above.

PIPE THAWING

(2010) Q. 1. S. E. Jones, Indianapolis, Ind., asks: Can you give some data regarding practical methods of thawing out frozen water pipes?

A. 1. Our illustrations in these columns show three of the most practical methods of accomplishing this work. Of course, there are others that are applicable to cases where only a few inches of the pipe is frozen, among them being the application of hot cloths or comparatively low temperature flames to the short section of the pipe that is frozen. However, there are safer ways and three of these are shown. The first is to use a heavy duty electric transformer taking current from an A. C. street circuit, delivering a low voltage and a very large amperage from the secondary coil. This current is conducted through the pipe in which the water is frozen and as a consequence, heat is generated in that pipe which serves to melt the ice. The second method also uses electricity but this time eight or more 6 volt storage batteries of the automobile starting type are connected in parallel with heavy copper wire or cables and the output is connected to the pipe in just the same way as with the transformer. The results are identical. The third method is to introduce steam into an open end of the pipe, whereupon it will act on the ice and melt it.

For the benefit of those who desire to use an electrical method and wish to use transformed A. C., the following transformer data is given. The core, as is usual with transformers of this type is built up of thin strips of silicon steel 2 inches wide and .014 inches thick. The outside dimensions of the core are 15 inches long by 8½ inches wide and the legs are built up to a height of 2 inches. The primary consists of 344 turns of No. 10 D.C.C. wire, carefully insulated from the core. Approximately 13½ pounds of this wire will be required. For the secondary, No. 0 D.C.C. wire is employed and 31 turns are necessary. This winding should also be carefully insulated from the core. Copper bars or wires equal in size to No. 0 B & S gauge are employed for connections between the secondary and the pipe.

Use this transformer only when the feed lines are adapted to heavy duty work. Do not leave the current on for a very long time because the intense secondary current used will tend to heat up the coils and core to a temperature that may become dangerous.

In any electrical method of pipe thawing it is desirable to connect the two conductors supplying heavy current at a low voltage to points on either side of the frozen section. In some cases it may be necessary to run heavy copper leads over distances of 25 or 30 feet in order to bridge the frozen section. Often, holes are dug at the curb where the pipe line leaves the mains and goes toward the house and one connection made to the pipe at this point. The other connection is then made somewhere inside the house.

The process is of special interest where a service pipe leading from a water main to a house has become frozen underground. A small hole is dug down to the pipe back or near to the curb for one connection and a wire is led into the house and connected to the pipe within it so as to give a complete circuit. This has over and over again been used with success, avoiding the digging of a large trench. It is used extensively by plumbers.

RAPID CHARGING ELECTROLYTE

(2011) Q. 1. Phillip E. Judd, Minneapolis, Minn., says that he has seen advertisements of various types of electrolyte that are supposed to be capable of completely charging dead storage batteries without any necessity of connecting to a source of electrical power. Furthermore, this material is supposed to reduce or eliminate sulphation of plates and to otherwise rejuvenate the battery. He asks if we have any information relative to solutions of this nature.

A. 1. Various members of the editorial staff of this magazine have tested out different types of so-called "quick charge" electrolytes but with little or no success. When a battery is so far gone that its plates are sulphated to such an extent that it will not take or hold a charge, the only satisfactory method of rejuvenating the battery is to entirely rebuild it.

As to the composition of the electrolytes that are advertised as those capable of recharging and rejuvenating a battery, we would suggest reference to patent No. 1,468,957, a copy of which can be obtained by addressing the Commissioner of Patents at Washington, D. C., enclosing 10c in cash. As put forth in this patent, the composition of the electrolyte which is designed to replace that already in use in the storage battery is one containing dilute sulphuric acid on the order of 80 gallons of water to 20 gallons of sulphuric acid. To this mixture is added approximately 50 pounds of Epsom salts which are thoroughly dissolved by stirring. Then 25 parts of alum, 33 1/3 parts of glycerine and some aniline dye to make the complete mixture look as though it had some unusual properties are added. The patent specification claims that this mixture will eliminate sulphation and prevent further formation of the same. Also that after introducing the mixture into the battery, the battery will, in five to thirty minutes time, be fit for use in an automobile for starting or ignition purposes without further charging. Our tests with similar electrolytes do not show this to be true.

FIRE

(2012) Q. 1. Robert J. Sullivan, Newfoundland, Canada, asks our opinion as to whether or not a fire such as described in his letter could have been caused by defective electrical wiring. Examination of the ruins showed all wires perfectly intact and no signs of short-circuits or overheating, as the insulation was not damaged.

A. 1. If the fire in the particular case that you mention occurred, or rather, started at a point after the wire had passed the fuse box, and the fuses were all OK, and the insulation was intact, we do not see how it would be possible for the electric wiring to have caused the fire. Since you say that you found the wiring perfectly intact, and no signs of short-circuits or overheating, you are perfectly safe in saying that the fire was in all probability not caused by the electric system.

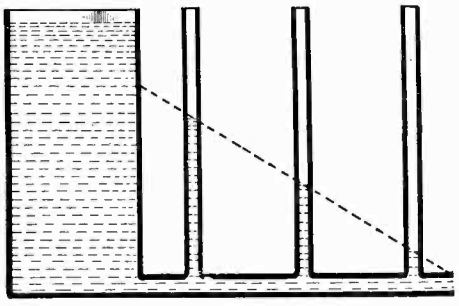
DETECTING GOLD

(2013) Q. 1. C. Anderline, San Francisco, Calif., asks how to distinguish between a solid gold object and one that is merely gold plated or filled without resorting to the well known physics demonstration of the principle of Archimedes.

A. 1. It is very easy to distinguish between a solid gold object and one that is filled. The first thing to do is to file a very small notch in the metal and apply dilute nitric acid to it. If there is an effervescence and a greenish tincture formed, it is safe to say that the metal base is not pure gold.

WATER FRICTION

(2014) Q. 1. James Oliver, San Antonio, Texas, asks if there is friction in water pipes which opposes the flow of water just the same as there is resistance in electrical wires.



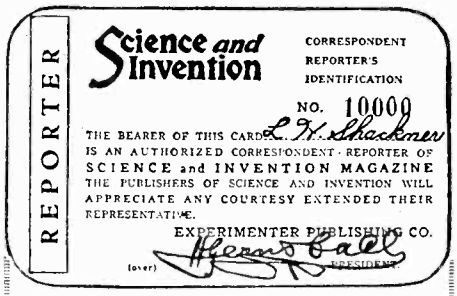
The friction between water and its conducting pipes is quite great as explained here and illustrated directly above.

A. 1. This is quite true and can be readily demonstrated with an apparatus such as that illustrated in these columns. Although water tends to seek its own level, still it cannot do so while the water is flowing as the friction in its conducting pipes will at least, to some extent, overcome this tendency. As shown in the diagram, the friction between the large stand pipe and the first upright tube is great enough to cause a fall of pressure in the first tube equal to the amount illustrated. If the friction in the pipes is uniform throughout, the pressure will decrease uniformly and the water in the various successive pipes will reach to uniformly decreasing heights. This will continue until such a time that the pressure at the end of the pipe is equal to atmospheric pressure.

FACIAL MAKE-UP

(2015) Q. 1. Frank Bohnert, Hanover, Ont., Canada, says that he has heard that in various stage performances, an actor, while facing the audience, causes his eyes to change to different colors and also changed the color of his nose and chin. He asks how this weird spectacle might be accomplished.

A. 1. It would seem from the brief description that you gave us that there is a slight possibility of concealing very small electric bulbs under make-up wax on various parts of the face. This would, of course, lead to a very grotesque appearance and is the only possible manner in which we see that the results can be accomplished. We do not see how it would be possible to change the color of the eyes while looking at the audience. Those effects might, however, be obtained by using certain qualities of grease paint around the eyes which would appear to change color when different colored spotlights were thrown upon the actor.



IN ORDER to present to the public the very latest scientific details, SCIENCE AND INVENTION maintains a large staff of field reporters. Any one of our readers is eligible to join this staff and, upon request, a reporter's card will be forwarded, together with complete instructions for gathering material. The reporter's card is illustrated above, and its use will gain admittance to many places that would otherwise be closed to the ordinary person. You need not have any special ability to obtain one of these cards other than a desire to help others to gain knowledge.

Address Field Editor, SCIENCE AND INVENTION.

Submitted manuscripts cannot be returned unless accompanied by postage.

FLOATING WEIGHTS

(2016) Q. 1. Harrison Deckert, Indianapolis, Ind., says that, in the course of some experimental work that he is conducting, he has attempted to make hollow iron balls float by placing liquids in the air-tight interiors. He has not been able to accomplish this work and asks our assistance.

A. 1. The answer to your question will depend entirely upon the size of the ball in comparison with its weight. If it, in an empty condition, will sink, there is no way in which you can add a material to it so as to cause it to float. It may be, however, that if the ball is of such a size in comparison to its weight that it barely sinks, that by filling it with hydrogen or helium gas in place of air, or evacuating it, it might be made to float. Any liquid which you would place within the ball would only cause it to sink further. With the exception of the above, there is no way of obtaining the results you desire. A vacuum would be best of all.

WIND GENERATORS

(2017) Q. 1. Paul E. Vaughn, Waynesboro, Pa., asks if it would be a feasible and practical idea to build wind-driven electrical generators.

A. 1. This is entirely practical, and several types of similar machines have been described in various past issues of this periodical. They are in use on farms all over the land.

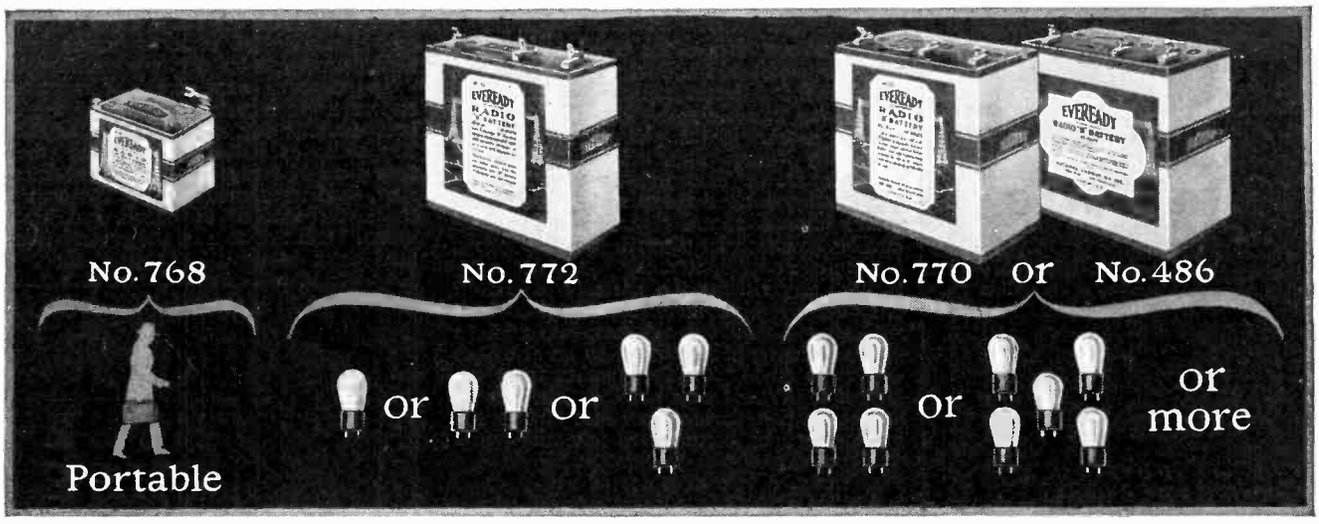
RELATIVE SPEED OF TRAVEL

(2018) Q. 1. D. M. Gritz, Adams, Mass., asks two questions which involve relative speeds of travel between different objects and which questions can be readily construed from the answers given below:

A. 1. If two ships are traveling at a speed of 2,000 feet per second in the same direction, and a gun is fired from the bow of the rearmost one toward the foremost one, which projectile has a speed of 2,000 feet per second, theoretically, the projectile will reach the foremost ship in exactly one second. Of course, this disregards air friction, which may be very easily seen, because the two ships may be regarded as standing still, due to the fact that they are keeping a constant position in relation to each other. Therefore, the shell will travel at the same relative speed forward as if fired from a stationary gun.

If a person stands upon the floor of a boxcar, said car going at a speed of 2,000 feet per second, and he jumps into the air to a height of about three feet, he will come down at approximately the same spot as he jumped from, due to the fact that his motion is equal to the speed of the train. Of course, this is neglecting air resistance, for if he stands upon an open flatcar, there will be so much air resistance going at a speed of 2,000 feet per second, that he will no doubt be blown back and will land on a spot slightly to the rear of that from which he jumped.

Perhaps you, too, can cut your "B" battery costs in half. Just follow the chart. It gives you the secret of "B" battery economy.



THOUSANDS of people have made the discovery that Eveready "B" Batteries, when used in the proper size and with a "C" battery*, are the most economical, reliable and satisfactory source of radio current.

On sets of one to three tubes, Eveready "B" Battery No. 772, used with a "C" battery, will last a year or longer, usually longer. On sets of four and five tubes either of the larger Heavy Duty Eveready Batteries No. 770 or No. 486, used with a "C" battery*, will last eight months or more.

These figures are based on the average use of receivers, which a country-wide survey has shown to be two hours daily throughout the year. If you listen longer, of course, your batteries will have a somewhat shorter life, and if you listen less, they will last just that much longer.

Here is the secret of "B" battery satisfaction and economy:

With sets of from 1 to 3 tubes, use Eveready No. 772.

With sets of 4 or more tubes, use either of the Heavy Duty Batteries, No. 770, or the even longer-lived Eveready Layerbilt No. 486.

Use a "C" battery on all but single tube sets.

Eveready give you their remarkable service to the full when they are correctly matched in capacity to the demands made upon them by your receiver. It is wasteful to buy batteries that are too small. Follow the chart.

In addition to the batteries illustrated, which fit practically all of the receivers in use, we also make a number of other types for special purposes. There is an Eveready Radio Battery for every radio use. To learn more about the entire Eveready line, write for the booklet, "Choosing and Using the Right Radio Batteries," which we will be glad to send you on request. This booklet also tells about the proper battery equipment for use with the new power tubes. There is an Eveready dealer nearby.

Manufactured and guaranteed by
NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

EVEREADY
Radio Batteries
-they last longer

*NOTE: In addition to the increased life which an Eveready "C" Battery gives to your "B" batteries, it will add a quality of reception unobtainable without it.

Tuesday night means Eveready Hour —9 P. M., Eastern Standard Time, through the following stations:

WEAF–*New York*
WJAR–*Providence*
WEEI–*Boston*
WTAG–*Worcester*
WFI–*Philadelphia*
WGR–*Buffalo*
WCAE–*Pittsburgh*
WSAI–*Cincinnati*
WEAR–*Cleveland*
WWJ–*Detroit*
WGN–*Chicago*
WOC–*Davenport*
WCCO {*Minneapolis* / *St. Paul*}
KSD–*St. Louis*
KGO–*San Francisco, 8 P. M. Pacific Coast Time*

Behind the Scenes in Hollywood

By CAPT. FRANK G. KERK

(*Continued from page* 996)

haps, an hour later. When the camera starts grinding again just as the train dashes over the crossing, it appears that the automobile had just escaped being wrecked.

If the action has not been gauged close enough, the defect can be remedied in the cutting room afterward with a pair of scissors. The surplus frames of pictures are cut out to the point where the automobile has just passed over the tracks, and the train has reached the crossing, so that the close decision is obtained, to the great thrill and satisfaction of all movie audiences.

JUMPING FROM GROUND TO ROOF

Discussions have often taken place as to whether Douglas Fairbanks actually enacts all the flying leaps supposedly to second stories, up into the trees, etc., that are seen on the screen in his pictures. It can be truthfully stated that, wherever humanly possible, Doug. does put the thrill in his pictures by going through many hairbreadth stunts himself where others would employ doubles to enact for them in the long shots. On the other hand, it really is not necessary to take any risk as the same thrill can be put over by what is termed "stop-camera" methods. Take, for an example, a scene where Doug. is being chased by an army, he decides to elude them by jumping from the ground to the roof of a building. The camera is in operation during the chase and to the point where he crouches to take the jump. The camera stops at the crouch. Following this, Doug. climbs a ladder of the building and takes a position on that portion of the roof, upon which he would have landed had he actually made the jump. So standing, running or falling, or whatever position desired at this point, the camera again starts to grind on the chase until ready to make another leap to a higher point, where the same camera action is enacted. When seen on the screen, the jump through the air to the roof is entirely optical, and is aided by the fast action from the time of Doug.'s stooped position, ready for the spring, and the chase immediately taking place on the next higher roof.

ANOTHER JUMP FROM GROUND TO ROOF

Another method that would give practically the same results would be to take the action in reverse, or, in other words, in place of jumping from the ground to roof, to have Doug. drop from the roof to the ground and hold a natural position of the body, while the camera is being run backward, or in reverse. When this negative is developed and a positive print made, it also would show Fairbanks actually jumping from the ground to the roof.

DANCING CHICKEN OR TURKEY

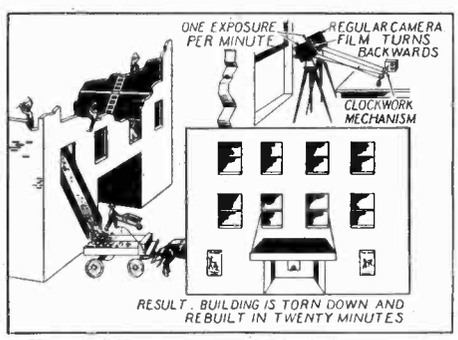
In Farmyard Comedies you have seen chickens or turkeys dancing around as though to music, or on a spree.

Here's how it's done: A strip of sheet-iron resembling a pancake griddle is set up before the camera. Upon the sheetiron is placed the chicken or turkey in a standing position. Heat under the iron sheet is turned on and in a few moments one foot lifts, then the other, until you see a succession of movements as the heat becomes more intense. Care is taken to see that their feet are not burned by adjustment of soft pads underneath.

TEARING DOWN A BUILDING AND REBUILDING IT IN 20 MINUTES

When it was announced that the old Star Theatre was to be torn down, the Biograph Company rented an office across the street and mounted two cameras in the window, which were run by clockwork mechanism.

The cameras were arranged to make one exposure per minute each, during the eight-hour working day, and were stopped at night. The action of the cameras started when the first piece of tar paper was ripped from the roof, and continued their exposures until the last shovelfull of debris had been removed from the hole in the ground that was used as a basement. It took about three



How buildings are apparently built and torn down in 20 minutes—in the movies.

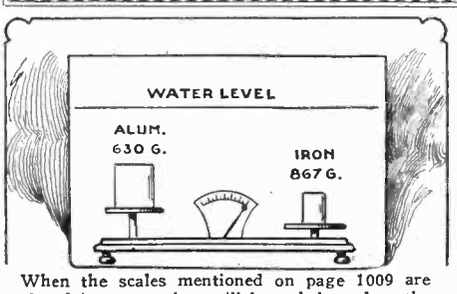
weeks to complete the job, during which time the cameras clicked about eight thousand times each. This amount of film goes through the projecting machines in less than ten minutes, so that when shown to the public it was running at 960 times natural speed.

When the negatives from both cameras were developed and positive prints made and then projected on the screen, the print taken from the camera set up in normal position, the public saw the theatre torn down and carted away in ten minutes. With the positive print taken from the reverse-action camera (turns backward), when projected on the screen, the building was rebuilt in ten minutes. It seemed almost uncanny to watch a wagon back up to the curb, the materials fly up through the air into a wheelbarrow, to be backed away by a laborer and to fly into the wall as solid masonry. There were 500 feet of film used in each camera.

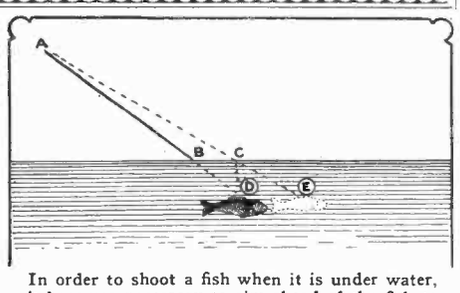
What took three weeks to photograph, the public perceived enacted on the screen in 20 minutes.

Answers to Problems of Physics

(*Given on page* 1009)



When the scales mentioned on page 1009 are placed in water, they will be unbalanced to the extent shown in the diagram above and explained on the page mentioned.



In order to shoot a fish when it is under water, it becomes necessary to aim ahead of the fish to the point E shown in the diagram. See explanation on page 1009.

Patent Advice

Edited By
A. P. PECK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain patent phases. Regular inquiries addressed to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are published 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.

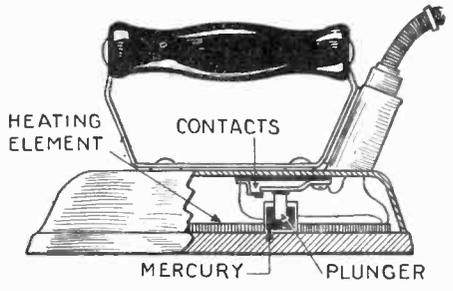
Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTE:—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

ELECTRIC IRON CUT-OFF

(923) Q. 1. W. W. Holland, New Kensington, Penn., submits a design for a proposed type of electric pressing iron cut-off which design is shown in these columns and asks our opinion upon it. It is so designed that when the iron becomes heated to a greater degree than is necessary for pressing purposes, a column of mercury will expand and break the circuit. The iron will then cool until the temperature is such that the mercury contracts and again the circuit is closed.

A. 1. We would not advise you to proceed further with your particular type of automatic shut-off for electric irons. Several of the large companies who manufacture irons of this nature hold quite broad basic patents covering shut-offs. Many of them are much simpler than the one that you have designed and operate upon principles that are more nearly mechanically perfect. Various types of quick acting thermostats are far superior to any mercury device of the type you have designed. Considering these facts, we would not advise you to proceed further.



A proposed type of electric flat iron cut-off that is not at all new or worthy of application for a patent.

SWIMMING GLOVES

(924) Q. 1. Joseph C. Horn, Schofield, Hawaii, has designed gloves to be used by swimmers, the fingers of which are connected together by means of web-like pieces. The glove is to assist swimmers by enabling them to act upon a greater quantity of water with their hands, and therefore, propel themselves forward in a faster manner. He asks our opinion.

A. 1. In regard to the value of the device, we would advise in the first place that the idea is comparatively old. Similar swimming gloves have been designed and described in publications heretofore, but have never attained great popularity. There is a possibility, however, if you will manufacture your device cheaply and advertise it extensively that you will be able to make somewhat of a financial success of the idea.

CLEAN-OUT BOX

(925) Q. 1. Joseph D. Bindrup, Logan, Utah, has designed an insert to be placed within the ordinary curb boxes such as are used for the shut-off valves of gas and water supplies, the inserted device to be removed to clean out the curb box. He asks our opinion on this clean-out system.

A. 1. We do not really see just what advantage your removable clean-out box possesses over an ordinary cover for a device of this nature such as is in wide use today. These covers, if properly attached and bolted in position, completely protect the curb box from collecting dirt which would render the operation of the valve impossible until cleaned out. It would seem to us that your particular device would be more expensive to install than the ordinary covers and would not serve any other purpose than these covers.

CHEMICAL ERASER

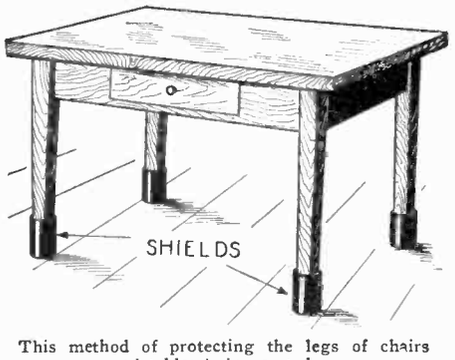
(926) Q. 1. Edward J. Wilkinson, Brooklyn, N. Y., proposes that a small receptacle containing a fluid capable of erasing typewriter ink be hung just above a typewriter and a flexible hose fitted with a pad of felt at the end be used for applying the liquid erasing material to any mistakes that happen to be made on the page. He asks our opinion on it.

A. 1. Your particular idea for erasing is very old indeed. Similar devices have been proposed many times in the past, but have not been found to be entirely practical. The use of chemical erasers is not to be desired, particularly in the way that you suggest. In any case, abrasive erasers have been found to give satisfaction fully equal to the liquid types for this work. We would therefore not advise you to proceed further with your idea.

DESK AND CHAIR PROTECTORS

(927) Q. 1. Marlow G. Augustine, Buffalo, New York, has invented a small metallic shield for use on the legs of desks or chairs to protect its legs from damage due to other furniture being pushed against them or from any other source. His design is reproduced in these columns and he desires our opinion upon the patentability of the device.

A. 1. Your proposed protective device for the legs of desks and chairs is rather old indeed. In fact, a good many desk manufacturing companies equip the legs of their furniture with metal protective shields that accomplish exactly the same purpose as your proposed device and furthermore, are a permanent part of the article of furniture. We are very much of the opinion that you would encounter difficulty in obtaining a patent upon this device and, therefore, would not advise you to proceed further with the same.



This method of protecting the legs of chairs and tables is in use today.

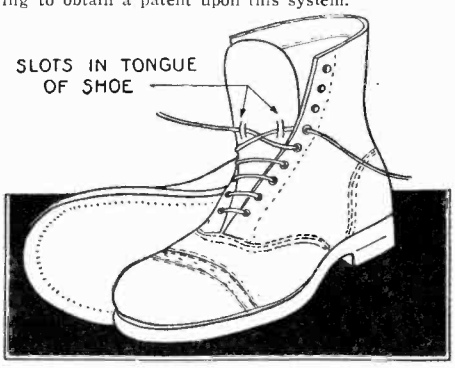
(*Continued on page* 1042)

Patent Advice
(*Continued from page* 1040)

SHOE LACING

(928) Q. 1. Emanuel C. White, Welland, Ont., Canada, has designed a new type of shoe lacing system wherein the lace is to pass through slots cut in the shot tongue, as shown in the illustration in these columns. He asks our opinion upon it.

A. 1. There are several drawbacks that become immediately noticeable when considering your proposed system. The greatest one of all is that by using slots cut in the tongue as you have described, the purpose of the tongue is immediately defeated. It is placed in the position that it occupies so as to protect the foot from the laces and if we have to thread the laces through the tongue as described, they immediately come in contact with the stocking and would tend to wear through rapidly and also to cause unpleasant pressure on the foot. We would certainly not advise attempting to obtain a patent upon this system.



A proposed type of shoe-lacing method that is not to be desired.

A PLAIN TALK ON PATENTS

"Patent Pending"—a Safeguard or a Menace?

By F. G. FOSTER

"PATENT Pending," "Patent Applied For"—what do those terms mean to you, Mr. Inventor? Do you consider them a charm? Has your patent attorney assured you that these words have a great "moral effect" on your ambitious competitor? Has he suggested that they are a "Keep Off the Grass" sign which causes other manufacturers to stand back in fear and trembling and hesitate to copy an article so marked?

If he has told you this, you can pardon him for a slight exaggeration. They have a decided moral effect on the guileless and unwary rival who knows nothing of patent procedure. As to the patent-wise and unscrupulous competitor, who is a potential infringer of your patent rights, such markings may, and very often do, prove boomerangs.

The words "Patent Pending" or "Patent Applied For" on an article which you are making give you absolutely no legal rights. They do, however, inform your dishonest or it may be your broad-minded rival that you have an application pending in the Patent Office. Whereupon he promptly files an application himself and ties your application up in an interference proceeding. Having done this he proceeds to calmly copy your invention, possibly to undersell you, knowing full well that you cannot have your patent issued to stop him until the interference has been adjudicated. You may consult any attorney as to many and varied methods best suited to the delay of such adjudication.

In case your invention is a novelty or a passing fad, it is safe to say that the market will have been glutted, or the fad have become passé long before your patent issues—always providing that you win the interference. And what redress have you against the competitor who caused the delay? None, unless you try to send him to jail for taking a false oath. Needless to state, the penitentiaries are not overcrowded with this class of criminals. The proof of guilt is too difficult.

"Patent Pending" or "Patent Applied For" are not marks which are prescribed or authorized by the Patent Office. There is no penalty for falsely so labeling an article. The only penalty seems to be for the legitimate use of the marks as witnessed by the situation outlined above. It is by no means an imaginary situation. It occurs every day.

No man infringes your patent until you have one. The whole world is free to make use and sell exact duplicates of articles marked "Patent Pending," and they are not accountable to the inventor for any articles sold prior to the time that the patent actually issues. The marks amount to mere bluff and should be used with discretion if at all.

If you are only a little fellow, take out your patent first, and market your article afterwards, with a notice of patent thereon. If the invention is a novelty which won't keep, file an application and then flood the market with the device. Use no "Patent Applied For" mark. These words "Patent Pending" might frighten your competitor. So would an unloaded gun. For hunting big game we suggest a few ball cartridges.

When Nations Listen In

By CHARLES D. ISAACSON

(*Continued from page* 1027)

Shrew"; and the Richman dance orchestra—jazz and Shakespeare following each other. Radio is a faithful reflector of life.

It will be a long time before we forget the night Belle Bennett came to WRNY. She brought with her Vera Gordon, who was the mother in "Humoresque"; and told how this fine interpreter of Jewish character had helped her when she (Miss Bennett) was in distress. Then Miss Gordon paid a sincere and generous compliment to the younger woman. But the thing which followed was the dramatic sensation.

I asked Miss Bennett to try to put into words her climax scene in "Stella Dallas." She never tried it; but, suddenly, the inspiration came to her. She was the Irish woman who comes to the woman of her husband's choice, offering to divorce him that the lovers may have each other. She was the dignified, but kindly, rival; she was again asking her rival to take not only her husband, Stephen Dallas, but her own daughter, whom she loved, that the girl might be free to wed, and not tied down by such a mother as Stella. The listeners were in tears; and I doubt that anything more beautiful has ever been broadcast.

WOMEN'S CLUB ACTIVITIES

Turning to entirely different activities, I wish to say just one word of the club women's hour. Mrs. Edgar Cecil Melledge has done splendid work, and those who listen in on these events will hear the foremost women in every field of life.

Again the meeting place. The Bowery, Chinatown, fashionable Riverside Drive and Park Avenue, the Battery, Yorkville—all have been aswering to their names in the roll call of WRNY's "Side Walks of New York," and all are getting better acquainted with one another.

Once more of the theatre. Stars of "The Enemy," "The Vortex," Channing Pollock, the playwright himself, and those whom I mentioned above, have all been with WRNY's big Broadway Revels.

And such novelties! Did you come backstage with us at "Twelve Miles Out" and hear the creaking of the boat, and the orders of the stage hands—or, on another night, were you with us backstage at "Earl Carroll's Vanities," where so many of the prettiest girls were? Or were you aboard when a phantom ship sailed out of a phantom port, and able-seamen enacted a sailing vessel leaving port, entering a storm and finding calm again?

Or when Homer Croy, Will Irwin, Joseph Auslander, Inez Hayes Irwin and Dorothy Scarborough held the WRNY Literary Round Table discussion? Every newspaper, it seemed, had a big story about it.

Of course, the popular music goes merrily on; and you can be sure of grand opera and concert numbers almost any time you tune in on WRNY.

I'll see you again next month.

Tarrano the Conqueror

By RAY CUMMINGS

(*Continued from page* 1007)

Another girl was plucking at me from behind. Alda shouted: "You shall not have him!" and cast me off. But I heard her whisper, *"Come outside for a moment—then come back!"*—and then, aloud, she cried to the other girl, "You shall not have him! He is coming to watch me dive and swim! I am more beautiful than you—you could not win him from me!"

I let them drag me out into the grove by the scented pool.

CHAPTER XXII
REVOLUTION!

I realize that I am, by nature, not overly observant; and in those moments, when I stood out there beside the pool, I think I came most forcibly to appreciate how little I habitually observe that which is not readily apparent. An incident now occurred to bring it home to me; and, quite suddenly, a score of things which I had seen during the past two hours at the festival were made plain.

Music, feasting, merry-making, love! In the midst of it all, an undercurrent of events was flowing. Unseen events—but I had partly seen some of them, and now, at last, I began to understand.

In the main hall of the pavilion, midway to its roof, a line of mirrors was placed along the wall facing Tarrano. A hundred small mirrors, side by side. On them were moving images of what was taking place in different parts of the festival—so that Tarrano and the others might see the merry-making, not only in the pavilion, but elsewhere, as well. It was interesting to watch the mirrors—and sometimes amusing. The scene of a gay battle of boats in a nearby lagoon; the diving girls in the pools; a view from the sky above of the whole scene; another, looking upward at the color bombs bursting overhead; a bridge on which a dozen girls were besieged by as many men, who sought to climb upward from their boats underneath, flowers for missiles, and the alcholite fumes which held off the attackers, or, perchance, caused a girl to fall into the water, to be instantly captured.

Other mirrors, eavesdropping upon the secluded islands, making public, for the amusement of the spectators in the pavilion, the furtive love-making of couples who fancied themselves alone.

All this I had seen. And now I remembered that, occasionally, a mirror had gone dark, and then turned suddenly to a scene somewhere else. I understood now. Quiet incidents against Tarrano were in progress. The mirrors were being tampered with, that none of these events should be shown.

There were, scattered throughout the festival, fully a hundred men of Tarrano's guard. Some of them I knew by their uniforms; others were concealed by red masks and

March Issue of "Radio News"

WRNY Broadcasts Christmas Greetings from Germany. By Stanley McClatchie.

This article relates the manner in which the station of "Radio News" broadcast by an entirely new method Christmas greetings from the heads of the German government.

$1000 Prize Contest. "What Type of Radio Set Does America Want?"

How Radio Tubes are Evacuated.
By Dr. Charles B. Bazzoni.

Controlling Power and Motion by Radio.
By A. K. Laing.

An Automatic Double Range Receiver.
By Sylvan Harris.

A Piezo-Electric Loud Speaker.
By R. F. Shropshire.

Awards of $375 Prize Radio Play Contest

robes like myself. When first we entered the pavilion, some twenty or thirty of them had been there with us. But many of them did not stay; and now I remembered that, one by one, I had seen them slip away, lured by the slim, white shapes of girls who came from the pool to beguile them.

I realized now that these girls of the scented pool were very possibly all working for Maida. Most daring of all at the festival, these fifty girls who now disported themselves in the water at my feet. All beautiful, none beyong the first flush of earliest maturity. Slight, grey-white nymphs, laughing as they discarded their hampering veils, tossing their white hair as they plunged into the shimmering pool. Seemingly the most seductive, most abandoned of everyone.

Yet, as I stood there, I saw three of them climb from the water and, with gay shouts, rush into the pavilion. Back in a moment; and with them a flushed man—one of Tarrano's guards—flushed and flattered at their attention. His hat was gone, his robe disheveled, as the girls fought for him. They stopped quite close to me; and I saw that one of them was Alda.

"You shall not have him!" she shouted to her companions. "He is mine! He loves me—none of you!"

From her thick hair I saw her draw a tiny cylinder, wave it in the man's face. And, with another laugh, she flung her arms around his neck and fell with him into the water. I watched the splash and the ripples where they went down. In a moment, the girl came up—*but the man did not*. In all the confusion of the crowded pool, it was not very obvious. But with bated breath I watched—and the man did not come up.

A dozen, perhaps, of such incidents, which now, that I was alert to understand, were apparent. The mirrors might have shown some of them—but the mirrors always went dark just in time.

Tarrano's guards were disappearing. And now I saw a *slaan* skulking in the shadows of the shrubbery nearby. And I noticed, too, that this pool at my feet had a stream flowing outward from it—a waterway connecting it with the main lake. And I remembered the Earth-man in sub-sea garb whom I had seen. Were there many Earth-men down here in the water?

"When Tarrano dances with the Red Woman, you drop to the floor."

I remembered Alda's words and her admonition, "Be inside the pavilion." And presently I caught her glance as she was

poised for a dive—and it seemed directing me to leave.

Wrapped in my drab cloak, I went back inside. The merry-making had increased; the place was more crowded than ever. I had been there but a moment when a gong sounded. The music stopped. In the hush Tarrano, on the balcony, rose to his feet.

"The tri-night hour* is here." He removed his mask; his face was grave, but a slight smile curved his thin lips. "Let us see ourselves now as we really are."

He slipped his robe from his shoulders and stood in his festive costume. For so slight a man, I was surprised at the strength of him. Bands of gold-metal encircled his naked torso; a broad girdle of purple cloth hung from his waist. His bare limbs were lean and straight; sandals of red were on his feet. And a band about his forehead with a single feather in it.

Yet, for it all, he was no male *nada,* but every inch a man. Gravely smiling, as, with a gesture, he bade them all discard their masks and robes. From overhead the colored lights turned white. And in the glare, the robes and masks were dropped. Costumes grotesque, some of them; others symbolic; others merely beautiful. Vivid colors, needing nothing save the white light to display them. Dancers daringly garbed, with whom the girls from the pool now mingled.

A moment of breathless silence; then ripples of applause from the spectators. And then the music and the dancing went on.

Barbaric costumes? Some frankly imitated the by-gone ages of Venus, Mars and Earth. But the spirit that prompted them was decadence—nothing more.

Presently, as I stood unmasked in my effeminate garb, holding myself aloof from the girls who would have carried me off to the dancing floor, I saw the roof of the pavilion roll back. The open sky spread above us. And from it came down an effulgence of silver light, from a source high overhead. It bathed us all in its soft radiance; and, simultaneously, the lights in the pavilion went out. A single golden shaft rested on Tarrano. Elza, Georg and Maida were still there. In the golden light I could see them quite plainly—could see that Elza was flushed with suppressed excitement. Not the alcholite fumes now. Georg, too, seemed very alert. And Maida. There was, indeed, a tenseness about them all—an air of vague expectancy which made my heart beat faster as I realized it.

Was Tarrano totally unaware of what was about to happen? Was he unaware of this hidden, lurking menace to him, which now, to me, was so obvious? I could not believe that; yet, he was imperturbable, solemn as ever.

A shaft of golden light upon Tarrano. The darkened chamber. The silver radiance coming down upon us in a shaft from the sky. A hush lay upon the room. The music had ceased; now it began again, very soft, ethereal. Everyone in the room was gazing upward. From high overhead in the silver shaft a shape appeared, slowly floating downward. A woman's figure. It came down, supported by what mechanical or scientific device I never knew. It seemed floating unsupported.

Within the pavilion, suspended in mid-air, I saw that it was a woman in filmy red veils. Poised on tip-toe in the air. Arms outstretched, with the red veils hanging from them like wings. A woman fully matured. White hair piled in coils on her head, with a huge, scarlet blossom in it. A face, somewhat heavy of feature, powdered white; with glowing eyes, dark lidded; and a scarlet mouth. A face, an expression in the smouldering eyes, the full lips half parted—a face and an expression that seemed the very incarnation of all that is sensuous in humans.

*Half-way between midnight and dawn.

The Red Woman! The living symbol of all that lay beneath this festive merry-making.

The Red Woman! For a moment she hovered there before us. A shaft of red light now came down from above. It caught her, bathed her in its lurid glow. On her face came a look of triumph, and a leer almost insolent, as slowly she began fluttering through the air toward Tarrano. He rose to meet her. Whispered something aside to Elza.

Close before him, the Red Woman hovered. And now a circle-dais from the floor came up to her. She rested upon it; began a slow, sinuous dance; one by one loosening the veils; the red light deepening until it painted her body red in lieu of the draperies.

No frivolous mockery here. Intense, smouldering eyes as she held her gaze on Tarrano's face and slowly raised her arms in invitation to him. At her gesture, he rose to his feet. Yet I knew he was not under her spell, for his lips were smiling, bantering.

But he rose obediently, and stepped from the balcony to the upraised dais. Around his neck the Red Woman wound her arms—white arms stained red by the lurid light.

A flash! I did not see from whence it came; but within me some subconscious impulse made me drop to the floor. The light from overhead was out. Momentary darkness. A woman's scream of terror. Then others. The sound of running feet; bodies falling. Panic in the crowd. Confusion everywhere.

Then light from somewhere came on. People were trampling me. I fought them off, climbed to my feet. On the dais the Red Woman lay dead. Huddled in a heap, with a brand of black searing her forehead. *Slaans* were leaping about the room—huge, half-naked men—brandishing primitive knives. Flashing steel, buried in the backs of the fleeing merry-makers. Other figures—Earth-men they seemed—gripping the *slaans*, staying their murderous fury.

Tarrano? I did not see him at first. The air above the floor of the pavilion was full of snapping sparks—a battle of some unknown rays. The mirrors were shattered; glass from them was falling about me. Then, in the semi-gloom on the balcony, Tarrano's figure materialized. Invisible before, the hostile rays upon it now made it apparent. But Tarrano seemed proof against the rays. I could see he was unharmed; and as he stood there, no doubt using a curved, duplicating beam, the like of which I have seen used in warfare, the image of him seemed to shift. Then it doubled—two images, one here, one further down the balcony. Then still others—appearing and disappearing, always in different places, until no one could have said where the man himself really was. A dozen Tarranos, each enveloped in hostile sparks, each with his face grinning at us in mockery.

Abruptly, I heard Georg's voice shout above the din: "Elza! Elza is gone!"

The images of Tarrano faded. He, too, was gone.

And then I saw Maida on the balcony, standing with upraised arms. Her voice rang out.

"Down with Tarrano! Death to Tarrano!" And then her pleading command:

"*Slaans,* no more bloodshed! Be loyal, *slaans,* to your Princess Maida!"

And Georg calling: "Loyalty, everyone, to your Princess Maida. Lovalty! Loyalty!"

END OF PART NINE.

Is Einstein Right?

By PROF. DONALD H. MENZEL, Ph.D.

(*Continued from page* 991)

made to move in the direction of the arrow, it also appears obvious that the flash which goes over the path AB will be the victor; owing to the fact that the other ray will have to chase a considerable distance after the mirror C in order to be reflected. The greater the velocity of the table, the greater the interval between their returns until, when the table was moving with the speed of light —186,000 miles a second—the beam would never return because it couldn't catch up to the mirror.

When an experiment much resembling this one was performed, it was found that the two rays continued to arrive simultaneously no matter what the direction or velocity of the table. We accept the experiment, in spite of the fact that it seems contrary to experience. The unexpected result could be explained if, due to the motion, the distance AC had been shortened. A simple computation shows that for a speed of 161,000 miles a second the amount of this contraction would be just one-half. This conclusion is contrary to experience—at least at first sight —but for all we know, we may actually possess that velocity. The mind refuses to grasp or accept the thought, but the relativist may defy anyone to prove that he is not three feet long when lying on the table and six feet when standing upright (see Fig. 2) for any measuring stick we may try to use will shrink in the same proportion. When prone, a man will measure six "half-feet" and when upright he will lengthen to his "normal size"—if that expression has any meaning.

Notice that the above conclusion is derived from experiment. In a similar manner we may prove other facts just as paradoxical as the above. Yet, if length behaves in such a curious manner, we should not be surprised to find that mass and time, also, act in a manner contrary to experience. The mass of a particle is found to increase with the velocity. Space is *bent* near very massive objects, so that a ray of light passing near it would not proceed in a straight line. A clock on the sun will go slower than a clock upon the earth, because of the more intense gravitational field.

The Einstein theory, thus, predicts a number of things which may be tested experimentally. One of these is shown in Fig. 3. Newton's law of gravitation predicts that the motion of a planet around the sun will be in the form of an ellipse. When the planet is nearer the sun it is obvious that the force of gravity will be greater and so the planet will move more rapidly than when farther away in order to keep from falling into the sun. According to Einstein, then, a planet will weigh the most when moving the fastest. Of all the planets, Mercury shows the largest variation in velocity, and therefore the greatest variation in mass. Due to this, the planet will speed up just a trifle more than Newton's theory requires and, instead of revolving exactly in an ellipse, will change its direction as shown in Fig. 3b. The motion, as predicted by Einstein, is that of the second case and, though differing very minutely from the ellipse of Newton, the observed discrepancy was sufficient to lead astronomers at one time to propose amending the law of gravitation from the square of the distance to the 2.00000016 power of the distance.

Einstein also foretold not only the fact that light would be bent in passing near the gravitational field of the sun, but also stated the exact amount of the deflection. His

calculations have been verified in a remarkable manner. (See Fig. 4.)

At first glance it might appear that his statement that clocks upon the sun would run slower than clocks on the earth would admit of no experimental proof. An atom, however, might be said to be Nature's clock, since the color of light it emits depends upon the *number of vibrations per second* which it gives out. An atom on the sun should, therefore, give off fewer vibrations per second—that is, the light emitted would be of a slightly different color than it would have on the earth. Again the change is minute, but the observations confirm the theory.

The most recent test of relativity was made at Mt. Wilson. A certain star was known to have a gravitational field approximately 500 times that of the sun. The observations show that the colors radiated from the atoms of that star are exactly that predicted by the theory—a final and convincing proof of the theory's correctness.

Professor Dayton C. Miller of Cleveland, Ohio, has recently completed a series of tests with an apparatus similar to that diagrammed in Fig. 1. The results obtained did not quite confirm those of the first experiment—that both flashes should return at the same time.* No definite conclusion could be drawn from these tests, however, for, while the results did not confirm Einstein, they were also in disagreement with the simpler prediction computed from the known velocity of light and velocity of the apparatus which, of course, shares the velocity of the earth.

In order to explain the fact that light appears to travel in waves, physicists had postulated the existence of the "ether"—a hypothetical medium which was a *perfectly frictionless* fluid which permeated all space. It has been pointed out that the result of Professor Miller's work could be interpreted, if the medium in which the light waves traveled were dragged along with the moving earth as shown in Fig. 5, accounting for his observation that the observed drift was greater at the top of Mt. Wilson than at sea level.

Now, if the ether were carried along by the earth we should observe a displacement of the stars as in the diagram. Such a behavior of the ether is also contrary to the above definition—frictionless. Furthermore, since a more recent experiment by Professors Michelson and Gale, of the University of Chicago, reaffirmed the fixity of the ether near the earth, we would seek another explanation of Professor Miller's result.

In the meantime, our faith in the Einstein theory of relativity is unshaken. We regard it as definitely proved—not by experience, but by experiment, which should be the fundamental test of reality.

*For details of this experiment see article in SCIENCE AND INVENTION for September, page 411.

The Moon's Atmosphere

By PROF. DONALD H. MENZEL, Ph.D.

(*Continued from page* 1005)

sure exerted by one cubic inch of air expanded to fill a volume of two cubic feet. Fig. 2) it is still far from zero.

While usually we think of the word "vacuum" as appertaining to a space which contains nothing at all, this ideal state cannot possibly be reached by pumps or other physical means available to us. For a given temperature, the pressure is proportional to the number of molecules present. At ordinary pressure, a cubic centimeter of gas contains about thirty million, million, million molecules. Dividing this number by 3,600 still leaves a huge quantity of molecules and a lot of atmosphere for the moon. The statement of the astronomer, "The moon has little or no atmosphere," should, therefore, be interpreted advisedly.

Training Wild Animals

By DR. ERNEST BADE

(*Continued from page 989*)

until, finally, the creature can do them all with automatic certainty. If, during a performance, something untoward happens so that the animal loses its thread of continuity, the tricks must all be done over again from the beginning, for it cannot start in again at the place it left off. The animal can only do its tricks in a certain rotation. This is an important consideration that must be kept in mind in order to form an opinion of the performing "artist."

LION LEAST INTELLIGENT

It is a fact that the mentality of all beasts of prey is low. It is brute force that counts in their native haunts. And the lowest mentality of all beasts of prey is, undoubtedly, that possessed by the king of beasts, the lion. Even a glance at the massive skull with its tiny brain is sufficient proof thereof. This first impression is still further heightened while watching the performance of trained lions. Then it can be seen how infinite was the patience of the trainer in teaching even the simplest of tricks. In addition, the lion is the personification of cowardice and shows not the least trace of character. He is deadly afraid of the long whip of the trainer, and crouches, full of fear, as close to the ground as possible when he is being punished, should it be impossible to hide in some dark corner. But once roused to anger he is like a locomotive and charges anything that has aroused him, and there is little indeed that is able to swerve him from his intended victim.

TIGER MORE INTELLIGENT THAN LION

The tiger is far more intelligent than the lion. He is a large striped cat which, under correct training, has confidence in his trainer. The tiger purrs when he sees persons known to him and comes close to the bars of the cage, arches his back and permits his fur to be stroked. Things are quite different when the animal is in the big cage together with man and the restraining bars between them are gone. Here he refuses to be petted and the hand that then dares to come too near would soon make the acquaintance of his sharply clawed paw.

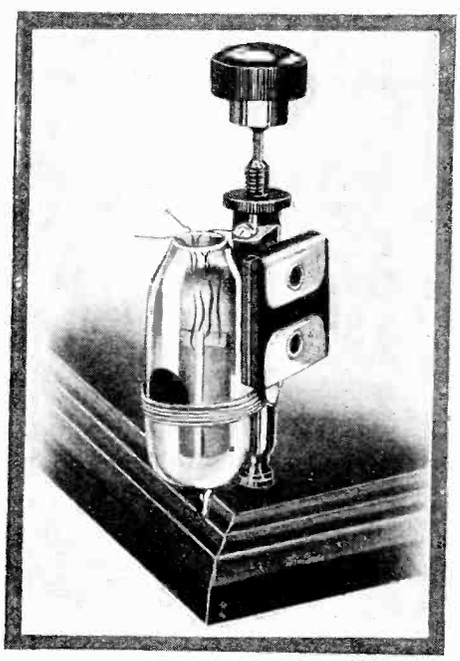
This greater intelligence of the tiger makes him a more dangerous beast to work with. He quickly learns the things required of him and will later gladly perform the tricks that have been taught him. It is the tiger, when tigers, lions and bears are performing in mixed groups, that is always first in taking his required position. Then come the bears, while the lions must be given more specific commands, intensified by a few touches of the whip, before they know what is required.

Really tame tigers are far rarer than tame lions, the former always retain a certain amount of independence. Such tame tigers are never as lazy as tame lions. The tigers are always doing something. Now they play with their tails, then with their paws, again they stand on their heads or assume grotesque and almost impossible positions. In short, they are just like a cat, a large striped cat, but still a cat.

RADIO WRINKLES

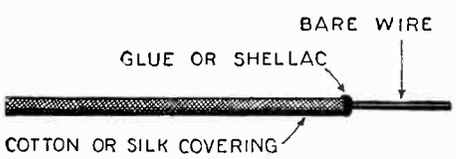
UNDER this heading we are going to publish items of interest to everyone who likes to build radio instruments. In order to continue this department it is necessary for our readers to tell us about their latest experiments. Write us a short description of some time- or money-saving kink you have discovered and send it to us along with a few sketches. Our regular rates will be paid for this material. Be brief and try to put everything in the drawing. Don't be too elaborate. Address "RADIO WRINKLES" Editor, care of SCIENCE AND INVENTION.

Short Wave Arrangement



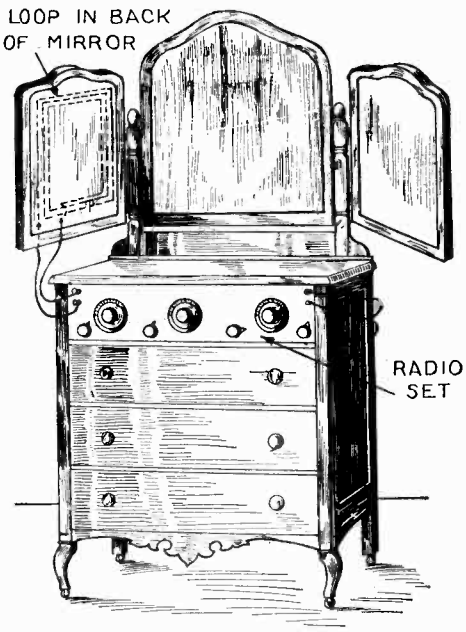
When building an ultra short wave receiver or one designed to operate below 20 meters, it is absolutely essential that every precaution be taken to eliminate losses throughout the layout. One of the most important points in radio receiving set construction is the correct location of the grid leak and condenser in relation to the tube. Also the capacity of the tube itself must be low and in order to facilitate this, a UV-199 type of tube should be employed and the base should be removed. Then the tube can be bound to a tubular grid leak with string as shown above and the grid condenser can be hung from one of the grid leak terminals by means of the connecting wire. When all this has been done, it will be found that the detector will operate very efficiently due to short leads in the grid circuit.—Leon L. Adelman.

Lead Kink



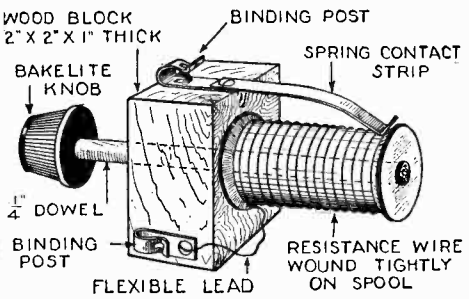
When using flexible wire or in fact any wire with silk or cotton insulation, the sightliness of the finished job is often marred by the loose ends of the cotton or silk insulation which seem to be almost impossible to eliminate. If, however, a drop of glue or shellac is placed at the end of the insulation as above, the results will be gratifying.—Ashton Kidder.

Compact Set



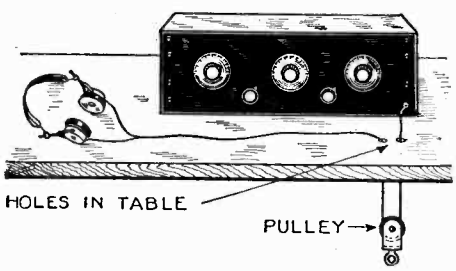
When it is desirable to conserve space in the arrangement of a radio receiving set, a layout similar to that shown above may be employed. Here the entire radio set is incorporated in the top drawer of an ordinary bureau and if it is of the type that operates with a loop antenna, that part of the installation can be mounted on the back of one of the hinged mirrors as illustrated. Many variations will suggest themselves. —D. J. Spillane, Rep. No. 1770.

Rheostat



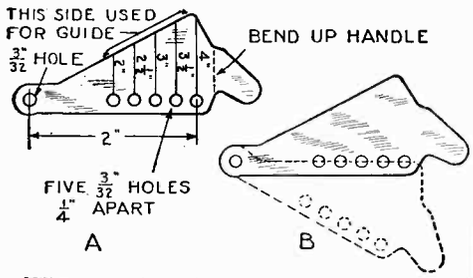
The ordinary type of rheostat is a rather difficult instrument for the layman to make but if the push-pull design illustrated above is followed, no trouble will be found. The resistance wire can be removed from an old broken rheostat or can be purchased. With few changes, this instrument can be mounted directly on a panel without the use of the wooden block. Herbert E. Hayden.

Eliminating Phone Cords



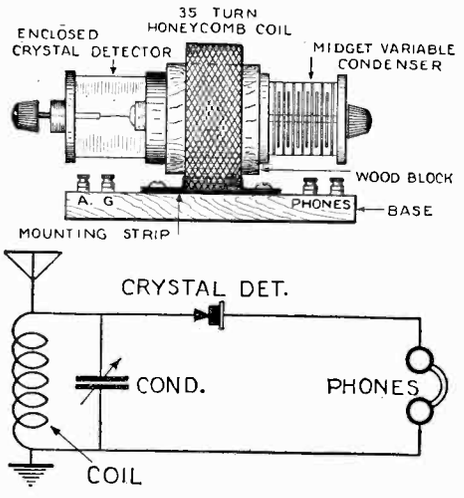
When a phone cord is allowed to lie on the top of the table, it is always in the way, However, if two holes are drilled in the table as above and the cord threaded through them and a pulley placed in the loop so formed, the cords will always be out of the way and just the right length for use. —Owen Keys.

Peg Spacer



When spacing the pegs to be used for winding coils of the Lorenz type, the little templet illustrated above will be found most useful. Make the templet from a piece of thin sheet metal and construct it with the same angle between the sides as that shown. To use, pivot it in the end hole and then mark the first peg hole according to the diameter desired. Then move the plate as shown in Fig. B until the guide edge lines up with the hole just marked. Now mark the second hole and proceed around the circumference.—Author please send address.

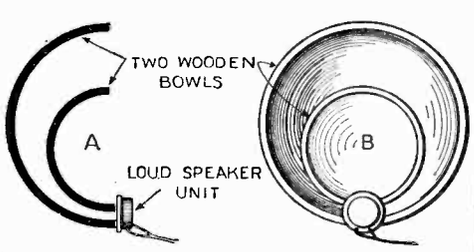
Crystal Set



A very novel type of compact, yet efficient crystal detector set can be made as shown in the upper illustration above and the wiring diagram shown just below it should be employed. The midget condenser used for tuning should be of the 13-plate, not 3-plate type. A set of this type can be carried in the pocket and used wherever an aerial and ground connection is available.

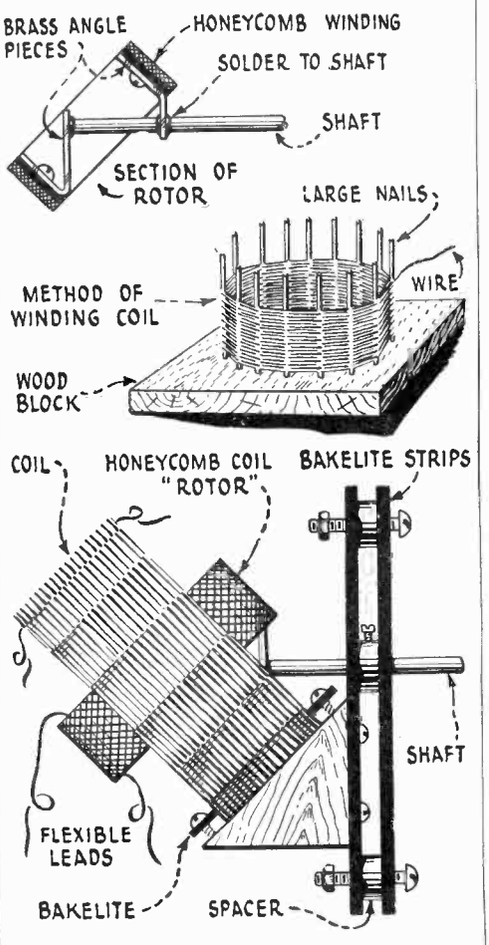
—David Borovitz.

Loud Speaker



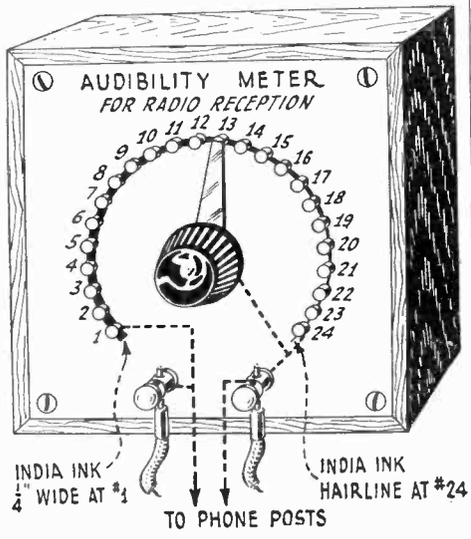
A most effective and novel loud speaker horn can be made by using two wooden bowls mounted as shown at A and B above. The loud speaker unit is placed near the small opening. The bowls and the unit are to be fastened in any way that may be found convenient. Vary the relative positions of the three component parts until the best possible results are obtained. —J. Bront.

Low-Loss Coupler



A low-loss 180° type of coupler may be made by using a honeycomb coil for the rotor and a basket-weave coil for the stator. The honeycomb coil is fastened to the brass angles by means of small bolts. The wire on the honeycomb coil is pushed to one side to allow the fitting of these bolts. —Evermont Fisel.

Audibility Meter



For quantitative tests between different tubes and other radio parts as well as between stations being received, an audibility meter is indispensable. One can be made as above. A series of switch points are arranged and connected together by means of an India ink line. The line should be drawn so as to make good contact with every switch point. The device is connected across the phones and adjusted until the signals are just barely audible. Comparisons can be made by the scale reading. —J. Bront.

The Radio Constructor

By A. P. PECK

(*Continued from page* 1030)

D.C.C. wire wound on a form 1 inch in diameter. With some transformers, this choke is necessary, whereas, with others, it need not be used. Try the circuit both with and without this choke in order to find which connection gives best results.

It will be noted in the various diagrams and photographs that a very small fixed condenser is used in series with the antenna. This is done so as to throw off the wave-length of the antenna circuit to such an extent that it can be considered semi-aperiodic. Thus, another tuning condenser is eliminated with little or no decrease in efficiency.

It is advisable to use a variable grid leak of good, standard quality in this set, as it is of great assistance, and when properly adjusted, the operation of the regeneration control is far smoother than with any ordinary leak. The leak should be adjusted until, by turning the knob actuating the regeneration condenser, the detector goes into oscillation with a very soft click or hiss, rather than with a loud bang. When the leak is adjusted to this position, the set is very sensitive and will give far better results than if the leak is improperly adjusted.

In order to amplify the control of the set, and because of the fact that loud speaker results are often obtained on the first stage of audio frequency amplification, a filament control jack is used in the plate circuit of the last tube. This controls only the filament circuit of the last tube, and by inserting the plug in it, the filament of that tube is lit. By pulling out the plug, just that one filament is extinguished, which filament, as well as the other three, are furthermore controlled by means of the push-pull switch in the usual manner.

This set is one of the most selective four-tube receivers that it has ever been the writer's privilege to build and operate. Located only about four miles airline from the new superpower station 2XAR, at Bound Brook, N. J., this set is amply selective to tune the 2XAR signals out completely when the station is operating on high power on 455 meters, and this set will then bring in surrounding stations. This has been done repeatedly when other sets of standard make and of home manufacture have to listen to 2XAR or else cease operation. A good many five-tube sets in the writer's location absolutely fail to eliminate this station on any point on the tuning dials, but, as mentioned, no trouble is experienced with the set under discussion. Furthermore, when properly tuned in, the superpower station will give loud speaker results on the detector alone, whereas, on the first stage of audio, there is ample volume to be heard all over the house. And so, you can see that nothing more can be desired in the line of selectivity than can be obtained with this set. It is very regular in operation and the regeneration control does not affect the wave-length settings. Stations can be logged and curves made covering the tuning ranges of the two dials, and from these curves, the approximate location of any station whose wave-length is known can be immediately ascertained. The set is also simple in tuning; it only being necessary to rotate the two tuning dials simultaneously in order to bring in stations far and near. With properly designed coils, it will be found that, at the mid-point of the tuning range, the dials will read almost the same, whereas, on the upper end of the range, the R.F. dial will be a few points ahead of the detector dial. On the lower bands, the detector dial will be a few points ahead of the R.F. dial.

Due to the selective qualities of this receiver, it is an absolute necessity that vernier dials be used for tuning, and those shown in the photograph are recommended. They have no back lash and are so smooth in operation that tuning with them becomes an absolute pleasure. In no event should anyone attempt to tune this set with ordinary dials that have no vernier or vernier attachment, as disappointment is sure to result. With such dials, stations will be passed over so quickly that they may never be heard, whereas, with vernier dials, they will come in with excellent loud speaker volume. On the regeneration control, only a knob and pointer are used, as this is not critical in adjustment.

When tuning this set and rotating the dials simultaneously, as mentioned, the regeneration control should be placed near the oscillation point, which latter is evidenced by a soft hiss or pluck in the loud speaker. Stations will then come rolling in with a regularity and volume that will surprise even the most hardened of radio constructors.

Readers Forum

(Continued from page 1023)

to be any sequel? I hope there is because the conclusion of the story left me in suspense. The story you are printing now, "Tarrano the Conqueror," is excellent too, but I would like to hear more of the other one.

MRS CYRIL H. GOODSPEED,
Seattle, Wash.

(We wonder how many more of our readers liked John Martin Leahy's story "The Living Death" and want to read a sequel.—EDITOR.)

PERPETUAL MOTION

Editor, SCIENCE AND INVENTION:

I have been greatly interested in the article in the March issue of SCIENCE AND INVENTION by Joseph H. Kraus on "The Perpetual Motion Myth." However, I was disappointed in the reason for the non-operation given by this author for some of these machines. I refer to those cases where it was stated that friction made the device inoperative, the would-be inventor being allowed to assume that if he could sufficiently reduce the friction he would become the inventor of perpetual motion. Since this is one of the most common fallacies which lead men to waste endless energy along these lines, it occurs to me that it is the duty and privilege of such high class magazines as your own to eliminate it in the popular mind in as far as possible. While this article on the whole is excellent in this regard, the point mentioned tends rather to counteract the good effect and mislead the reader.

The explanations I refer to are in connection with the last two devices on page 1080, the one on the right hand side middle and the other in the lower right corner. Neither of these devices would be perpetual motion machines any more than would an ordinary wheel, regardless of the extent to which the friction were reduced, unless it could be made zero. The inventor is allowed to believe that there will actually be a buoyant effect tending to produce the desired motion which is only counteracted by friction. That this is not true can very easily be explained when buoyancy is considered as the resultant of unbalanced hydrostatic pressure rather than as a vague and mysterious phenomena. It can very readily be seen that in the vertical section of the submerged rope all the forces acting upon it due to the water pressure are in a horizontal direction (since such forces can only be perpendicular to the surface) and also that they neutralize each other. Also it is evident that any forces on the curved section of rope at the bottom are neutralized in their effect to produce the desired motion, those on the left side of the lowest point exactly counteracting those on the right side.

AN ENGINEER.

(In the article "The Perpetual Motion Myth" Mr. Kraus didn't state that friction was the cause of the non-operation of most perpetual motion machines. In the particular device to which you refer, the most serious drawback is the friction at the point where the rope enters the water chamber. Your statement that the forces on the curved section of the rope are neutralized, those on the left side exactly counteracting those on the right side, is not absolutely correct because of the fact that the opening for the rope could be made on the right side and then there would be no left side to counteract the forces.

As a general rule every perpetual motion machine will be found inoperative even if friction is neglected. We generally mention friction because it is always present and it is an additional obstacle which must be overcome. It is quite obvious that any machine developing more power than that put into it could be made to operate if modern roller bearings or jeweled bearings were used. In the article to which you refer you will find a lengthy discussion in the center of page 1080 describing the other drawbacks to the particular device to which you allude.—EDITOR.)

Book Review

THE MARVELS OF MODERN PHYSICS. By Joseph McCabe. Stiff cloth covers, 5 inches by 7¾ inches, illustrated, 145 pages. Published by G. P. Putnam's Sons, New York City. Price $1.50.

The preface of this book discloses its object, which is to give opinions on physics in general without the use of mathematical formulas, and with as little appeal to the generalities of mathematics as possible. There is a touch of conservatism to be observed in the author's statement, which, to the writer's mind, is very acceptable. When a book appears on "the new physics" or "the new chemistry," or any other branch of "new science," it always excites one's suspicions that the author is trying to make a revolution or at least to inaugurate a revolution in science. So we find the author stating that the new knowledge has deepened and expanded the old knowledge. This is, in a sense, one of the foundation stones of the book, for throughout there is this enlightened conservatism to be observed. We wish there were more illustrations. The table of contents shows that the nine chapters are devoted to general subjects. The text is not divided up in the usual sub-divisions of a text-book, so that it has a literary aspect and will make thoroughly good reading. We certainly commend it to our readers.

RADIO-LEITFADEN, by Dr. Ing. Max M. Hausdorff. Stiff cloth covers 6¼" x 9", profusely illustrated, 152 pages. Published by Union Deutsche Verlagsgesellschaft, Berlin.

We may fairly well translate the German word "Leitfaden" by the rather ugly English term "Hook-ups." The book is devoted largely to these, but brings in, of course, battery manipulation and the mounting of apparatus. The subjects of the book are garnered from many sources and we recognize emanations from our own No. 53. The illustrations are both schematic and diagrams, while reproductions of photographs in half-tone are given for apparatus. It may be surmised from what we already said that the book is not restricted to German sources and this is particularly in evidence from the cuts on page 103. We are glad to see at the end the thanks given to various authorities for the material and the illustrations; recognition is awarded to such authorities as Dr. Nesper of Berlin, Mr. Richards of the Marconi Company of London, Mr. John Scott Taggart, Mr. Hugo Gernsback, the Brown Co. of London, and Thomas Alva Edison. Some five pages at the end of the book are devoted to changes since the rest of the text went to press. The publishers, however, do not seem to have been affected by the German propensity for double and triple indexes, as they give none at all.

THE MECHANICAL INVESTIGATIONS OF LEONARDO DA VINCI, by Ivor B. Hart, B.Sc., Ph.D. Stiff cloth covers 5¾" x 9", illustrated, 240 pages. Published by The Open Court Publishing Co., Chicago, Ill.

Some years ago the writer of this review prepared an article on the wonderful work in mechanics of Leonardo da Vinci and the present book treats the same subject. Da Vinci is considered to have been one of the greatest painters that ever lived. His picture of "The Last Supper" has been followed by all artists using that subject, and even in "The Passion Play" at Ober-ammergau there was almost a reproduction of the great fresco in the old Milan Convent Refectory. The book we are reviewing treats of him as a mechanical engineer and his drawings and descriptions of mechanical inventions certainly seem to put him generations ahead of his day. One can go over this book and find in it most interesting presentations of the laws of mechanics, the pulley, the lever and the like.

One of his famous lines of investigation was in the production of airplanes and parachutes. We even have a parachute shown, a reproduction of one of his drawings. He gives its dimensions as about twelve yards on a side and also gives the pyramidal shape essential to its safe descent. The investigations into the flight of birds are no trivial thing, but are true mathematical investigations and are elaborately carried out in the text. Even soaring was treated by him and we find an interesting parallel given on pages 171 and 172 of Leonardo da Vinci's views and those of Hiram Maxim, recently deceased. The author considers the much debated question as to whether Leonardo da Vinci ever flew. The closest reference from a contemporary that we have is by the father of the famous mathematician, Jerome Cardan, who knew Leonardo, and he says that Leonardo da Vinci also attempted to fly, but misfortune befell him from it. The book has an adequate index and is edited with great judgment to bring out Da Vinci's serious work as well as the more picturesque topics which he illustrated.

How to Make Your Own

SPEECH AMPLIFIER

MICROPHONE Transmitter Buttons have been used for a number of years to make powerful sound transmitting elements. These very sensitive amplifiers offer every "Radio Fan" the means of building his own powerful speech amplifier. We offer herewith to the constructor these special *Amplifier Units.*

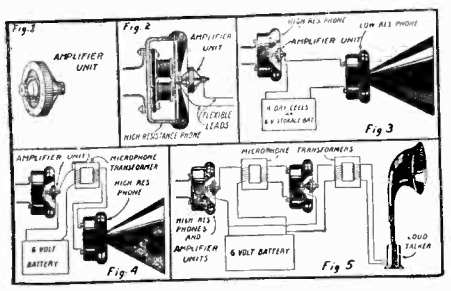


Fig. 1 shows the amplifier unit.

Fig. 2 shows how the unit is attached to a telephone receiver. The first procedure is to mount the unit on the diaphragm of a telephone receiver, which usually is a high resistance telephone, either 1,000 or 1,500 ohms.

Next we select the loud speaking telephone. If a low resistance telephone is available, it should have for maximum efficiency an impedance equal to the resistance of the amplifier unit, or about 10 ohms; it is connected up as shown in Figure 3. A 5 ohm telephone receiver is used in this circuit with a 6-volt storage battery.

Two telephones taken from a good double headset of 2,000 to 3,000 ohms which do not rattle on strong currents, are employed in Fig. 4, one at the receiving end, the other as loud talker. In this hook-up there is one instrument which must absolutely be used with this combination, the transformer. As stated before in connection with Fig. 3, the impedance of the telephone, if used in direct connection, should equal the resistance of the unit. But as the impedance of the telephone in Fig. 4 is much higher than the resistance of the unit, it may be 200 times as great, a transformer having a step-up ratio is used to match up the resistance of the unit with the impedance of the loud speaking telephone. In other words, the primary coil of the transformer should have an impedance (which is sometimes called "A. C. resistance") equal to the resistance of the unit, or about 10 ohms, and the secondary coil should have an impedance equal to the impedance of the high resistance telephone. This transformer may be purchased in any Radio Store and is called a microphone transformer or modulation transformer, designed primarily to use in radio transmitting sets. A 6-volt battery gives the best results. The current passing through the unit will vary from .1 to .25 ampere.

Fig. 5 shows a circuit for further increasing the volume of sound. This is simply two of the circuits, such as shown in Fig. 4, linked together. This arrangement is highly sensitive and the telephones on which the units are mounted should be packed in a box of cotton, as the slightest vibration or sound in the room will be picked up and heard in the loud talker. Any sensitive radio loud talker may be used in this particular circuit.

THESE and innumerable other interesting experiments are possible with these amplifiers. Every amateur should have at least one or two in his "Lab" or workshop. A four-page instruction pamphlet is sent with every unit.

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DYKE'S AUTOMOBILE & GASOLINE ENGINE ENCYCLOPEDIA, by A. L. Dyke, E. E. Flexible cloth covers 6½" x 9¾", illustrated, 1233 pages. New 14th edition. Published by The Goodheart-Wilcox Co., Inc., Chicago, Ill .

Dyke's Encyclopedia has won for itself an honored place in the literature of the automobile. It now has grown to over twelve hundred pages. The general index alone takes nearly eighty pages. The text of the work is profusely illustrated and reference to the typical engines and cars is made. Electricity as applied to automobiles is very fully treated with so many illustrations and so simply presented that the book can be understood by any competent chauffeur. The danger now is with the perfection of automobiles that they will be run too much by rule of thumb, although we have always deprecated to "too much fussing" with the machine. There are many automobile engines but they have come to at least an approximate standard of construction so that we may take everything as being covered here.

One of the most recent engines which have been introduced to the public is the straight line, eight cylinder engine. This, of course, is a mere multiplication of the very familiar four cylinder engine and again merely involves the addition of two cylinders to the very popular six-cylinder engine. Accordingly, we find two methods of placing the cranks on the driving shaft of a straight eight given, and it is quite surprising to see how seemingly irregular the arrangement is. The straight eight has the all-important feature of accessibility and this should certainly go to make it popular with those who wish a multi-cylinder drive.

There is no use of a reviewer trying to tell what is in the book because the matter is so very fully given and such a variety of details are contained.

The type is very legible even in its small size; the editors have been particularly fortunate in their selection of the same. As a sample of the thoroughness with which the book has been gotten out there is a list of places where parts and supplies for what the editor terms "orphan cars" can be found, cars no longer manufactured. Among these names the old time automobilist will find some familiar titles. Such names as Petrel, Pope-Toledo and Palmer-Singer appear which in the past days of the science were household words. To those who wish to be up on the subject, and who take care of their own cars, as well as for the advanced garageman, the book is absolutely indispensable.

METEORS, by Charles P. Olivier, Ph.D. Hard covers, 6½" x 9¾", 276 pages. Published by Williams & Wilkins Co., Baltimore, Md. $6.00.

Our first remark about this book must be in the nature of an encomium on its make-up. The typography is exceedingly pleasant and reads very easily, and the paper with uncoated surface does not reflect light into the eyes. The way the book is arranged is this; the half tones, of which there are a number, are put in independently of the signatures, and they are on the regular coated paper. This much we say because the use of coated paper for printed matter is in every way objectionable. Unwards of 250 pages are devoted to the titular subject, and every topic that can well be suggested in connection with comets, meteors, leonids, perseids and other families of these strange celestial objects, are given in great detail. Comets too come into the subject and are quite fully treated with numerous illustrations, some of them very beautiful presentations of these celestial visitors. A general treatment of the mathematics of the subject is carried throughout the book. It makes good reading, but the fact that astronomy without mathematics means absolutely nothing, is kept always in mind. The conclusions reached about comets is to the effect that they are extremely tenuous, so that we can feel that if a comet hit us, we might never know it. An interesting thing about meteors to be found in the pages of this work is an account of the late Professor C. C. Trowbridge of Columbia University, who did more for the study of meteor trains than all others combined. The curious thing to be noted in this connection is that he was not an observer himself and had to rely upon the work of others.

THE PAINTING TRADE HANDBOOK, by A. Ashmun Kelly. Hard covers, 4¼" x 6½", 165 pages. Published by David McKay Co., Philadelphia, Pa. $1.50.

Small as the book is, its thin paper and compact printing brings into it a quantity of matter. There is so much in the one hundred and sixty odd pages that one doesn't know where to begin to review it. It describes different details of the trade, such as troubles with paint, of which the amateur will certainly find there are many, construction of ladders and brackets, paint analysis, the different pigments, oils and turpentine used in mixing paint, sizes and sizing, and stenciling. All these things and many more are included. The glazier's work, the different kinds of putty, and how to use putty are given. As an example of the details, it even tells of several methods of removing old putty when the glass is to be taken out of the sash, something that always troubles the home mechanic.

Auto Trouble Shooting

By Tom C. Plumridge, Head of Automobile Engineering, American School of Correspondence.

SECTION 1.
Engine Troubles

1. *Engine will not start.*
No gasoline.
Choke not working.
Stoppage in jet.
No compression.
No primary current.
Battery discharged.
Battery disconnected.
Loose terminals.
Resistance coil burnt out.
Dirty contact points.
Contact points not breaking.
Fouled spark plugs.
Spark plug points set too wide.
Weak condenser.
Weak magnets on magneto.
(See "Carburetion and Ignition Troubles).

2. *Engine has no power.*
(See "Carburetion and Ignition Troubles).
No compression.
Leaking valves.
Sticking valves in guides.
Valves not seating.
Too much tappet clearance.
Too little tappet clearance.
Worn pistons and piston rings.
Faulty spark plugs.
Loose spark plug wires.
Loose valve plugs.
Broken valve springs.
Engine overheats.
Incorrect timing of valves.
Incorrect timing of ignition.
Weak condenser.
Scored cylinders.
Engine full of carbon.
Stopped up muffler.

3. *Engine knocks and rattles.*
Spark too far advanced.
Engine full of carbon.
Worn pistons.
Worn main bearings.
Worn connecting rod bearings.
Worn piston pins.
End play in crank shaft.
Play in cam shaft bearings.
Too much valve clearance.
Sticking push rod or tappet.
Worn rocker arms on shafts.
Worn push rod and guides.
Worn valve guides.
Worn mushroom tappets.
Worn push rod rollers and pins.
Scored cylinders.
Timing gears worn.
Too much back-lash in timing gears.
Flywheel loose on flange.
Engine hold-down bolts loose.
Flat cams.

4. *Engine overheats.*
Lack of water.
Lack of oil.
Water not circulating.
Oil not circulating.
Water hose partly stopped up.
Incorrect valve timing.
Incorrect ignition timing.
Mixture too rich.
Brakes drag.
Fan belt slips or broken.
Radiator dirty inside and in openings.
Radiator leaks.
Pump leaks.
Hose connections leak.

5. *Engine misses at slow speed and spits.*
Leaky intake valve guides.
Loss of compression.
Valves leaky and not seating properly.
("See "Ignition and Carburetion Troubles")

6. *Engine misses at high speed.*
(See "Ignition Troubles").
(See "Carburetion Troubles").

Engine overheats.
Sticking valves.
Valves not seating properly.
Weak valve springs.

7. *Engine runs unevenly.*
(See "Ignition and Carburetion Troubles").
Mixture too rich.
Choke not working correctly.
Uneven compression.

8. *No oil circulating and gauge showing no pressure.*
Oil line stopped up.
Gauge not working.
Dirt under valves in line.
Pump gears worn.
No oil in crank case.
Oil needs renewing in crank case.
Bearings need adjusting in engine.
Oil pressure out of adjustment.

CURES FOR ENGINE TROUBLES

1. *Engine will not start.*

No gasoline.—Clean out gas line. Examine gas tank to see if there is any gas in tank and for leaks. Clean out carburetor. The carburetor should be disassembled.

Choke not working.—Examine choke wire for worn places and broken wire. Examine butterfly choke valve and screw to see if loose or broken.

Stoppage in jet.—Clean out carburetor thoroughly.

No compression.—Grind valves. Examine pistons, rings and cylinders for wear. Examine valve adjustments and see that tappets have correct clearance.

No primary current.—See if battery is properly connected. See if breaker points are breaking properly. See if resistance or ballast coil is O. K. See if switch is O. K. See if all connections between battery and breaker mechanism are correct. See if battery is charged.

Battery discharged.—Test battery with hydrometer and voltmeter. Charge battery.

Battery disconnected.—See if all connections are tight. Examine ground connection and see if it is clean and tight. Examine battery connecting straps.

Loose Terminals.—(See "Battery Disconnected").

Resistance coil burnt out.—Renew with correct unit. Examine circuit and switch for shorts or grounds.

Dirty contact points.—If badly burnt, install new, test condenser. Clean and polish the points with an oil stone or fine file.

Contact points not breaking.—Examine fiber cam for wear. Examine and adjust points.

Fouled spark plugs.—Valves need grinding in. Valve port loose. Piston rings and cylinders and pistons worn. Too much oil in crank case, drain oil to the correct level. Bearings need adjusting. Clean and adjust spark plugs.

Spark plug points set too wide.—Set spark plug gap to correct distance, about .029th-inch. Spark plug electrodes too thin for the heat of engine explosion and compression. Purchase new spark plugs with heavier electrodes. Electrodes loose and gap will alter. Examine electrodes and see that they are tight in body of plug.

Weak condenser.—Watch breaker points for sparking when they break. If they spark badly, install new condenser.

Weak magnets.—Shown by failure to give strong pull when armature is turned by hand, and a weak secondary current.

2. *Engine has no Power.*

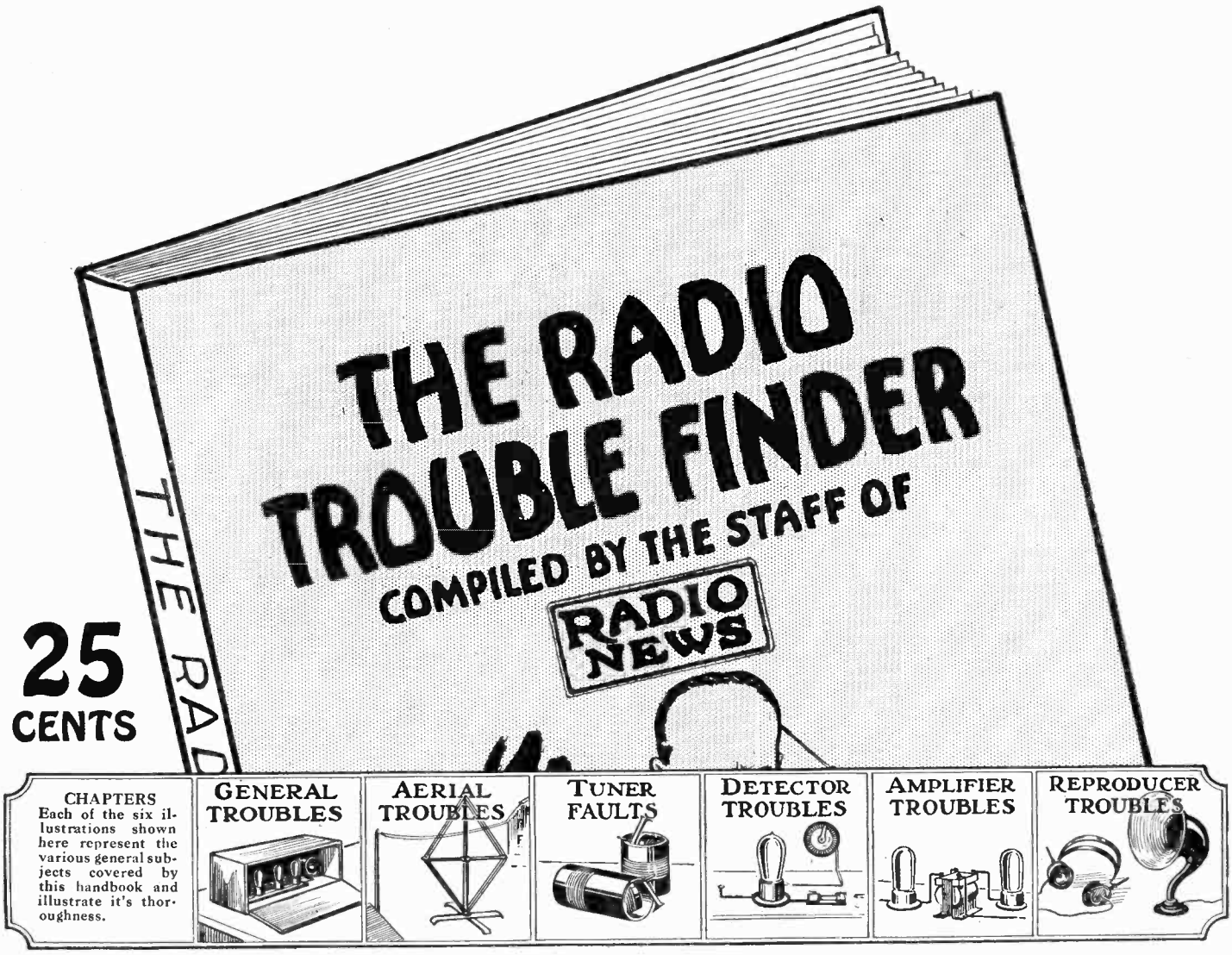
No compression.—(See "Engine will not Start").

Leaky Valves.—Tappets need adjusting. Valves need grinding. Examine valve heads and stems for warping and sticking. Test valve springs, and see that they are of about the same strength.

Sticking valves in guides.—Carbon on valve stems. Clean valve stems. Stems too tight a fit in guides. Ream out guides or reduce size of valve stems.
Valves not seating.—Tappets need adjusting. Carbon on valve fillet. Clean steaming. Carbon on valve fillet. Clean stem and fillets. Examine valve heads for pit-
Too much valve clearance.—Thread stripped on push rod adjustment screws. Lock nuts not tight on adjustment screws. Examine push rod rollers and pins. Adjust push rods or tappets.
Too little clearance.—Adjust push rods or tappets.
Worn piston and piston rings.—Rebore cylinder and fit new piston rings.
Faulty spark plugs.—Examine spark plug porcelains for cracked ones. Loose electrodes in plug body.
Loose spark plug wires.—Examine all spark plug wire terminals.
Loose valve chamber plugs.—New gaskets needed. Tighten chamber plugs.
Broken valve springs.—Renew.
Engine overheats.—Examine water circulation and water pump impeller. Examine ignition timing. Examine valve timing. Examine oil level and oil circulation. Tighten fan belt. Examine carburetor adjustment and adjust if needed. Clean carbon.
Incorrect valve timing. Incorrect ignition timing.—Check and re-time. Examine advance and retard mechanism and see that it is working correctly. Rod may be disconnected.
Weak condenser.—(See "Engine will not Start").
Scored cylinders.—(See "Worn Cylinder, Piston, Piston Rings"). Loose piston pins; examine and tighten if needed. Rebore cylinders if badly scored; lap out cylinders if lightly scored.
Engine full of carbon.—Examine carburetor adjustment. Worn pistons and cylinders. (See under "Engine will not start"; "Fouled Spark Plugs").
Stopped up muffler.—Clean out. The muffler must be disassembled to do this. See that all carbon and soot are removed from the pipes and passages.

3. *Engine knocks and rattles.*
Spark too far advanced.—Check and retime ignition.
Engine full of carbon.—(See "Fouled Spark Plugs" under "Engine will not Start").
Worn Pistons.—(See "Worn Pistons, Cylinders and Piston Rings" under "Engine has no Power").
Worn main bearings and connecting rod bearings.—Examine and adjust. Remove shims until bearing fits snugly on shaft. See that babbits are tight in housing.
Worn piston pins.—Examine and fit new pins and bushings.
End play in crank shaft.—Examine thrust side of main bearings for wear. Fit and install new main bearings.
Play in cam shaft bearings.—Fit and install new bearings.
Too much valve clearance.—(See "Engine Has No Power").
Sticking push rod or tappet.—Too tight a fit in guide. Guide scored.
Rocker arms worn on shaft.—Fit new bushings and shafts.
Worn push rods and guides. Worn valve guides. Worn mushroom tappets. Worn push rods, rollers and pins.—Install new.
Scored cylinders.—(See "Engine Has No Power").
Timing gears worn and too much backlash in timing gears.—Install new or refit main bearings. These can be brought closer by rescraping the main bearing.
Flywheel loose on flange.—Tighten bolts or set screws.

(*Continued on page* 1063)



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Auto Trouble Shooting

(*Continued from page* 1061)

Engine hold-down bolts loose.—Tighten bolts that hold engine to frame.

4. *Engine Overheats.*

Lack of water.—Examine radiator for leaks. Examine water pump for leaks. Examine hose connection for leaks.

Lack of oil.—Examine oil level. Examine crank case for leaks. See if oil pump is working.

Water not circulating.—Examine water pump for loose impeller. Examine hose connections for stoppage.

Oil not circulating.—Examine oil pump gears or plunger for wear. Examine check valve in oil line for dirt under it and in bearings. Examine lubricating system for stoppages in pipes.

Incorrect valve timing. Incorrect ignition timing.—(See "Engine Has No Power").

Mixture too rich.—Examine carburetor adjustment. Readjust. Examine float level and float. Float set too high. Examine choke wire and choke valves for broken, loose and worn parts.

Fan belt slips.—Shorten or install new.

Radiator dirty inside.—Rinse out with some kind of rust removing solution. Wash outside with a fairly strong stream of water and work the stream through the radiator.

Radiator leaks.—Repair.

Pump leaks.—Examine pump shaft for wear. Repack pump.

Hose connection leaks.—Tighten hose clamps. Remove and smear with white lead inside the hose and replace hose.

5. *Engine Misses at Low Speed.*

Leaky intake valve guides.—Fit new guides or valves or both.

Loss of compression.—(See "Engine Will Not Start").

Valves leaky and not seating properly.—(See "Engine Will Not Start").

(*See "Ignition Troubles"*) (*See "Carburetor Troubles"*).—(See "Ignition and Carburetor Cures").

6. *Engine Misses at High Speed.*

(*See "Carburetion and Ignition Troubles"*)—(See "Carburetion and Ignition Cures").

Engine overheats.—(See "Engine Overheats" under "Engine Has No Power").

Sticking valves.—(See "Sticking Valves in Guides" under "Engine Has No Power").

Valves not seating properly.—(See under "Engine Has No Power").

Weak valve springs.—Test and see that all are uniform and then replace those that are weak.

7. *Engine Runs Smoothly.*

(*See "Ignition and Carburetor Troubles"*)—(See "Ignition and Carburetor Cures").

Mixture too rich.—(See "Choke Not Working" under "Engine Will Not Start"). Adjust carburetor. (See "Ignition and Carburetor Cures").

Uneven compression.—(See "Leaky Valves" under "Engine Has No Power"). (See "Worn Piston and Piston Rings and Cylinders" under "Engine Has No Power").

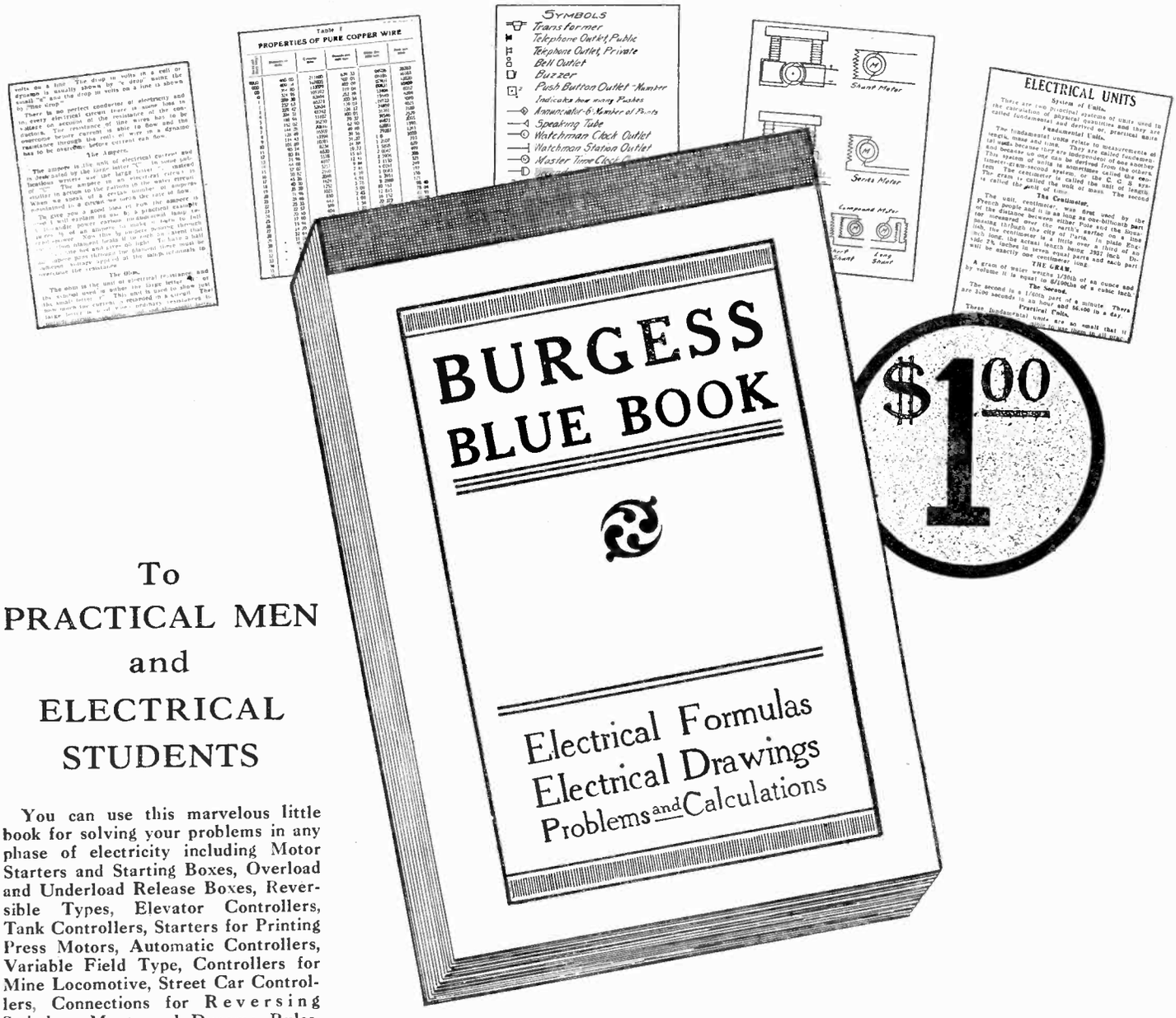
8. *No Oil Circulating and Gage Showing No Pressure.*

Oil line stopped up.—Thoroughly clean out oil system.

Gage not working.—Test out with new gage. Break in oil line between pump and gage. See that check valve and ball checks are working correctly. No oil in crank case. Bearings need adjusting. Pump gears worn.

Dirt under valves in line.—Take out check valve, clean and replace.

Pump plunger stuck.—Plunger return spring broken. Dirt in plunger cylinder.



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COPPER BETTER CONDUCTOR THAN SILVER

An enormous tonnage of copper now used in electrical transmission may be released for other fields of industry following the discovery that this metal is a super-conductor, according to L. A. Hawkins, research expert of Schenectady, N. Y., in a statement of scientific progress in this sphere issued by the Engineering Foundation of New York.

Laboratory experiments carried out by Dr. W. P. Davey of the General Electric Company, proves that the conductivity of copper can be greatly increased. Commercial utility, however, has not yet been attained, and Dr. Davey's work is regarded by science as a "tantalizing laboratory triumph," which promises to lead to industrial economy.

"A small increase in the conductivity of commercial copper would have great value," says the Foundation's statement. "An increase of even 10 per cent. would release for other fields an enormous tonnage of copper now used for transmitting power.

"The economic radius of all existing transmission systems would be increased ten per cent., increasing 21 per cent. the area served; or, the underground cable subways of cities, so many of which are taxed to capacity with their loads of today, could without enlargement carry additional loads of 10 per cent."

Possibilities of great scientific interest have been disclosed by Dr. Davey's experiments, according to the Foundation. Dr. Davey found by calculations, based on the arrangement of the copper atoms which the X-ray revealed, that copper composed of a single crystal should have a conductivity 14 per cent. greater than ordinary copper, *greater even than that of silver.*

The only known material with higher conductivity than copper is silver, a metal too costly for use in line wires. To check his calculations, Dr. Davey devised apparatus for producing large single crystals of copper.

"The single crystals were made by very gradually heating and cooling pure copper in an electric furnace," says the Foundation's statement. "When molten metal is quickly cooled, very small crystals are formed; if the melt is cooled slowly, the crystals are larger.

"Dr. Davey cooled the melt so slowly that only one crystal was formed, and that included all of the metal. By this method, he was able to produce single crystals three-fourths of an inch in diameter and six inches long, and one that is fourteen inches long.

"The conductivity of these crystals was then measured, the measurements checking within one-quarter of one per cent. of the calculated value.

"In a crystal, the atoms—the unit particles of the substance—are built up in regular fashion. The crystals of copper, for example, are made up of very tiny cubes, with atoms of copper at the corners and centers of the faces of each unit.

"The large crystals grow in such a direction that the atoms are arranged in columns along the length of the crystal. It is this regular arrangement of the atoms, which, it is believed, gives to the single crystals their superior conductivity when compared with ordinary copper, in which the crystals are small and the arrangement of these small crystals quite chaotic.

"There is reason to believe that the conductivity of copper crystals along another axis from that measured may be even 60 per cent. greater than the value for pure copper, but the growth of single crystals along this other axis has not yet been brought under control.

(*Continued on page 1067*)

Copper Better Conductor Than Silver

(*Continued from page* 1065)

"This newly-discovered high conductivity has not yet been utilized commercially, as the single crystals are very delicate and difficult to manufacture.

"One of the first facts discovered about single-crystal copper was that the specimens could be bent double with one finger, but that strength was required to straighten them afterwards.

"A crystal of the size of a lead pencil, if given a jerking motion, bends like a stick of soft wax. Having once been bent, however, it acquires the properties of ordinary copper, for the bending has transformed the large crystal into a mass of smaller ones."

Distilled Glycerine Anti-Freeze Solution

Mechanicians of leading manufacturers of motor cars are emphatic in their advice to car owners to use *distilled glycerine* in the radiators of their cars as an anti-freeze solution, and special caution is given to use distilled glycerine and not the ordinary commercial grade.

"We recommend a solution of glycerine and water, as its resistance to freezing is not weakened by evaporation," is the statement of the Packard people. "The original expense is somewhat greater but so long as none is lost by leakage, the addition of water is all that is necessary, as the glycerine itself will not evaporate even under high motor temperatures."

Automobile owners are cautioned against the contact of alcohol "with painted, varnished, or parts of the car finished with Duco as damage to the finish may result."

The Dodge experts state that "alcohol boils at about 180° and is constantly being boiled out of the solution whenever the engine becomes warm and therefore must be replaced to maintain any desired solution at the proper proportion." The instructions recommend a solution of glycerine and water, which will not boil until 220° is reached, and consistently maintains the proper proportion because of non-evaporation. "Glycerine solutions are not injurious to paint as are those containing alcohol," is the concluding statement.

All technical departments of motor car manufacturers which have recommended distilled glycerine assure owners of their makes of cars that there is no glycerine lost through evaporation, that it does not affect the finish of any car, and that its first cost is the only cost.

Each of these books of instructions give tables of solution to be compounded by the owners from distilled glycerine and water. In connection with this evident demand for a suitable commercial solution made of distilled glycerine of the correct specific gravity, it is interesting to note that a commercial brand of distilled glycerine has recently been placed on the market under the name of Ivo, which has been found to be not only correct in mixture but also safe in all contacts with parts or surfaces of cars, trucks, and buses.

One of the editors of this paper used a glycerine mixture in his car one winter, drew it off in the spring and used it the second winter. Glycerine should be tested by being mixed with water and having a bit of blue litmus paper dipped in it. If it turns it red some washing soda should be added to the mixture for the radiator and after solution it should be tested with both blue and red litmus paper. Enough washing soda should be added to prevent it affecting either the red or the blue litmus. If the glycerine is pure no addition will be needed.

MOON'S REAR SIDE REFLECTED IN SUN

(From the New York World)

From the top of a Paris apartment house moving pictures have been taken of the sun with an ordinary motion picture camera, showing the sun is a gigantic reflector which mirrors passing planets and projects their images. French astronomers have shown great interest in the pictures taken by Richard Klegin, an American photographic ray experimenter.

Klegin *registered a reflection of the moon against the dust envelope of the sun, showing on the surface of the sun a figure like a Chinese dragon which is on the moon. The dragon seems to be flying through a sea of flame.*

Recalling the ancient Chinese belief that a fiery dragon was chasing the sun, some speculate that the Chinese were able to see this phenomenon thousands of years ago.

Movies of the moon taken by Klegin show the same dragon.

Klegin says he is able to get better pictures of the sun than can be obtained with the biggest lenses because they are unable to penetrate the dust envelope of the sun, owing to decomposition of light. The Klegin method is to catch the image of the sun or planets by their own light in a prism intensifying the light of the image and throwing it on a screen many thousand times magnified. The moving celestial bodies are photographed on the screen.

(We referred this news clipping to Mrs. Isabel M. Lewis, of the U. S. Naval Observatory, and her comments, which are concurred in by Prof. Donald H. Menzel, Department of Astronomy, Ohio State University, follow.—EDITOR.)

"Two important facts are overlooked here. In the first place, the image or reflection of a disk, such as the moon, falling upon a surface ninety-three million miles away would be so minute that it would be hopelessly invisible from the earth even if it did not fall upon a brilliant background covered with countless flecks and spots of far greater size. It is absurd to speak of it being visible to the naked eye. It could not be picked up in a powerful telescope. Mercury, 3,000 miles in diameter, half as large again as the moon, when it crosses the sun's disk and is projected against it at a distance of 36,000,000 miles from the sun, is a tiny black dot invisible without a telescope. How much smaller, then, would be the image of the moon on the solar surface, since the moon is both smaller than Mercury and far more distant from the sun!

"In the second place, the surface of the sun is in constant turbulent motion. To expect to see any detail in an image falling upon its surface—even if the image had any appreciable size—would be like looking for an image of one's face mirrored in a turbulent pool of water. The whole thing is fantastical and absurd."

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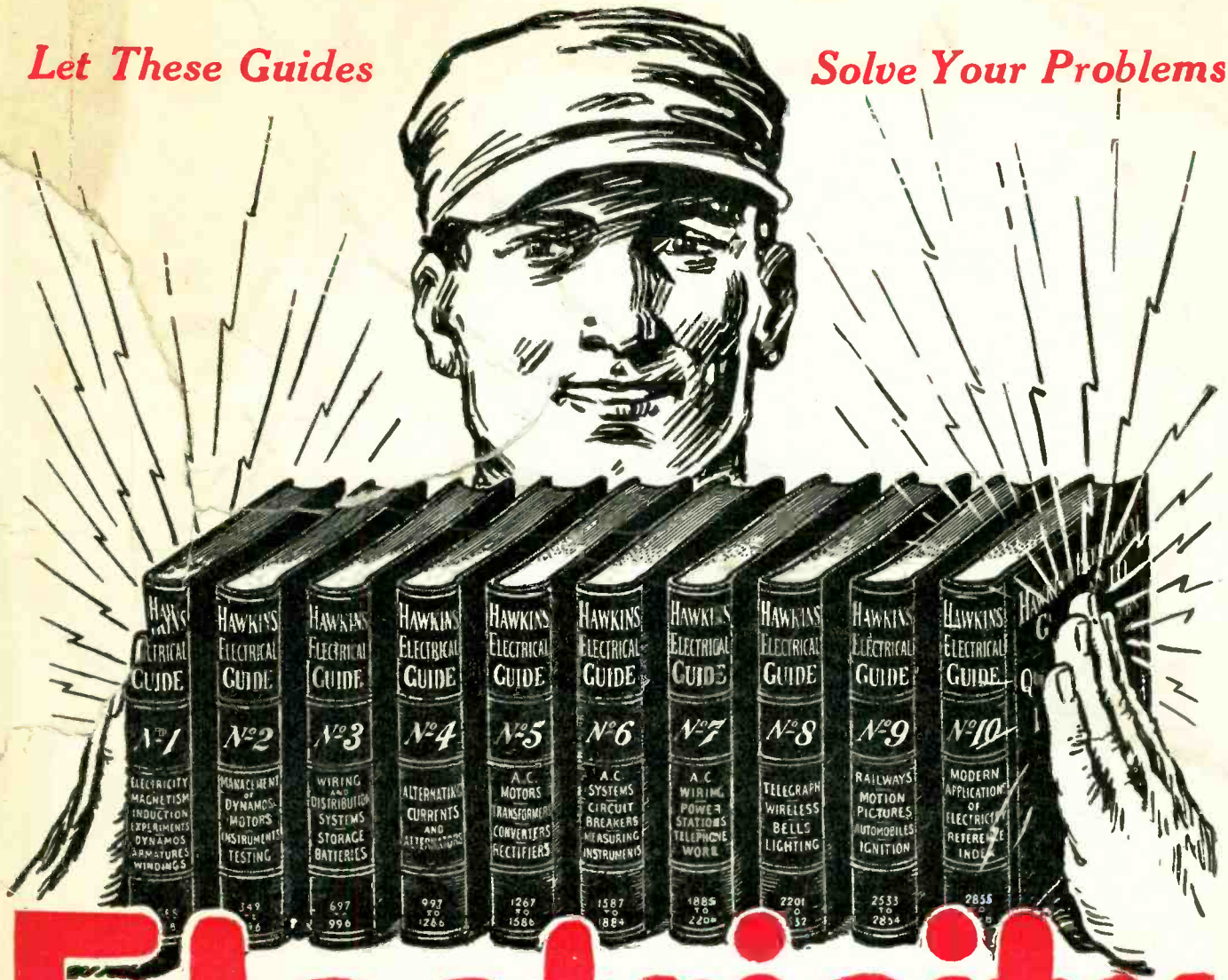

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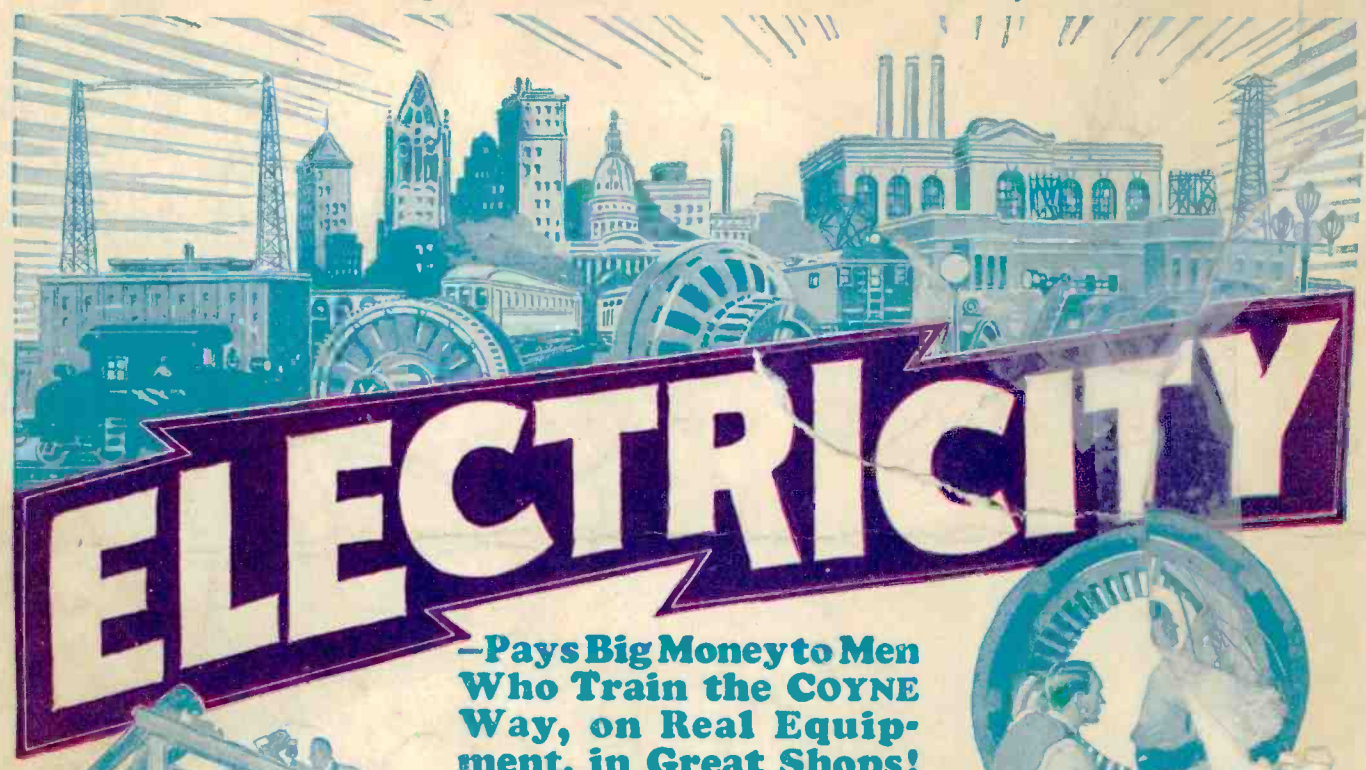

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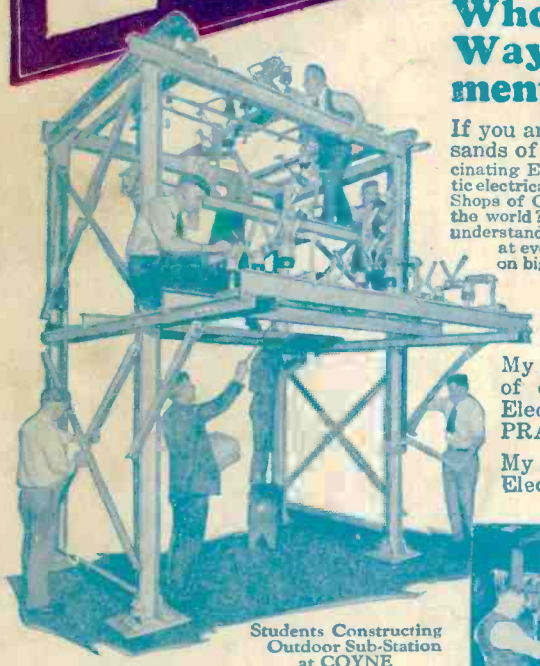

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