1	2	3	4	5	6	7
bright	*white*	*attractive*	*active*	*good*	*real*	*strong*
radiant	*snowy*	*pleasing*	*busy*	*fine*	*true*	*potent*
vivid	*chalky*	*charming*	*alert*	*splendid*	*genuine*	*powerful*
brilliant	*milky*	*magnetic*	*brisk*	*excellent*	*sterling*	*keen*
glowing	*hoary*	*enticing*	*lively*	*prime*	*sincere*	*intense*

Pick Out the 7 Best Words

Can you tell which is the most convincing word in each list? Try it. Learn to use words that win.

STUDY the words at the top of this page. See if you can select the most effective word in each list.

It's a mighty important thing to do. For the ability to use the right words in the right way, is one of the biggest, money-making powers you can possess.

No matter **who** you are—**where** you are—or **what** your daily task—words are the tools with which you work.

The only way you accomplish anything is through the use of words.

It makes no difference whether you are selling goods, buying goods, applying for a position or asking for an increase in salary, you **must** do it with words.

Therefore, the knowledge of how to use **powerful, constructive, convincing** words instead of **weak, negative, ineffective** words is of the utmost importance to you every waking minute of the day.

One reason why so many people are less than fifty per cent. efficient in speaking or writing, is because they use old, overworked, played-out, unconvincing words and phrases that have lost their power to interest and convince—words that no longer possess any real, forceful meaning.

To learn to use **right** words instead of **wrong** words, get and read our new, free book, **The Secret of Making People Say "Yes."**

Wrong Words Are Costly

The mistakes you make in the use of words cost money.

You gain or lose your friends—your position—your customers—your practice—your trade—by what you say and what you write.

Knowing how to express yourself in words that attract, interest and convince, often means the difference between humiliating failure and triumphant success.

Why is it that some salesmen earn $10,000 a year, while others, in the same line of work and with the same opportunities make only $3,000?

Why is it that one public speaker causes his audience to cheer with approval, and another speaker leaves them cold and unresponsive?

Why is it that one letter lands a good position while others only land in the waste-basket?

Why is it that some people are popular in society and make hosts of friends, while others, equally deserving, make no social headway whatever?

The answer is simple. It is because some people know **what** to say and **how** to say it. Others do not.

The subtle knack of expressing ourselves in a way that immediately secures the attention of others—the power to use interesting, forceful language — **language that convinces** — is the secret of success in almost every walk of life.

How to attain this knack is clearly set forth in our free booklet.

$10,000 a Year to Write Letters

Not long ago a business house advertised for a man to write their sales letters. The position paid a salary of $10,000 a year. The man who got the job and earns that handsome salary, does so simply because he knows how to use **persuasive, compelling** words instead of **ordinary, unconvincing** words.

There is an expert letter writer in New York City who prepares sales letters for some of the biggest business houses. It is said that he receives as high as $500 for a single letter. This seems a big price. But when you know that one of his letters sent to a big list of names, brought in more than $150,000 in orders, you can easily see that such a business-bringing letter is cheap at two or three times $500.

Any man who can put words on paper—in letters, circulars, catalogs, etc.—in a way that attracts, interests and convinces his readers can charge a great big price for his services.

And remember this: the only difference between the successful letters, circulars, or catalogs, and the unsuccessful ones—the kind that fill waste-baskets—is the difference in the words they contain—the difference between clear, positive, convincing language and hazy, negative, unconvincing language.

You will be interested in this important point as set forth in our free booklet.

FREE!

Mail coupon at once for a free copy of our new booklet which gives *The Secret of Making People Say "Yes."* You will find it amazingly interesting. Only 10,000 copies are now being distributed. They won't last long. So, get yours *today!*

Overcome Timidity and Fear

One of the important things that a knowledge of words—a mastery of speech—brings to you, is a total freedom from humiliating embarrassment and self-consciousness.

Men and women who are able to express themselves freely and fluently—who know what to say and how to say it—under all circumstances—never fall victims to the distressing influences of timidity and fear.

The ability to talk or write clearly, readily and easily at all times and under all conditions, produces a poise and power that can be obtained in no other way.

That quaking nervousness—that chilling fear—that overcomes most people when meeting strangers, when called upon to make a speech, or when they find themselves in any unusual position, is due almost entirely to the fact that they lack the power of self-expression. They do not know what to say or how to say it.

Why suffer in this way? Get our free book and learn how to get rid of this embarrassing difficulty.

Success Depends on Words

We are all salesmen—every mother's son of us. Some of us are selling merchandise. Some are selling services. Some are selling only themselves. But every one of us is trying to sell something to somebody. In other words, we are trying to convince somebody of something. We are trying to get others to do what we want them to do. We are trying to get them to say "Yes" instead of "No."

And we must do it with words.

So, you see, we all need a knowledge of the right use of words, because we all want to become better salesmen, no matter what we are selling.

The only way we can sell is by talking or writing. Therefore, our success depends upon our knowledge of what words to use and how to use them.

Get this important knowledge and get it now.

What Right Words Will Do For You

Our free booklet—**The Secret of Making People Say "Yes"**—points out the quickest and easiest way for you to learn to express yourself with the forceful effectiveness that persuades people to **do what you want them to do.**

It shows you how to gain a command of powerful English that enables you to get a good—or a better—position

—secure an increase in salary
—successfully handle important business deals
—make bigger sales and more of them
—explain embarrassing mistakes
—collect money
—write letters that win
—secure financial, and other accommodations
—attract worth-while friends
—win the admiration of those you care for.

A knowledge of the skillful use of words doubles your powers of accomplishment by doubling your ability to influence others. It gives you the power to persuade, which is the real secret of success.

Get this free book at once. It is the key to effective speech.

Do Not Delay

Send for this free book now. Do not put it off. Only 10,000 copies are now being distributed. They are sent to any one who asks for them—without cost or obligation of any kind. They will not last long. So, if you want one, be prompt.

You cannot possibly judge in advance of seeing it, what this little book can do for you, but

—by showing you how to get the maximum results from the right use of words;

—by showing you how you can easily acquire the word power to attract, interest and convince others;

—by showing you just how to please people and persuade them to say "Yes" instead of "No," it will convince you, beyond a shadow of doubt, that you took a wise step in sending for it, and that it is the most fascinating and valuable little book of information you ever got for the asking.

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Sc. & Inv. 10-22

Vol. X
Whole No. 114

Science and Invention

FORMERLY

ELECTRICAL EXPERIMENTER

October, 1922
No. 6

PUBLICATION OFFICE: 542 Jamaica Ave., Jamaica, N. Y.
EDITORIAL & GENERAL OFFICES: 53 Park Place, New York City

Published by Experimenter Publishing Company, Inc. (H. Gernsback, Pres.; S. Gernsback, Treas.; R. W. DeMott, Sec'y).

Publishers of SCIENCE AND INVENTION, RADIO NEWS, and PRACTICAL ELECTRICS

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SCIENCE AND INVENTION is published on the 25th of each month. There are 12 numbers per year. Subscription price is $2.50 a year in U. S. and possessions. Canada and foreign countries $3.00 a year. U. S. coin as well as U. S. stamps accepted (no foreign coin or stamps). Single copies, 25 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., Inc. If you change your address notify us promptly, in order that copies are not miscarried or lost.

All communications and contributions to this journal should be addressed to Editor, SCIENCE AND INVENTION, 542 Jamaica Avenue, Jamaica, New York, or 53 Park Place, New York, New York. Unaccepted contributions cannot be returned unless full postage has been included. ALL accepted contributions are paid for on publication. A special rate is paid for novel experiments; good photographs accompanying them are highly desirable.

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SCIENCE AND INVENTION is for sale at all newsstands in the United States and Canada; also at Brentano's, 37 Avenue de l'Opéra, Paris. Member of the Audit Bureau of Circulation.

General Advertising Dept., 53 Park Place, New York City.

Western Advertising Representatives, Finucan & McClure, 720 Cass St., Chicago, Ill.

Pacific Coast Advertising Representatives, A. J. Norris Hill Co., 1014 Hearst Bldg., San Francisco, Calif.

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$3 a Day for Muscle
$10,000 a Year for Brains

Only through *mental* power—not *physical* power can you achieve business success and make more money

YOU can't win big prizes with your *hands*.

You've got to use your *head*. Success is *mental* not *physical*.

Our free book—*The Secret of Mental Power*—makes this plain and tells you just how to get on the right road to mental supremacy.

Thousands of good men who were struggling along in the $100-a-month crowd are now forging ahead into the $10,000-a-year class because they had the sense to *see* and *seize* this opportunity to get and follow the invaluable advice contained in this little volume.

The only reason in the world that these men were stuck in the rut of *hard work* and *poor pay*—the only reason they never before attained the success to which they were entitled—was because they were traveling the wrong road, through ignorance of their inherent mental power—the *only* power that can possibly turn dreary failures into brilliant successes.

The big barrier to *your* advancement—the big stone against which *you* are forever stubbing your toe—will be removed the very instant you come to a full realization of the fact that your thought force—your mental power—is the *only* real productive power you possess.

Then—and not until then—will you develop your dormant abilities and possibilities.

Then—and not until then—will you graduate from the small-salaried class and go *on* and *up* into broader and higher realms of achievement.

Our free book makes this as plain as day.

The Greatest Secret of All

Why is it some men achieve success with very little apparent effort?

Why is it others succeed only after great struggles—trials and tribulations?

And still others—the great majority—never succeed at all—never pull themselves out of the mire of mediocrity?

It certainly is not due to *physical* reasons, otherwise the *physically* perfect man would be the *financially* successful man.

The secret of success is altogether *mental*. Mind is the creative principle—the producing power.

Therefore, the only difference between *leaders* and *followers*—*winners* and *also rans*—*success* and *failure*—*is* the ability to properly use, expand and direct your thoughts.

When you learn that *mental* power is supreme—that it dominates, regulates and directs every other power there is—that it can be acquired, developed and controlled—

This free book points a plain path to

- **—scientific mind-building**
- **—progressive unfolding of new ideas**
- **—destroying false fears and apprehensions**
- **—arrow-like thought processes**
- **—quick and easy learning**
- **—the faculty of focusing attention**
- **—the knack of attracting worthy friends**
- **—out-thinking your competitors**
- **—making your mind a treasure-chest**
- **—the art of being 100% alive**
- **—adaptability to circumstances**
- **—working with little effort**
- **—achieving a high reputation**
- **—gaining serenity through poise**
- **—mastering yourself and others**
- **—quick thinking in emergencies**

that it is ever available, *unlimited* in its activity, and *unbounded* in the scope of its operations, then you see that it is the most important thing for you to possess, for it will enable you to overcome your obstacles, solve your difficulties, gratify your desires, and equip you for permanent progress along an ever-ascending way.

The power to *think* implies the power to *know*. The power to think of and know *one* thing implies the power to know *all* things. Knowledge is power, and *complete* knowledge is omnipotence.

Therefore, the power of right thinking is the greatest power you can possess—the secret of all success.

"Tune Up" Your Mental Motor

Do not lose a minute's time in getting and reading this free book, *The Secret of Mental Power*.

Learn to use your mind with power and efficiency.

As soon as you gain an insight into the secret of right thinking, you will become conscious of a subtle, illuminating influence that will change your whole outlook on life, multiply your mental effectiveness and thoroughly stabilize your judgment.

These great benefits will not come as added burdens to your mind. They will come through a proper overhauling of your mental machinery—your thinking apparatus—just as your automobile is "tuned up" by an expert mechanic, who knows just what is needed to get the greatest power and efficiency from the motor.

When this important change has taken place—when the carbon of wrong thinking has been cleared out—when your mental cylinders are all firing on time and in the proper order—you will find yourself smoothly gliding over the hills of difficulty on high gear—hills which before you could climb only on low or were never able to climb at all—just because you lacked the mental power.

And you will experience the keen thrill of passing other men on the road of business accomplishment—men who have kept ahead of you only because you never before knew the *mental* secret of getting ahead.

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A great writer once said: "The surest way to miss success is to miss the opportunity."

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ELECTRICAL EXPERIMENTERS!

Actual size.

THIS BUTTON IS FREE!

SKINDERVIKEN TRANSMITTER BUTTON

MOST SENSITIVE MICROPHONE

—*IT WAS USED BY THE SECRET SERVICE OPERATIVES DURING THE WAR*

The button may be used to amplify RADIO SIGNALS by using it in a local circuit. It should be mounted on the diaphragm of a telephone receiver connected to the radio set and in circuit with a battery and a telephone induction coil.

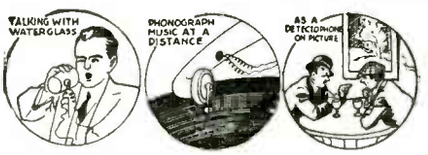
You can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

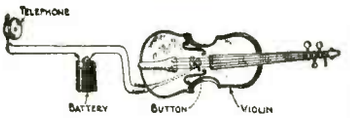
You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This outfit was used by secret service operatives during the War. It is being used on the stage.*

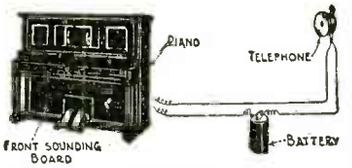
So much for its commercial adaptations! *You* can procure apparatus of the same type.

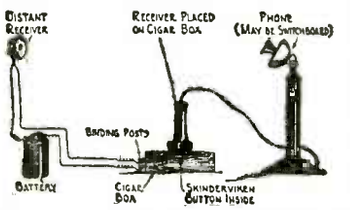
One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in microphones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.

The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.









A wire should be soldered to the diaphragm to make good contact, or to the case of the receiver if it is a metallic one. A low resistance phone is used in the primary circuit of the coil.

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

Mr. H. GERNSBACK, editor of this magazine, who is the dean of electrical experimenters, said: "In the writer's opinion, obtained by actual elaborate tests, the Skinderviken Transmitter Button is probably the most efficient device of its kind on the market today, due to its simplicity and other outstanding features. Should have a great future."

We have acquired a limited amount of these Transmitter Buttons and offer same free to our subscribers as a Premium, with a one year subscription to SCIENCE AND INVENTION. These Buttons sell everywhere for $1.00 and are worth it. We send you one prepaid upon receipt of the coupon below and the subscription price of our magazine. Do it today.

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S. I. 10-22

Volume X
Whole No. 114

Science and Invention

OCTOBER
1922
No. 6

H. GERNSBACK, EDITOR AND PUBLISHER
H. WINFIELD SECOR, ASSOCIATE EDITOR
T. O'CONOR SLOANE, Ph.D., ASSOCIATE EDITOR
Editorial and General Offices, - - - 53 Park Place, New York

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

Human Progress

WHEN we contemplate the future progress of the human race, as viewed in the light of our present civilization, a beautiful picture is stretched before our eyes. We see the millennium just ahead, man emancipated; in other words, paradise on earth.

If the progress of the human race should go along unabated as it has during the last one hundred years, Science, in five hundred years, would lift the race up to a point where it never stood before. The world then would be a place that even our most fervid imaginations could not conjecture today.

But to the student of history, all does not seem so rosy, and if we really contemplate history carefully we become a good deal more pessimistic in our views as to the future of human progress. We need not look back centuries ago. All we have to do is remember the last world war, which retarded human progress a great deal. Without wishing to be over-pessimistic, we might well tremble for the future of the race, if another such war is let loose among us before a great while.

Our present civilization is but a spider web in strength, and it does not take much to break it. Our economic and our social life is such that a complete cessation of any great industry might cause chaos. Thus, for instance, if some agency should suddenly destroy our transportation means, such as our railroads, automobiles, and ships, for as short a period as one year, civilization would be plunged immediately into a condition akin to that of the Dark Ages. The penalty of our present civilization is that it makes us soft and without resistance. We are not as hardy as our forefathers used to be. The recent war proved this conclusively, where millions of people died, simply because they were not used to the hardships which they were suddenly called upon to face.

On the other hand, if we read the past aright, we also know that as a rule history repeats itself. The Egyptians, as well as the Romans, were a highly cultured and civilized people. The Romans built the most wonderful roads in the world, which have lasted for two thousand years and upon which traffic passes every day in Europe at this very minute. They have known how to build and how to do things. The Egyptians were just as highly cultured and, perhaps, if we leave out scientific achievements, they were on a higher plane of civilization than our own. It is a mooted question today how they built their pyramids, and no architect will venture to say how they did it with the tools and facilities at their command in those days. We have never been able to embalm as well as the Egyptians, and we might recall dozens of other examples, but the point we wish to make is that it *did not last.* The Egyptians, as well as the Romans, disappeared, and left the world plunged into gloom, barbarism, and the dark Middle Ages. We might cite many other examples of great peoples who had reached seemingly the pinnacle of civilization, only to be destroyed and plunged into darkness.

In the light of these facts, will any one dare to affirm that our present world may not experience a similar fate in the future? If we take this fate for granted—and it is highly probable—should we not follow the Egyptians' example and build our own monument that would outlast the most severe ravages, just as the pyramids have outlasted not only the fury of the elements, but the destructive powers of man as well?

One of the things that has helped to create our present civilization is the electrical current, and specifically the dynamo. Why should we not build the representation of a 1,000-foot generator in concrete, of such proportions that it would not be easily destroyed, either by man or by the elements? In the interior passages, following the Egyptian example, we might engrave upon the granite walls the principles of modern electricity, so that if our world should be plunged into darkness those that follow would read what has gone on before.

Of course, there are many other suggestions that come to mind to make such a monument not only a lasting one, but a practical one as well. For one thing, if the base of the generator were solid rock there might be great vaulted passages, which would contain a complete electrical museum. A representative piece of apparatus could be placed behind glass in air-proof vaults, illuminated by electricity, either from the outside of the corridor, or from the vault within. The more air-proof we make such walls, the longer the apparatus will last. It is questionable if we should place one of our present-day electric motors in a vault that was not protected against moisture and air currents that it would last more than one hundred years. The insulation would rot very soon, and once rust started its work there would not be left much for future generations to see of this particular motor. It is this way with most of our present-day apparatus and appliances; unless they are placed almost in a vacuum they do not last long.

It is a well-known fact that our present-day books are very short-lived; even if they are kept in an up-to-date library printed books will certainly not last more than five hundred years. The ravages of small micro-organisms, as well as the destructive qualities of modern ink, make our books only of a passing interest. For that reason, anything placed in our electrical monument should be, preferably, engraved upon stone in as few words as possible. After all, stone or granite is the only material that will outlast centuries.

H. GERNSBACK.

America's Fast Mine Layers

By GRASER SCHORNSTHEIMER
NAVAL EXPERT

NEW weapons of war are constantly being developed in all countries. And this development is particularly rapid in the navies. For three centuries we have had naval mines. But up to a short time ago they were used almost exclusively for harbor defense and blockade purposes. Now various nations have high-speed mine layers capable of going to sea with their fleets to lay mine fields directly in the path of an enemy.

The idea was first conceived by the British, who refitted several flotilla leading destroyers for the purpose. The leader *Abdiel* was with the British fleet at the time of the battle of Jutland. When the Germans had started their retreat, the British commander-in-chief ordered this vessel to encircle the enemy and lay her complement of mines in their path.

Proceeding at top speed, 32 knots, this vessel worked itself entirely around the van of the retreating Germans and laid her mines at a point of vantage. The result was that the battleship *Ostfriesland*, which was bombed and sunk by our airmen a short time ago, fouled one and nearly went to the bottom. A large hole was torn in her side and it was only with the greatest difficulty that her crew was able to get her to a near-by port.

This proved the value of the type. The British refitted a number of other flotilla leaders and destroyers and the Germans built two very fast cruisers for that special purpose. However, it was not until the war was over that our Navy Department was able to attack the problem. The result is that fourteen of our 1,191-ton type destroyers were converted.

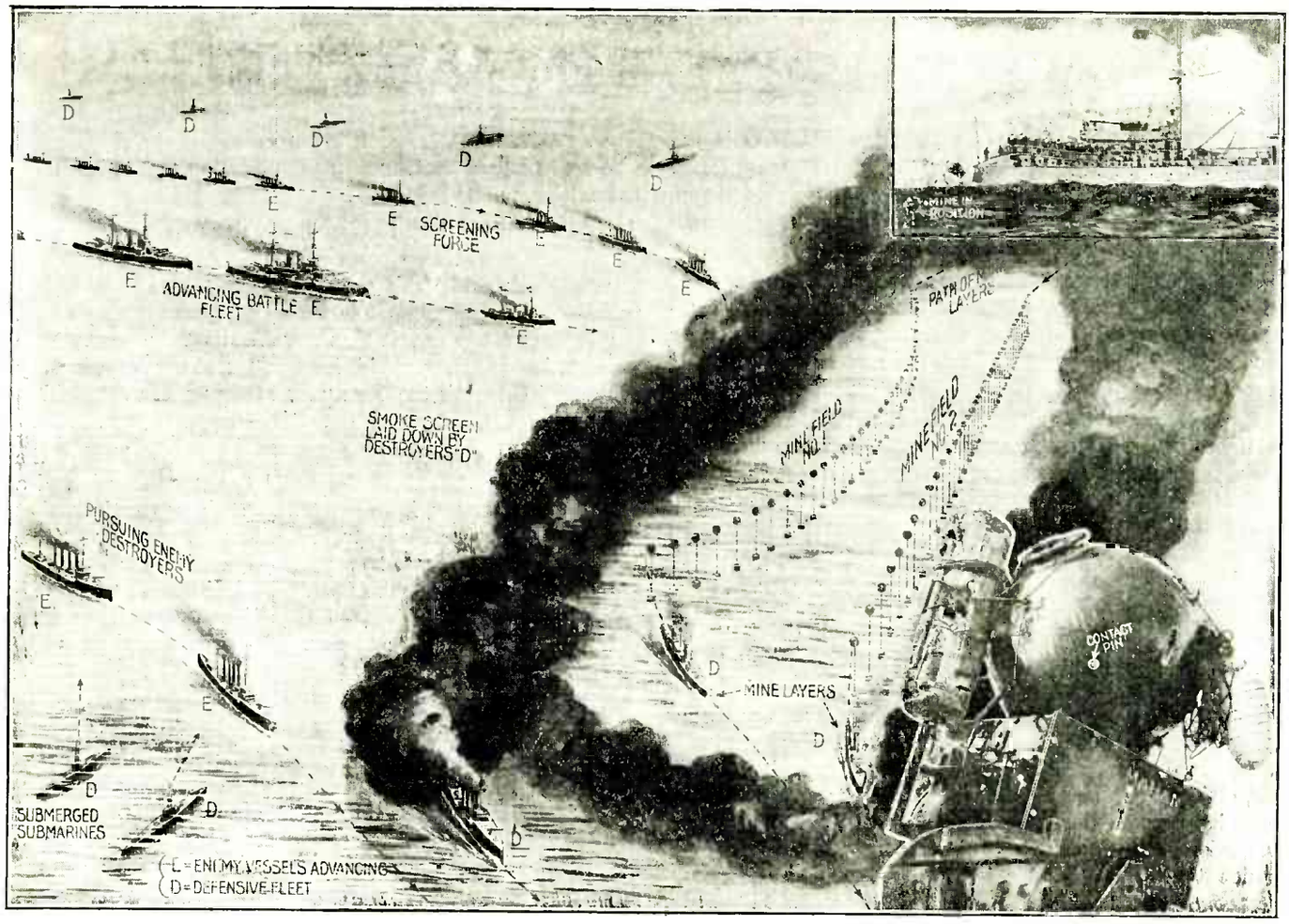
They are the *Anthony*, *Burns*, *Hart*, *Ingraham*, *Israel*, *Lansdale*, *Luce*, *Ludlow* *Mahan*, *Maury*, *Murray*, *Sproston*, *Stribling*, and the *Rizal*, the destroyer built as a gift ship at the expense of the Philippine government and which is manned entirely by a Filipino crew. All are of the same general type. The length over all is 314.5 feet, the beam 31 feet and the draft 10 feet. At their full load they displace about 1,300 tons. They are twin-screw boats and the motive power is supplied by Curtiss geared turbines, which can generate 27,000 horse-power for a top speed of 35 knots. Steam is raised in four Yarrow oil-burning boilers. The complement is about 130 officers and men, although even the few boats now in service are being operated with 80 per cent of this number, due to the Congressional cuts in the naval personnel.

Originally these boats carried four triple 21-inch torpedo tubes on their decks, but in order to make room for the mine rails they were removed. The main armament consists of four 4-inch, 50-caliber guns and a single 3-inch, 23-caliber anti-aircraft gun. However, on three of the ships one of the 4-inch guns has been removed.

The mine rails run from the sterns of the vessels to well amidships. It is understood that no less than eight of the large Mark IV mines are carried on each vessel. They are run along the rails to the stern where they are discharged into the water through a chute. These mines weigh about 1,400 pounds; as much as a 14-inch shell. The charge consists of about 300 pounds of T.N.T. The mine itself is spherical in shape, having a diameter of about three feet. The detonating apparatus consists of a set of prongs on the top sides of the mines, which explodes them on contact with any sizable object. These detonators are protected by a special safety plug, which is soluble in water.

Let us consider a squadron of ten boats operating with the main fleet in action. The commander of the fleet orders them to impede the advance of a powerful enemy fleet of battleships and battle cruisers. Scout cruisers and planes have searched out this fleet and ascertained its strength and disposition. The mine layers dash out at 35 knots and plant a double row of mines across 4,000 feet of the path of the advancing fleet, under the cover of a destroyer smoke screen.

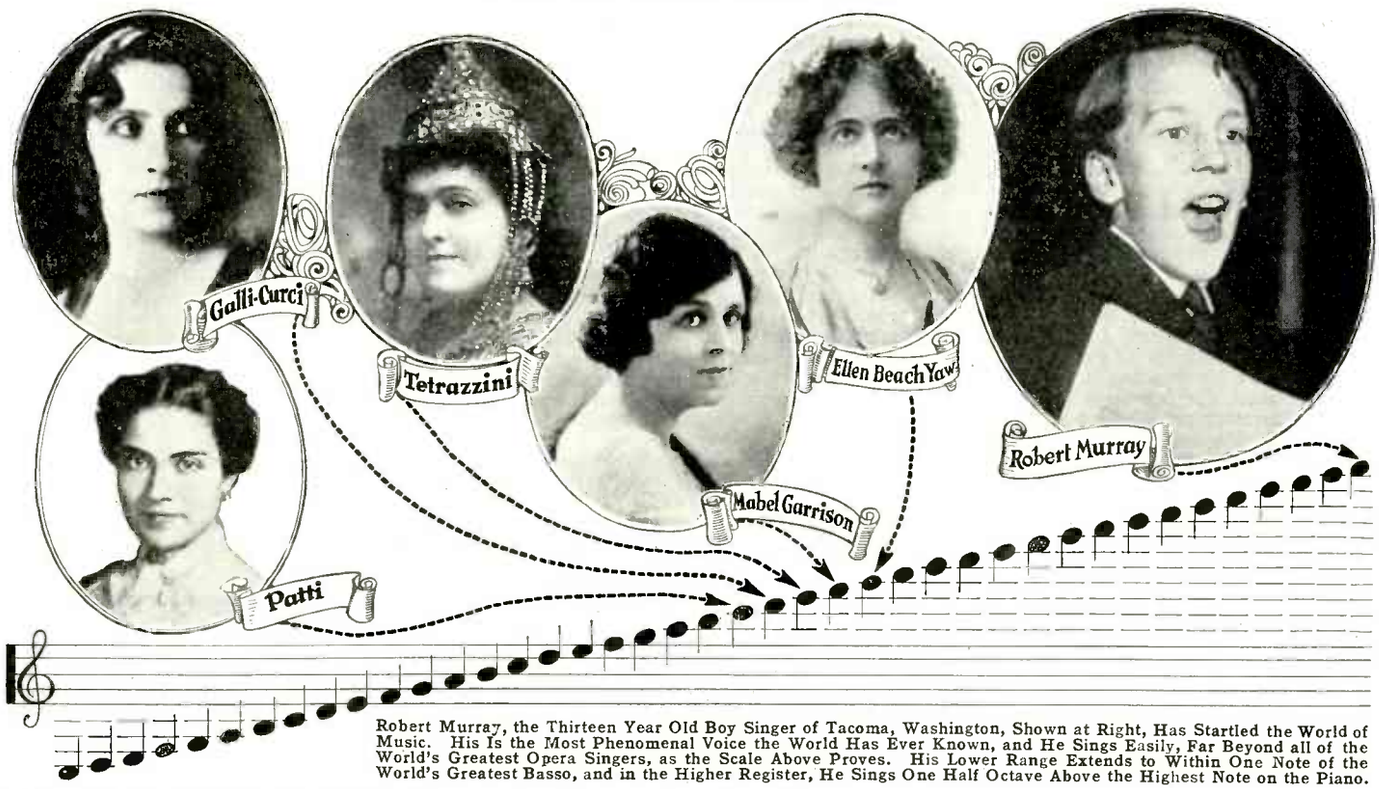
(*Continued on page 596*)



How the New U. S. Naval High Speed Mine-Laying Ships Can Lay Down One or More Mine Fields Behind a Smoke Screen, So That an Advancing Enemy Fleet "E" Will Be Wholly or Partially Destroyed. Defensive Submarines "D" Also Aid in Carrying Out This Maneuver. These New High Speed Mine Layers, One of Which Is Shown in the Act of Dropping a Mine (See Insert Photo) Can Obtain a Speed of Thirty-five Knots. These Mine Layers Can Carry One Dozen or More of These 1,400-Pound T.N.T. Mines. The Mine Is Held in Position by an Anchor or Base, So That It Is Just Below the Surface, as Shown in the Picture; the Mine Is Fired When a Vessel Hits One of the Protruding Contact Pins.

Boy Sings Six Octaves

By FRANK E. MILLER, M. D.
FAMOUS NEW YORK THROAT SPECIALIST



Robert Murray, the Thirteen Year Old Boy Singer of Tacoma, Washington, Shown at Right, Has Startled the World of Music. His Is the Most Phenomenal Voice the World Has Ever Known, and He Sings Easily, Far Beyond all of the World's Greatest Opera Singers, as the Scale Above Proves. His Lower Range Extends to Within One Note of the World's Greatest Basso, and in the Higher Register, He Sings One Half Octave Above the Highest Note on the Piano.

ROBERT MURRAY sings the highest tone ever reached by the human voice, which is more than half an octave above the highest limit of the piano keyboard and over two octaves higher than Galli-Curci's highest. The only way to determine its pitch is by the use of the Galton whistle, which is a small bore piston attached to a rubber bulb, the pitch being regulated by means of a screw-cap over the top. Each turn of the screw raises the pitch half a tone.

In a recent test young Murray reached A above the highest C on the piano, making a world's record. This is twelve full tones above the highest ever sung, and two and a half octaves higher than the high "C," the goal of the operatic tenor. The low limit of his voice is C below middle C. This is only one note higher than the lowest of Jose Mardones, the famous basso.

Robert's voice extends over a range of almost six octaves.

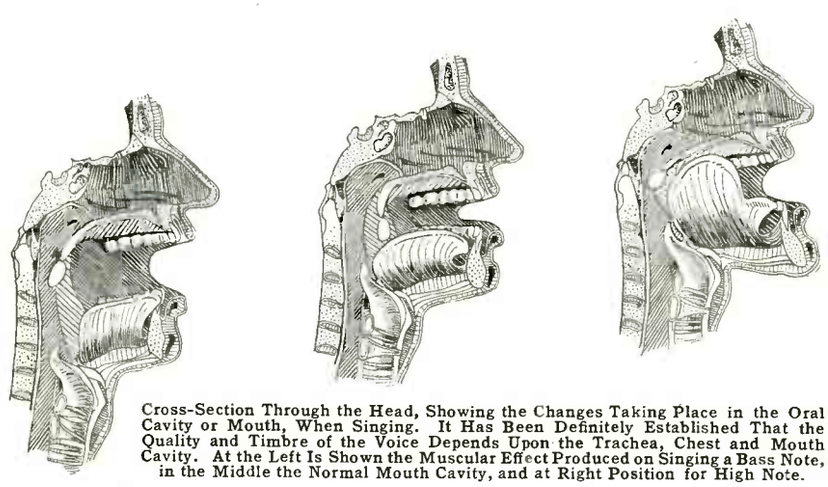
Dr. Frank E. Miller, the New York throat specialist, was one of Caruso's advisers.

I HAVE made several scientific examinations of the thirteen year old boy soprano, Robert Murray, and state that this marvelous boy has one of the most wonderful voices in the world, and has with it the geometrical brain so much desired by Plato, the philosopher, producing the strange combination of a perfect scientific singing voice and a perfect bird voice at will.

He sings twelve arpeggios from G to G in five seconds or with three times the rapidity of the usual coloratura singers.

He sings with greatest ease coloratura arias in the original keys and languages with difficult intricate traditional and original cadenzas running to G in the altissimo or the end octave of the pianoforte. These are sung with accuracy, agility, flexibility, accurate tonality, pitch and with artistry. The range of his voice runs from C 128 V.P.S. below middle C or over five octaves to A 6827 V.P.S. (or over the top of the present pianoforte) and as high as the Galton whistle, the tone tester which is higher than any known singer's record. The highest record by the late A. Theodore Wangermann who made numerous vocal experiments all over the world with the Edison Company and personally with J. Brohms Lankow and with European savants told in a personal conversation that the highest tone he had ever heard in any laboratory or conservatory was like a bird call or whistle resembling the tone of the Galton whistle, the altissimo A above the F, of the celebrated Mozart coloratura aria in the "Queen of the Night." It is also the tone of the highest note ever made by a seven-months child (prenatal) as I have personally conducted experiments with their voices on many occasions. His voice is both the highest and of the greatest range, shown in musical literature, even exceeding in the height Lucrezia Azujari, who sang before Mozart in 1770, an account of which and the music sung is given by him in a letter written in 1770, in which cadenza the artist reached C in altissimo, and which has stood as the highest record from that time to the present.

He is the most remarkable vocal phenomenon in the rare eccentric vocal attainments of ancient Farinelli fame I have ever seen or heard, partly due to the wonderful development of his throat and especially his epiglottis, which presides over a beautiful throat patterned somewhat after that of the sublime artist Melba. The factors which make his voice phenomenal are, vocal cords of unusual density, elasticity and flexibility, almost the size of an adult soprano; an epiglottis of unusual size and thickness and highly developed, which he uses with great effect in tone production; resonance chambers in the head of unusual size and clearness and adapted both in size and form to great resonance of tone; roof of palate high, well arched, and the rugae there well buttressed in form for the absolute centering and correct poise of true tone production, small tonsils and uvula. All these features or factors of the ultimate tone production while supernormal are in no sense abnormal or freakish. They are in some respects the highest development of the characteristics and most necessary voice architecture and acoustics necessary for the vocalist that I have ever known.



Cross-Section Through the Head, Showing the Changes Taking Place in the Oral Cavity or Mouth, When Singing. It Has Been Definitely Established That the Quality and Timbre of the Voice Depends Upon the Trachea, Chest and Mouth Cavity. At the Left Is Shown the Muscular Effect Produced on Singing a Bass Note, in the Middle the Normal Mouth Cavity, and at Right Position for High Note.

A Motor-Driven Parachute

By ERIC D. WALROND

A FALL in an airplane in Flanders, a broken arm and ribs, and several weeks in a hospital in Nice, gave Dr. Hubert Julian, a West Indian Negro, a first lieutenant in the Canadian Air Corps during the war, the idea for a parachute invention that is destined to revolutionize the science of aeronautics.

At the age of thirteen Lieut. Julian, who is the son of a wealthy cocoa planter in Trinidad, B. W. I., won a trade scholarship, and was sent to England to study automobiling and mechanical science. He is an expert mechanic. There he became interested in aviation, and learned to fly.

After two and a half years of experiment, during which the practicability of the parachute was demonstrated, Lieut. Julian applied to the United States Patent Office for a patent. In the estimation of Commissioner Robert Fulton, the invention was the kind that the aeronautical world had long been in need of. Demonstrations were held and its practicability established.

The device, as explained to the writer by Lieut. Julian, consists of a parachute built like an umbrella and mounted on the top of the plane, and of a motor-driven fan below it to force air into the parachute. It relates to new and useful improvements in safety appliances for airplanes.

The primary object of the invention, said Lieut. Julian, is the provision of a safety appliance for airplanes so constructed as to prevent the machine from falling in case of engine trouble, and thereby preventing resultant damages by the machine or injury to the occupants.

Another feature of the invention is the provision of a machine having a collapsible parachute attachment secured thereto and positioned above it, together with means for raising the said parachute attachment from inoperative to operative position.

A further object of the invention is the provision of a safety appliance for airplanes, including a parachute attachment adapted to be secured thereto and which is normally disposed in closed position, together with a suitable fan or propeller adapted to raise the said parachute mechanism to its extended position when desired.

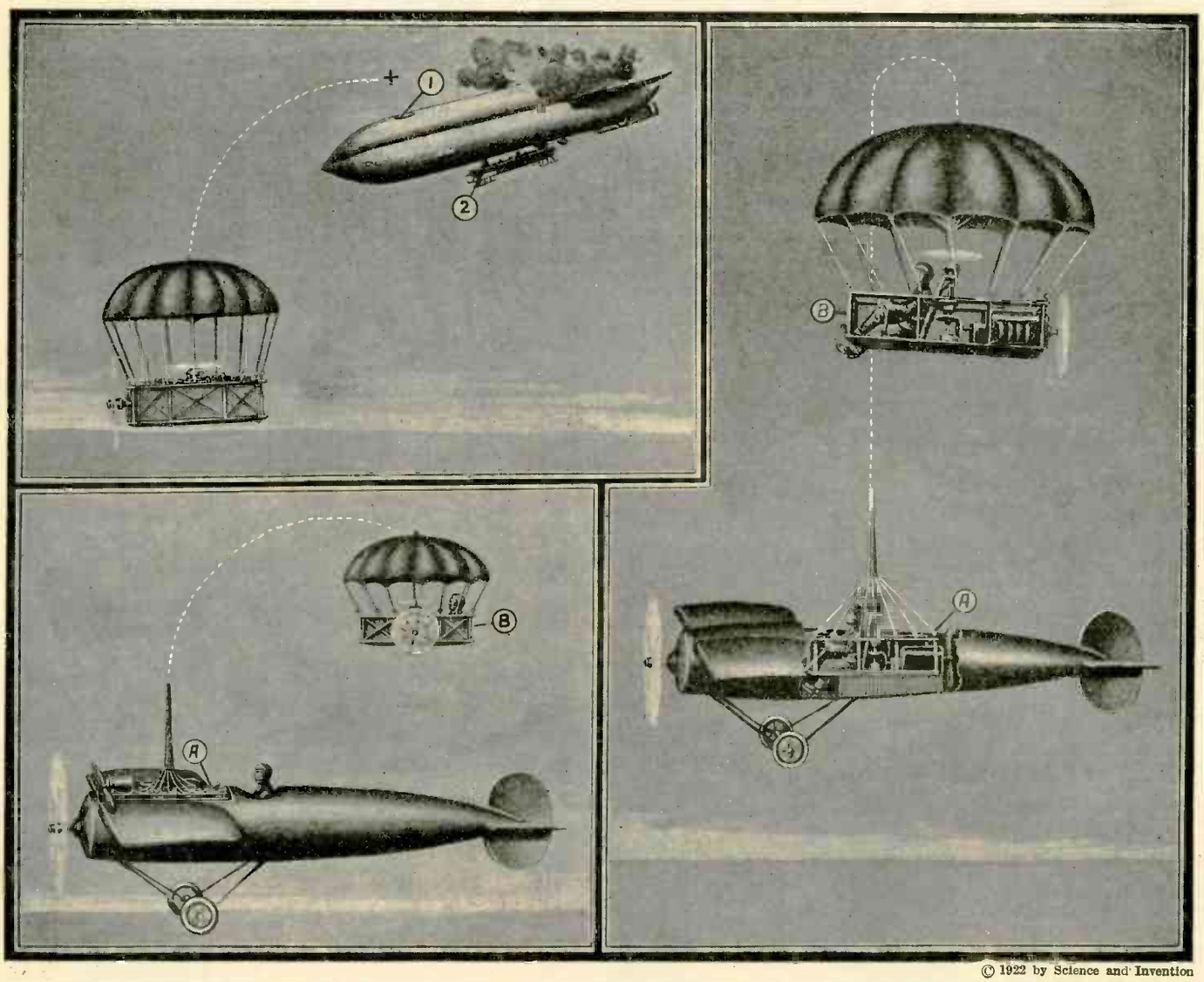
A still further object of the invention is the provision of a safety appliance for airplanes which will be comparatively simple and inexpensive to manufacture, reliable and efficient in use, and readily operated.

In case of engine trouble, it was explained, or any other difficulties which would cause the machine to fall to the ground without control, the motor is set in operation, which rotates the horizontal fan with sufficient rapidity to raise the parachute from the deflated position to full inflation, and the speed of the fan is so controlled that the air driven against the under side of the parachute will allow the machine to descend gradually and without danger of injury thereto or to the occupants.

From the description given above, and the accompanying illustration, it will be seen that a safety appliance for airplanes is provided which will fulfill all of the necessary requirements of such a device.

The parachute may be made to function as a separate device, being fitted with a small gasoline engine, fuel tank, etc., so that the parachute is dirigible or controllable, enabling the flyer to steer it in any direction. It can be used on dirigible airships as well as airplanes.

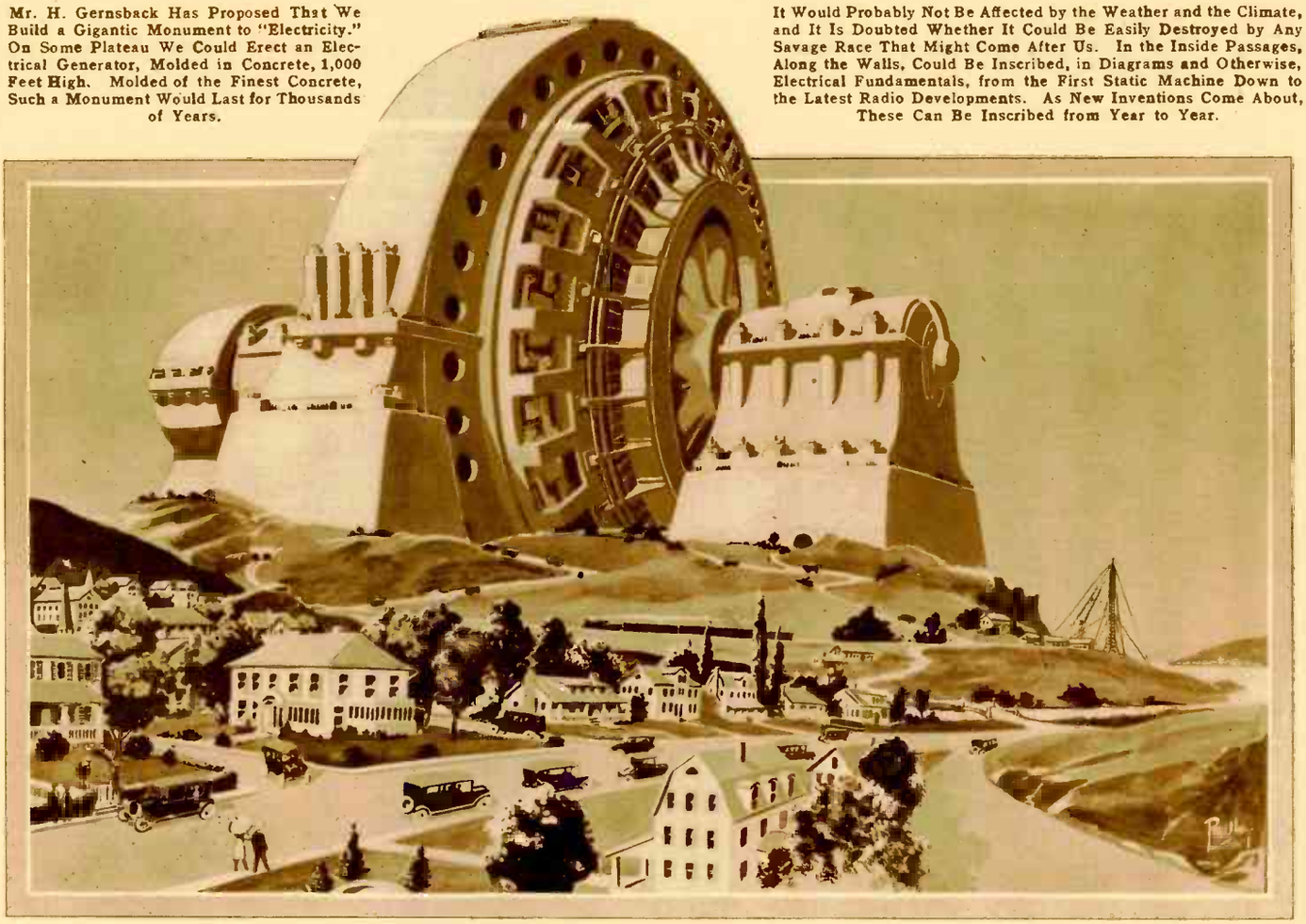
In October of the present year the company is planning a great aeronautical pageant to be held at the Glenn Martin fields in Cleveland, at which prominent airplane manufacturers will be represented.



A "Motor-Driven Parachute" Such as That Illustrated, to Aid Aviators in Descending Safely From a Burning Dirigible, as Shown in the Upper Left-Hand Picture; or Else From an Unmanageable Airplane, as Shown in the Two Lower Pictures; Is Something Radically New and a Device Which Possesses a Great Deal of Merit. With the Ordinary Parachute One Cannot Land Where He Chooses, Because He Is a Victim of Air Currents and May Be Blown into a Tree or Far Out Over Water, Etc. This Motor-Driven Parachute in One Form Is Built as a Part of the Airplane Fuselage, But Is Quickly Released by Pressing a Trigger. The Vertical Fan, Driven by the Auxiliary Parachute Engine, Helps to Quickly Inflate the Parachute Envelope, While the Propeller, Together With a Rudder at the End of the Parachute Cradle, Enables the Pilot to Steer the Craft as Desired.

Mr. H. Gernsback Has Proposed That We Build a Gigantic Monument to "Electricity." On Some Plateau We Could Erect an Electrical Generator, Molded in Concrete, 1,000 Feet High. Molded of the Finest Concrete, Such a Monument Would Last for Thousands of Years.

It Would Probably Not Be Affected by the Weather and the Climate, and It Is Doubted Whether It Could Be Easily Destroyed by Any Savage Race That Might Come After Us. In the Inside Passages, Along the Walls, Could Be Inscribed, in Diagrams and Otherwise, Electrical Fundamentals, from the First Static Machine Down to the Latest Radio Developments. As New Inventions Come About, These Can Be Inscribed from Year to Year.



Electricity's Monument

By H. GERNSBACK

IN connection with our editorial of this month, we show on this page a monument dedicated to the age in which we are living. Electricity, more than anything else, has made our present civilization what it is, and if this civilization should be wiped out by war or some other cataclysm, nothing would remain to tell what Electricity did for the race during the past century.

Before the Egyptians built their first pyramid they probably foresaw that unless they built something of a tremendous size it would not stand the ravages of man and Nature. Hence the size and form were chosen in such a way as to make it last for practically all time.

When we therefore propose to build a gigantic monument to Electricity, we have the same objects in mind. On some plateau we could erect an electrical generator, molded in concrete, 1,000 feet high. Molded of the finest concrete, such a monument would last for thousands of years. It would probably not be affected by the weather and the climate, and it is doubted whether it could be easily destroyed by any savage race that might come after us.

In the inside passages, along the walls, could be inscribed, in diagrams and otherwise, electrical fundamentals, from the first static machine down to the latest radio developments. As new inventions come about, these can be inscribed from year to year.

If the entire electrical industry would think well of such a plan, a monument of this kind could be built without taxing any one concern a great amount. It would be a lasting tribute to our race, and to the progress that is exemplified by Electricity.

Blue and Yellow Light Have Same Speed in Space

The chances are five to one that the difference in the time of passage of blue light and yellow light through empty space is less than one second in 300 years, according to a result just announced by the Harvard College Observatory. It is inferred from this result that there may be no difference in velocity whatever.

The new and extremely sensitive test of the relative velocity of light of different wavelengths is made possible, it is stated, by the recent determination of the distance of a remote globular star cluster named Messier 5, and by the completion at Harvard of a long study of the variations affecting the light of some of the cluster's brightest stars. The distance of Messier 5 is 12.2 kiloparsecs, which is the equivalent of two hundred million billion miles. It takes light nearly 40,000 years to travel across the space between the star cluster and the earth.

From a study of photographs made at the Harvard astronomical station at Arequipa, Peru, a large number of variable stars have been found in this remote star swarm. The changes in the lights of these variables have been studied at Harvard, and more recently several series of photographs of the cluster were made with a big reflector at Mount Wilson, California, using plates sensitive to blue light and to yellow light. The time of the brightening of the variable stars was then determined separately for the two colors; but no difference in the time of arrival of the blue and yellow pulses of light was found at the end of the journey across empty space—a journey that has taken the last 400 centuries.

The uncertainty of the measured result is so small, according to Dr. Harlow Shapley, director of the Harvard Observatory, that he finds the chances are twenty to one that blue and yellow rays differ in velocity by less than two inches in a second while traveling through space at the rate of 186,000 miles a second.

Blue light is closer to the X-rays and radium emanations in frequency or wavelength than yellow light, which approaches more closely the electrical waves. Whether the velocity of light changes with the color, that is with its frequency or wave-length, has been a disputed question among physicists and astronomers, although most of them believe that the velocity is constant. The velocity of light is 186,330 miles per second.

A MONUMENT TO INVENTOR OF TELEPHONE

THIS illustration depicts a proposed monument to Dr. Alexander Graham Bell, the inventor of the Telephone, who died recently. The idea of a monument was proposed by Mr. H. Gernsback, Editor of this magazine, and the idea is as follows:

Somewhere along Riverside Drive, New York, or some other prominent point, a monument in the form of a telephone receiver, from 200 to 250 feet high, should be erected, somewhat along the lines of the design shown. The monument would be built entirely of black marble or dark granite.

The interior would be hollow, with the exception of the foundation on which the imitation telephone receiver rests. This bottom section could be fitted out as a museum with all the historical models of Dr. Bell's inventions, which could be housed here for the benefit of visitors and students.

It would seem proper that the American inventors should get together and build a lasting monument of this kind by popular subscription. A voting coupon is printed on the bottom of this page, where readers may vote as to their opinion on the plan outlined. It is thought that if every inventor in the United States would subscribe only $1.00, the monument could be built.

COUPON

I, the undersigned, am in favor of a monument for Dr. Bell as outlined in the October issue of SCIENCE AND INVENTION.

I { would / would not } be in favor of contributing a small amount to the monument. The signing of this coupon does not obligate me in any way whatsoever.

Name.....

Street.....

City.....State.....

A Sub-Conscious Murderer

By NELLIE E. GARDNER

AS the Professor whipped the gun from his pocket and fired, the bailiff and attorneys rushed toward him. He had fallen, with a black spot in his temple, and then a sticky red blot formed on the collar that always had been spotless.

I bent to feel his pulse, and then drew back. Could this be the man who had shared our home, since Elaine had been a child? to whom I had entrusted her education,—the shaping of her mind and soul? This figure, now limp, had it once been the master of science?

I looked across the courtroom at my daughter's gray face and saw the staring, focusless eyes,—the windows of a brain that comprehended little and acted involuntarily.

This unexpected turn would mean the ending of the State's prosecution, and the acquittal of Elaine of the charge of murder. Would it restore my daughter's sanity? Or bring back John Cavendish, whose body had been laid, a few weeks before, in the green-hedged lot? Could anything undo the entanglement into which Fate had knotted those three lives?

I returned to my daughter's side and pressed her hand, as I had been accustomed to do, when she was a little curly-head and had cut her finger, broken her doll, or carried home her puppy killed in the streets. Always, in the crises of girlhood and young womanhood, she had come to me for sympathy. And I trust I never failed. We had no secrets from each other. I was almost as happy as she, the night she came to my bed and told of her love for John, and confided the news of their engagement. I recalled the nervous laugh, the burning cheek she pressed against mine, and her age-old cry, "Oh, Mother, you can't understand how much I love him!"

Smiling at her youthful intolerance, I cuddled my grown-up baby girl very close in my arms. And every other night, during her engagement, I lived with her in the dreams of love and watched her unfold under its radiant, warming touch. My little girl was growing up, very rapidly, these last days, and her mother couldn't help being just a little jealous and sad. It is not easy for one woman to watch another reach maturity and step across the threshold. But I had trusted to the big tenderness in the face and hands of John, whom I had known since he was a lad in knickers, and I prayed that he might make Elaine very happy.

Then came the day when I rushed to the parlor, at the sound of the shot, and found Elaine on the couch beside John, with her arms about him, sobbing, "Why did I do it?"

It was incredible. Could Elaine have fired that shot? Impossible! A burglar must have entered the room and killed John, in the struggle. Yes, he had died defending Elaine! That must be the explanation. But there was no one else in the room, and the gun on the floor was her father's which I always kept, loaded, in the table drawer. Only ten minutes before, I had passed through the room, and the lovers were sitting close together, talking low, and smiling fondly at each other.

And now, I found her sobbing, again and again, "Oh, John, what made me do it?" Then she collapsed, and became unconscious, leaving me nothing except the agonized question, "Why?"

That question burned into every thought from that terrible day until this minute. At first I could not believe that it had actually happened. But the days brought no denial, and only repeated the unanswered question.

Once I asked Elaine to tell me all about their last hour together. "We were so happy," she said dully. "Just sitting and talking, as always. Suddenly, he seemed far away, and his face was blurred. I couldn't hear his voice plainly. All at once something pulled me, and I went to the table drawer for Father's gun,—and then—— Oh! And John just looked at me, and didn't speak. I can't tell what made me do it! Something told me to. And just a minute before he had been kissing me!"

Again she broke down, and repeated, "What made me do it? If I could only die!"

(*Continued on page* 584)

"There the Manipulator of Sciences, Physical and Metaphysical, Produced an Instrument Which Had the Appearance of a Combined Radio Vacuum Tube Set and a Stock Ticker, and Which Could Translate the Thought Waves on the Recorded 'Hyp' Film into Sound Waves That Could Be Expressed in Words and Reproduced Through the Horn, So That All the Room Might Hear and Comprehend. At Last, the Secret of the White-Streaked Ribbon and the Metal Plates Was Made Clear."

The Very Latest Advertising Stunt is to Write Your Company Slogan or Name Across the Sky in Letters of Smoke. The Other Day the People of London, England, Were Startled by Hearing an Airplane Overhead and Presently the Tail of the Plane Began to Spout a Stream of Dense Black Smoke, and Before They Had Gazed Skyward Many Minutes, They Saw that the Pilot Was Writing the Words "Daily Mail" Across the Sky in Letters of Smoke. From the Accompanying Picture Our Readers May Gain an Idea of How the Words "Read Science and Invention" Would Look Written Across the Sky Above New York. This is Not Quite as Simple as It at First Appears, the Pilot Having to Spell Out the Words Backward. One Method of Producing the Smoke is Shown in the Inset Detail Picture. A Simple Valve Mechanism Allows the Pilot to Cut Off the Smoke Producer Whenever He Desires.

Airplane Writes Words in Smoke

DURING the World War, aviation experts brought out many ingenious inventions, which would never have been thought of under peace-time conditions perhaps, and one of these was the smoke barrage for aircraft, which was described at length in the January, 1919, number of this journal, with illustration and complete details. The object of the smoke barrage for aircraft, is to prevent enemy anti-aircraft gunners from seeing the plane and accurately training their weapons on it. We are at present more interested in the peace-time application of this airplane smoke machine, and at least one aerial expert has electrified a whole city, by writing the name of a daily newspaper across the sky in letters of smoke; the name appeared 2,000 feet, or nearly one-half mile long. Major J. C. Savage, who has been experimenting with this smoke production apparatus for use on aircraft since 1913, for the British Air Ministry, holds the secret, or at least one of the best formulas so far evolved, it is said, for producing a satisfactory smoke for this particular work. Ordinary barrage smoke, such as used by the destroyers during the war for laying smoke screens to hide transports or battleships, is not satisfactory for the purpose, as it disintegrates too rapidly, and does not hold together long enough.

One of the chief difficulties met with in writing the letters in the sky, which are written in a horizontal plane usually, lies in the fact that only a very skillful pilot is able to steer the airplane properly along the tortuous course necessary in forming one or more words, particularly as the writing has to be done backward, as becomes evident on a little reflection. It is said that Captain Turner, who recently piloted a plane over London, and startled the whole city by writing the words "Daily Mail" across the sky, used as much as one-quarter million cubic feet of smoke per second. The smoke produced by the Savage formula persisted in the air for about five minutes. The words "Daily Mail" required a smoke trail about ten miles long, and the letters were all completed in less than five minutes by the aviator. The airplane flew at an altitude of about two miles or about ten thousand feet.

The detailed diagram in the accompanying illustration shows one form of smoke producer for use on aircraft, devised by John Koltko, of Watertown, Conn., during the World War. The method of producing and delivering smoke in large quantities by the Koltko method is as follows: By means of a suitable cut-off control valve in the pilot's cock-pit, the exhaust gases from the engine are directed into a by-pass tube communicating with a steel boiler or tank in the rear part of the fuselage or body. This tank contains certain heavy oils and chemicals for developing a very dense smoke. When the hot exhaust gases from the engine shoot into this tank, thru holes or perforations in the spiral exhaust pipe within the tank, a dense black smoke is produced in large quantities, and the pressure of the gases acting within the closed chamber, causes the smoke to be forced out thru the pipe leading to the tail of the plane, as shown in the drawing.

To stop the smoke production, the pilot directs the exhaust back to the usual channel. There is a good opportunity for a chemist who will perfect a first class smoke, or rather suitable chemical means for its production, as this is apparently bound to become a recognized advertising method of tomorrow. A similar effect and one capable of producing startling results, would be some form of continuous pyrotechnic display or luminous vapor, which could be liberated from an airplane at night, so as to glow against the dark sky.

SMOKE SCREEN RECIPE

In an article in the *Journal of Industrial and Engineering Chemistry*, Dr. George D. Richter reveals for the first time the formula for the most successful of the smoke screens used by the navy during the war.

The Chemical Warfare Service had a combustion chamber at the American University Experiment Station, Washington, D. C., in which various smoke-making mixtures were burned and density of the vapor studied by ascertaining how much it obscured the rays of electric lights placed in the midst of it. Thus the various mixtures were measured according to their "T. O. P.," which means "total obscuring power" in its full form.

The material which showed the most promise is known as the "B. M." mixture, because it was originated at the United States Bureau of Mines.

The proportions in the following representative formula were varied somewhat, depending on the method and the form of device in which the smoke was used:

	Parts
Zinc	35.4
Carbon tetrachloride	41.6
Sodium chlorate	9.3
Ammonium chloride	5.4
Magnesium carbonate	8.3

After the mixture is ignited it makes such a cloud that the result is absolute concealment.

Doctor Hackensaw's Secrets

By CLEMENT FEZANDIÉ

No. 9—The Secret of Television

[AUTHOR'S NOTE.—*One of the inventions of the near future is the Telephotograph or Television apparatus, which attached to the telephone will enable us to see the sender of a message at the same time that we hear him, or will enable us to view a theatrical performance at home. Something has been already done in this line, but nothing satisfactory will probably be accomplished until we discard the selenium cell and use some radically different method.*]

"WELL, doctor; busy as usual, I see?" Doctor Hackensaw looked up from the peculiar instrument he was adjusting, as he answered:

"Yes indeed, Silas, busier than usual, in fact, if such a thing were possible."

"What's that new device you have there? I don't remember ever seeing it before."

"No, Silas, I haven't made it public yet, though I expect to do so very shortly, for I have the instrument pretty well perfected."

"What is it for?" asked Silas Rockett, gazing at the instrument with unfeigned curiosity, for every visit he made to the doctor's laboratory seemed to disclose some unique invention.

"This is a television apparatus. It does for images what the telephone does for sounds—carries them hundreds of miles and even further if desired. By means of electrical waves the image of an object in Chicago or even in San Francisco is brought to me here in my laboratory in New York. Nor is it a motionless photograph in black and white that I receive. The object in motion, in its natural colors is thrown upon this screen here enlarged to any size I desire. I really have a moving picture in colors of whatever scene is thrown upon the receiver of the apparatus at the sending station. You will perceive, by the way, that my screen, instead of being the usual impervious screen used in the movies, is a large plate-glass mirror, thus insuring a perfect reproduction. Sit down in this chair and you will see for yourself. To begin with, here is an oriental dance being given at this moment at the Knickerbocker Theatre by the pupils of a celebrated dancer. See how perfectly every graceful movement and every harmony of color is reflected in the mirror. I get a better view of the performance here than if I were sitting in the orchestra behind some lady's tall coiffure."

The reporter gazed at the picture on the screen with interest. He had seen movies in color—either hand-painted negatives or photographs taken by the three-color process, but never had he seen any reproduction so perfect as this. The images were as life-like as if the dancers were in the very room and he were looking at their reflection in the mirror. By means of a telephone amplifier the sound of the music could be heard at the same time, thus adding greatly to the effect of the rhythmic movements. When the dance ceased, the applause of the audience in the theatre was distinctly heard.

"It's wonderful, doctor! really wonderful!" cried Silas, enthusiastically.

"Pshaw!" exclaimed Doctor Hackensaw. "This is nothing! The idea of transmitting images by telegraph is not new by any manner of means. I am not speaking now of the tel-autograph for transmitting pictures. Both Gray and Edison perfected practical forms of the tel-autograph. In Edison's machine, a picture drawn in special ink will reproduce itself at the other end of the telegraph. In Gray's machine, the artist draws the picture at one end of the line and the stylus at the other end traces the same picture—but neither of these is real television."

"But," objected Silas, "it seems to me that I have seen accounts of real television apparatus."

"Yes," replied Doctor Hackensaw, con-

(*Continued on page* 589)

"This Is My Television Apparatus. It Does for Images What the Telephone Does for Sounds—Carries Them Hundreds of Miles and Even Further if Desired. By Means of Electrical Waves the Image of an Object in Chicago, or Even in San Francisco Is Brought to Me Here in My Laboratory in New York. Nor Is It a Motionless Photograph in Black and White That I Receive. The Object in Motion, in Its Natural Colors, Is Thrown upon This Screen Here Enlarged to Any Size I Desire. I Really Have a Moving Picture in Colors of Whatever Scene Is Thrown upon the Receiver of the Apparatus at the Sending Station. . . . To Begin With, Here Is an Oriental Dance Being Given at This Moment at the Knickerbocker Theatre by the Pupils of a Celebrated Dancer. See How Perfectly Every Graceful Movement and Every Harmony of Color Is Reflected in the Mirror."

Popular Astronomy

By ISABEL M. LEWIS, M. A.

OF THE U. S. NAVAL OBSERVATORY, WASHINGTON, D. C.

A Remarkable Double Star System

THE discovery has recently been made of a most unusual double star system by Dr. J. S. Plaskett, Director of the Dominion Astrophysical Observatory at Victoria, B. C., by means of the spectroscopic attachment of the 72-inch reflector, the second largest instrument of its kind in the world.

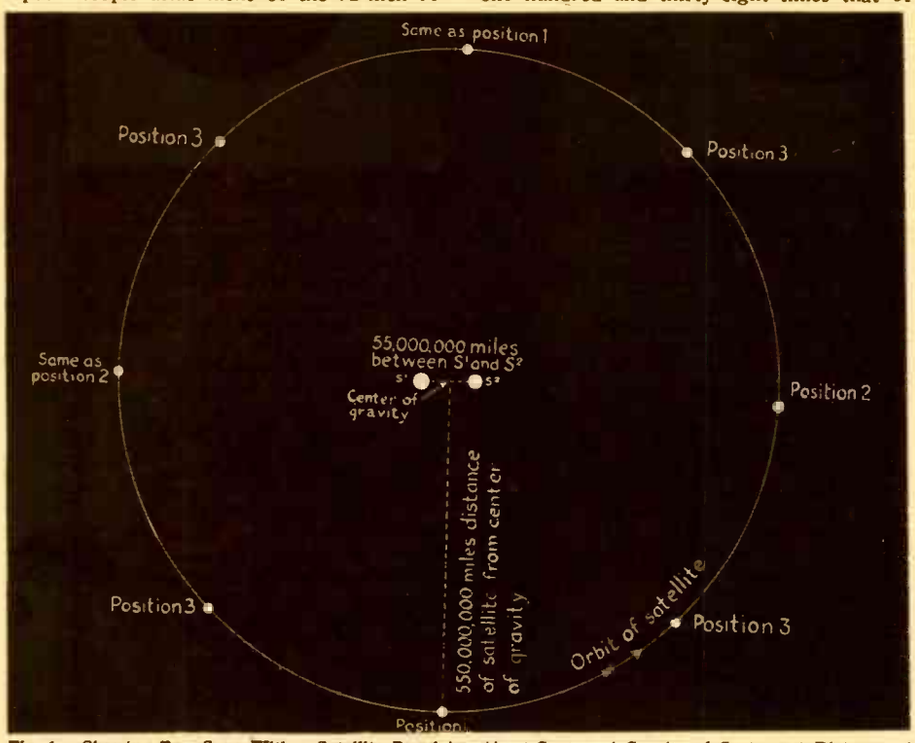


Fig. 1. Showing Two Suns With a Satellite Revolving About Center of Gravity of System at Distance of 550,000,000 Miles. There Will be No Phases, for Both Suns Shine by Their Own Light and Are Intensely Luminous, But the Sides Toward Each Other May be a Little Brighter Than Opposite Sides, Due to Reflected Light From Other Sun.

Position 1. Two Suns at Greatest Angular Separation From One Another in the Sky—About 6 Degrees; Each Sun About Four Times Greater Than Our Sun in Diameter, or About Size of Earth as Seen From Moon.
Position 2. One Sun in Conjunction With Other and Partially Eclipsed by It if Observer is Nearly in Plane of Revolution of Two Suns. More Distant Sun is Only Nine-Tenths as Great as Nearer Sun in Diameter Because It is 55,000,000 Miles Farther Away. This in Addition to Difference in Actual Size of Two Suns. (One is 18,000,000 and Other 16,000,000 Miles in Diameter.)
Position 3. Midway Between Positions 1 and 2 Angular Separation Half That of Position 1 and One Sun Slightly Smaller Than Other.

In the inconspicuous and little known constellation of Monoceros, The Unicorn, which lies just to the east of Orion, on a line connecting Betelgeuse with Procyon and about two-fifths of the distance from Betelgeuse to Procyon is a faint star of the sixth magnitude known as No. 1309 of the Sixth Degree Zone of Argelander's Catalog. The position of this star in the heavens has been recorded for over seventy years. Many observers have doubtless gazed at this star casually, but there is nothing remarkable about it when viewed telescopically, while without the aid of the telescope it would be invisible except to an exceptionally keen eye on a night of exceptionally fine seeing and, if seen, no one would give it a second glance. Yet by the aid of the spectroscope attached to one of the greatest telescopes in the world Dr. Plaskett has made the following discoveries concerning this modest looking little star of the sixth magnitude.

It consists of two suns in mutual revolution separated by a distance of fifty-five million miles. These stars are both of the type known as Orion or B-type stars, which are believed to be the hottest and most massive of all the stars. The mass of one of these stars is at least seventy-five times that of the sun, and the mass of the other is at least sixty-three times that of the sun, the combined mass of the system being about one hundred and thirty-eight times that of the sun. These values are obtained on the assumption that the plane of revolution of the two stars lies in the line of sight, which is very doubtful. If the plane of revolution is inclined to the line of sight the masses would be even greater, so the values given are *lower limits* for the masses of these stars. The temperatures of the two stars, since they are of the helium type and exceptionally massive, is probably close to 30,000° Fahr. The period of mutual revolution of the stars, the observations show, is about 14.4 days, and their orbital velocities, which are given directly by the spectroscope in miles per second, are 128 miles per second for the larger, brighter star and 154 miles per second for the smaller, fainter star. The extreme shortness of the period of revolution of the system and the high orbital velocities of the stars, which were found by direct observation of the shift in the spectral lines, were an indication to the observer that he had discovered an exceptionally massive binary system. Since the stars are too close together to be seen as separate stars, telescopically they belong to the class known as spectroscopic binaries. An examination of the spectrum of such a star system, when the stars are comparable in brightness, shows a doubling of spectral lines owing to the fact that the two star spectra overlap. There is also a continual shift of the corresponding spectral lines relative to one another which results from the fact that the two stars are in mutual revolution. It is one of the fundamental laws of spectrum analysis that, when a source of light, as a star, is moving with respect to the observer, the lines of the spectrum are shifted from the normal position toward the blue as the star approaches the observer and toward the red as the star recedes from the observer. The velocity in miles per second with which the star in question is approaching or receding from the observer is found by measuring the amount of the shift of the spectral lines. (The extremely simple formula employed is $\Delta\lambda = \frac{V}{v}\lambda$ in which V is the velocity of light, v — the velocity of the star relative to the observer, λ is the wave-length of the line observed and $\Delta\lambda$ the measured shift of the line from its normal position in the spectrum of the star.) Of course, as the stars are in mutual revolution about their common center of gravity, they are always moving in opposite directions at any one particular time, and the shifts of the corresponding lines in the two overlapping spectra are always in opposite directions, for as one star approaches us in its orbit the

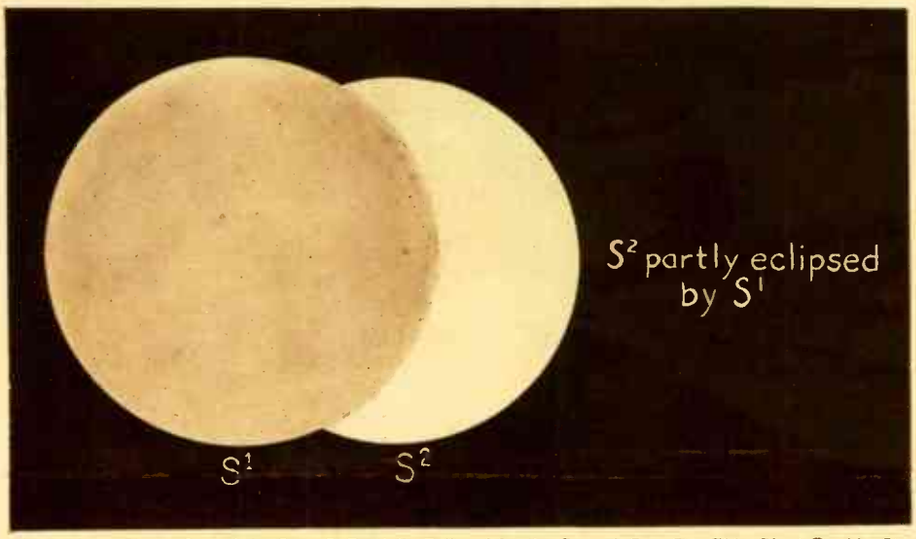


Fig. 3 Above Shows One of the Suns S² Partially Eclipsed by the Second Sun S¹. This Giant Double Star System Has Only Recently Been Discovered by Dr. J. S. Plaskett, This System Having for Many Years Been Considered a Single Star, Owing to Its Great Distance From the Earth.

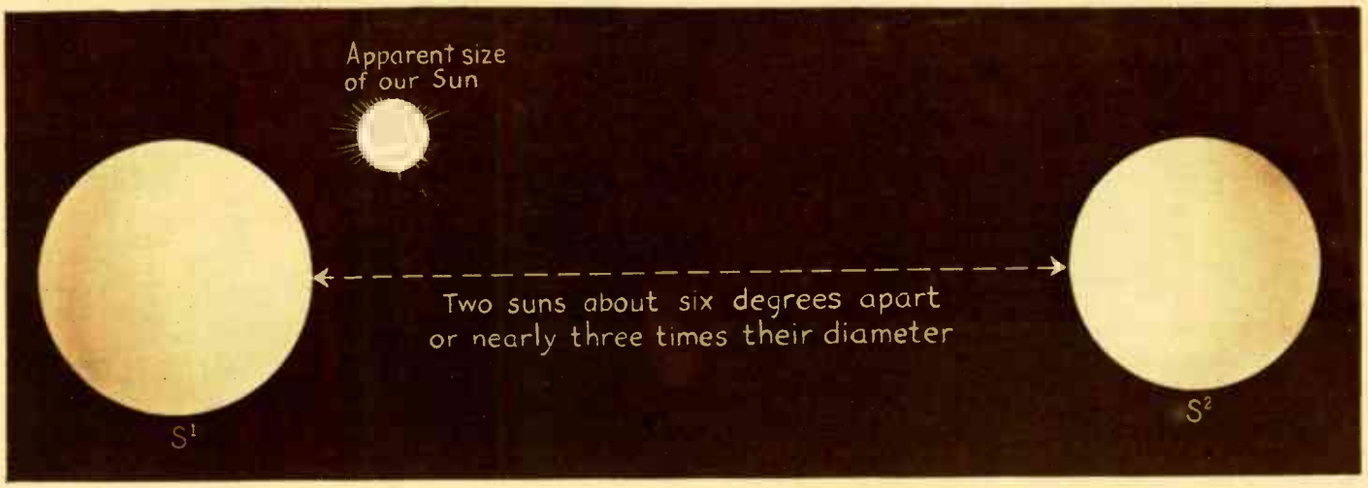


Fig. 2. This View of Two Giant Suns Spaced Approximately 6 Degrees Apart, or About Three Times Their Diameter, Shows Also Their Relative Size as Compared with the Apparent Size of Our Sun in the Heavens. This Corresponds to Position 1 Shown in the Large Diagram, Fig. 1, Wherein the Orbit of a Satellite Revolving About the Center of Gravity of Such a Double Star System is Depicted.

other star recedes from us. It is customary in making observations and measurements of spectroscopic binary stars to throw the light from some terrestrial source through the spectroscope at the same time with the light from the stars, so that the normal positions of the spectral lines of certain elements can be seen for purpose of accurate measurements of the amount of shift.

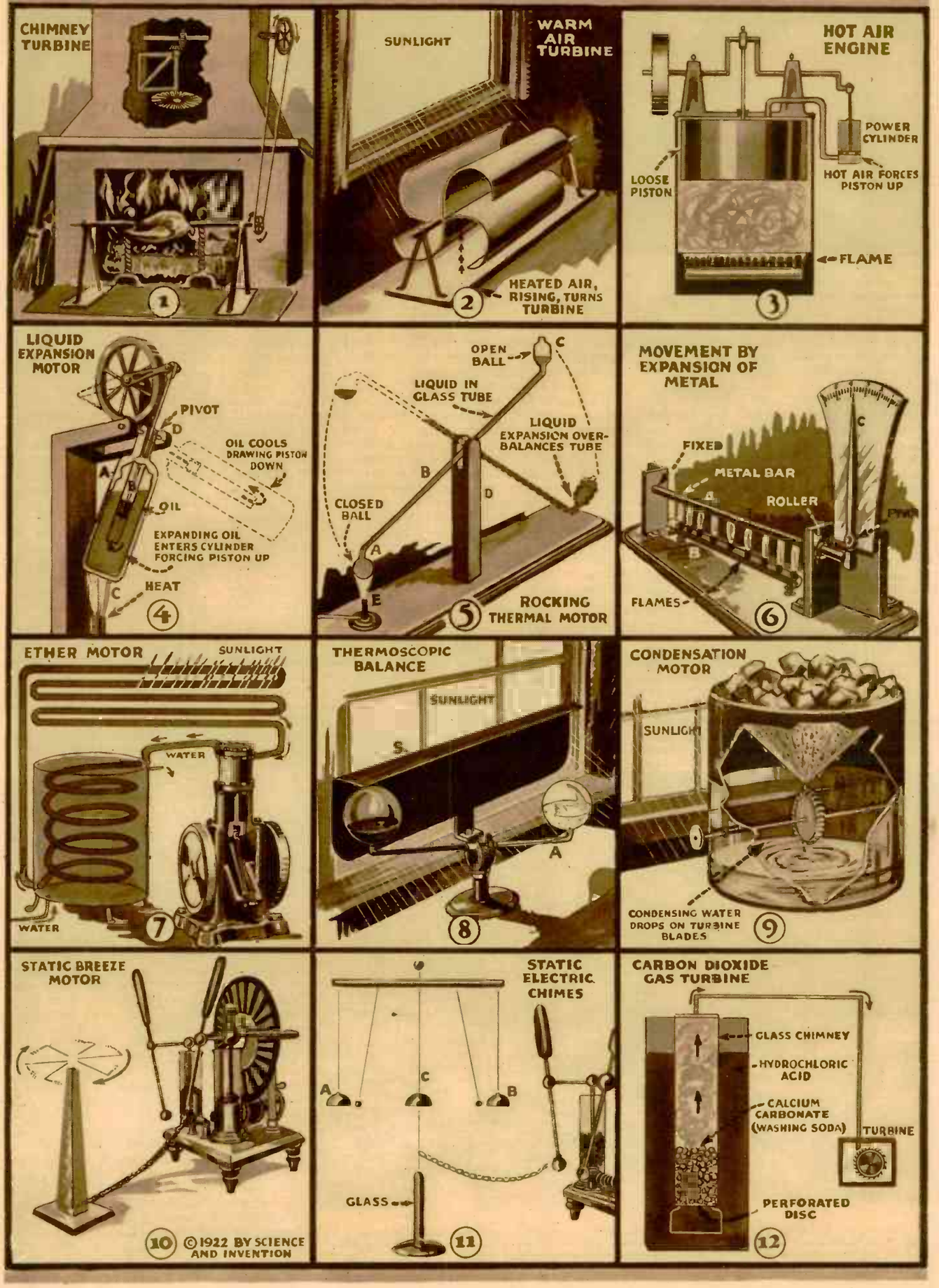
The outstanding feature in the observations made by Dr. Plaskett of this remarkable star is the exceptionally high value of the masses of the two stars, which are at least *four times greater than any previously determined masses of spectroscopic binary stars.* In fact the masses in many spectroscopic and visual binary systems are either about the same as that of the sun or only a few times in excess. It is only in binary systems that it is possible to make direct determinations of the masses of the stars through the measured gravitational pull of one star of the system on the other. It is impossible to determine directly the mass of a *single* star, though estimates of the masses of different types of stars are made by theoretical considerations of the probable densities and diameters of such stars. It is well known that mass is equal to volume times density. Knowing any two of these three, mass, density, and volume, we can find the third, and, knowing the volume or bulk of a star, we can find its diameter relative to the sun's diameter by taking the cube root of its volume relative to the sun's volume. By making an assumption as to the probable density of a star of the type to which this star belongs it is possible to compute its volume, and so indirectly its diameter. Dr. Plaskett assumes that the probable density of each of the two stars in the system he has discovered is about one hundredth of the density of the sun. Since he has already found their *combined* masses from the Harmonic Law, following from the law of gravitation, which states that the combined mass of the system compared to the sun's mass equals the cube of the separation, of the stars divided by the square of the period of revolution, he is in a position to determine the volumes of the individual stars, and so their diameters, after he has found the values of their *individual* masses by a comparison of the absolute amounts of their spectral shifts. In this way he comes to the conclusion that the diameter of the brighter star is about twenty times the diameter of the sun, and the diameter of the fainter star about eighteen times the diameter of the sun. The densities of these stars are, of course, considerably in doubt. If the density was taken as one-tenth instead of one-hundredth of the sun's density, the diameter of the greater star would be nine times the sun's diameter instead of twenty times. It is possible that some stars of this type are much denser than others, and the chances are in favor of the more massive stars of the same type being the denser. The value of the diameters found by Dr. Plaskett are, therefore, probably upper limits for the diameters of these stars. Making next the assumption that stars of this type radiate unit for unit of surface forty times as much light as the sun, which is generally accepted as true, the luminosity of the brighter star is found to be 40 times $(20)^2$, or 16,000 times that of the sun. In a similar manner the luminosity of the fainter star is found to be 12,000 times that of the sun. The total luminosity of the pair is, then, 28,000 times that of the sun. Now, knowing the apparent and actual brightness of the system compared to the sun, it is possible to find its distance from a relationship between the two, and it comes out that the star system is about ten thousand light years distant from the earth. It must be kept in mind, however, that a change in the estimated density would change the figures for volumes, diameters, and luminosities of the stars and their distance from us. With a density one-tenth instead of one-hundredth that of the sun, the distance of the star system from the earth would come out four thousand five hundred light years instead of ten thousand light years.

The giant red stars Betelgeuse and Antares, with diameters respectively 318 times and 500 times that of the sun, are, of course, much more bulky than the members of this newly-discovered system, but the masses of these red giant stars are unknown. It is generally considered that their densities are about one-thousandth part of the density of air at sea level. This would mean that their densities are only about eighty-nine hundred millionths (.00000089) of the density of the sun. Now, since the mass of a star equals its density times its volume, we can get approximate values of the masses of Betelgeuse and Antares by multiplying their densities as given above by their volumes. It has been found from measurements made with the interferometer at Mt. Wilson that the diameter of Betelgeuse is approximately 318 times the diameter of the sun and the diameter of Antares is about 500 times the diameter of the sun. The volumes of these stars are then, respectively, 32,000,000 times and 125,000,000 times the volume of the sun. Multiplying these values by the assumed density for stars of their type given above, we find that the mass of Betelgeuse is about 29 times the mass of the sun, and the mass

(*Continued on page 583*)

Fig. 4 Above Gives Us Some Idea of the Remarkable Effect Produced by the Double Sun System in the Heavens, Both Suns Being of Equal Size and Brilliancy. This is a Possible Condition on a Distant Planet in Proximity to the Double Star System Here Illustrated and Described and Known as No. 1309 of the 6th Degree Zone of Argelander's Catalog. This Interesting Double Star System Was Previously Believed to be Only a Single Star, Due to Its Great Distance From the Earth and the Consequent Faint Light Visible Through Our Ordinary Telescopes. This Remarkable Discovery Has Recently Been Made by Dr. J. S. Plaskett, Director of the Dominion Astrophysical Observatory at Victoria, B. C., by Means of the Spectroscopic Attachment of the 72-Inch Reflector, the Second Largest Instrument of Its Kind in the World.

SOURCES OF MOTION



Unusual Methods of Obtaining Motion

By E. R. CALEY

WE are so accustomed to watching the usual means and modes of obtaining power that we often forget that besides these more common means there are many others known to science. Our steam, gas and electric devices for obtaining power are so cheap and so general that any other means of generating mechanical energy seem almost superfluous. And so they are, in a practical sense. But, these other means of obtaining motion are many of them exceedingly interesting and instructive and serve oftentimes to illustrate some general law of physics in an unusual manner. The ordinary methods of obtaining power from nature by means of wind and water-turbines are too well known to need any discussion, although the many novel and diverse forms of these motors present an interesting study in themselves. It is with the unusual and little known sources of power that I wish particularly to deal in this article. For purposes of convenience I will classify the various devices under the different forms of energy.

I. Devices Operated by Means of Heat Energy.

(*a*) *Those operated by the expansion of heated gases.*

Under this heading come the great variety of hot air engines. The simplest form of the hot air engine is the turbine illustrated in Fig. 1. In many old houses in Europe these turbines are found to be mounted, usually above the kitchen fireplaces. In England they went by the name of "spitjack," and were used to turn a fowl or joint that was to be cooked over or in front of the open fire. Very little power, of course, is generated by a device of this nature, although the application of the power of the ascending gases expanded and made lighter by the fire is in itself interesting. The same principle obtains in the child's paper spiral revolving over a hot air register. A little-known device operating on the same principle is shown in Fig. 2. This consists of a very lightly constructed and delicately balanced turbine wheel made out of wire and tissue paper mounted upon a wire stand. When this turbine wheel is placed in direct sunlight on the floor in front of a window the wheel revolves due to the ascending current of heated air. We now come to the true hot air engine; i. e., one of the reciprocating type based upon the expansion and contraction of a confined gas. Perhaps what is the simplest type of this engine, which has been made in many forms, is shown in Fig. 3. This consists of two cylinders, the first a large one containing a large, hollow, loosely fitting piston and heated on the bottom with a fire. The second cylinder is the power cylinder, much smaller, and containing a tightly fitting piston. The two cylinders are connected by a short passage, as shown in the figure. These two pistons are attached to a common crankshaft at an angle of 180°. When the loosely fitting piston is at the top of its stroke the confined gas is heated by the fire and in expanding forces up the piston in the power cylinder. This, of course, causes the loosely fitting piston to descend, forcing the gas or air past it up into the top and cooler part of the large cylinder, when it contracts and causes the descent of the power piston. This action takes place quite rapidly so that these engines develop several hundred R. P. M. Hot air engines are used in laboratories as a convenient small source of power. The great defect of these engines is the large bulk necessary in proportion to the power obtained from them, as well as a rather low efficiency. The great engineer Ericsson of Civil War fame attempted to apply these engines to the propulsion of boats with no great success.

(*b*) *Devices based upon the expansion of liquids.*

Liquids when expanded by heat and contracted by cooling are capable of exerting enormous pressures in changing their volume. This principle may be applied in an engine to produce motion. Such a machine is shown in Fig. 4. It operates as follows: A strong iron vessel A is filled with a liquid having a high coefficient of expansion. Oil is a very good liquid for the purpose. This vessel has inserted in it a smaller cylinder B containing a tightly fitting plunger. The plunger is connected to a crank which in turning raises weights that may be utilized to run a train of gears. When the cylinder A is in the first position, as shown, it is then heated by the fire C. The force of the expanding liquid turns the crank and at the same time causes the cylinder to move out of the flame since it is pivoted at point D. On cooling, the liquid contracts and the cylinder returns to the first position. As this reciprocating motion is necessarily slow the device of first utilizing the power to raise weights and then having these operate a gear train is necessary if a continuous, uniform motion is desired.

A simple device to produce motion simply from the volume change of liquids is shown in Fig. 5. A small bore glass tube B pivoted on the pillar D has blown on it at one end a round bulb A; on the other end an open vessel C. The tube is filled with some liquid such as colored water or alcohol. When the burner E is placed under the bulb A some of the liquid is forced into C by expansion, causing C to lower and lift A out of the flame. On cooling the liquid returns, causing A to sink again. This alternating motion continues as long as heat is applied, varying in speed according to the degree of heat applied and the nature of the liquid.

(*c*) *Devices based on the expansion of solids.*

Solids also exert an enormous force on contracting or expanding and this force may be utilized to produce motion. An instrument used in physics lecture experiments to illustrate the expansion of solids is shown in Fig. 6. A metal bar A is heated by a long burner B. On expansion the bar moves the lever C and the amount of expansion somewhat multiplied is shown on the index. The expansion of a solid, however, is usually such a small per cent. of its original length that it is difficult to apply the motion and exhibit it in the form of continuous, circular motion. If two solids having different coefficients of expansion, such as brass and steel, are riveted together then the motion produced will be very considerable and has been applied in operating a clock train or some similar device.

(*d*) *Devices based on the conversion of gases into liquids and liquids into gases.*

The most familiar type of engine operated by the conversion of liquids into gases is the common steam engine. In this connection the utilizing of the sun's rays to raise steam in a boiler is peculiarly interesting. Some of these sunpower motors are in successful operation in some of our southwestern States, such as Arizona and California. The importance of these devices is bound to be great in the future when our ever-decreasing supply of natural fuels becomes so depleted that other sources of power become a necessity. Besides water, other liquids of course may be used to operate engines of this type. Naphtha and ether engines have been constructed and successfully operated, although there is, of course, considerable danger connected with engines using such volatile and inflammable liquids as a medium. An engine using ether that may be operated in ordinary sunlight is shown diagrammatically in Fig. 7. The series of copper coils which are blackened superficially with lamp black act as the boiler while the exhaust ether vapor is condensed in an ice condenser and again returned to the heating coils. The thermoscopic balance is an interesting means of illustrating motion produced by the conversion of liquids into vapors and the subsequent condensation of the vapor into a liquid again. This instrument consists of an exhausted tube A having similar bulbs at each end and pivoted in the middle (Fig. 8). A quantity of water is placed in the tube just sufficient to fill one of the bulbs. A screen S is so placed that the sun rays striking the apparatus can only affect one of the bulbs at a time. If the liquid is in the left-hand bulb as shown, then when the sunlight strikes it, it will quickly evaporate into the other bulb by reason of the greatly lowered boiling point. Then when the other bulb has received enough liquid to cause it to descend, the process is repeated in the reverse order and a slow, alternating motion

(*Continued on page* 593)

Radio Typewriter Here

By H. WINFIELD SECOR

THE radio typewriter illustrated in actual use in the business office of tomorrow on our front cover by Mr. Howard V. Brown is, contrary to what one might think at first, an actual reality, and typing letters and words from an airplane constituted the remarkable stunt recently carried out by the U. S. Naval Air Station, at Anacostia, D. C., near Washington. The accompanying official naval photographs show the radio teletype apparatus set up in the land station, and also in the cockpit of the F5L naval seaplane.

It sounds almost impossible to the uninitiated, especially when one thinks of the interference and other conditions, such as freakish atmospheric effects, which often spoil the perfect reception of radiophone concerts. However, the naval radio experts were eminently successful in hooking up their radio transmitting and receiving instruments to a Morkrum teletype machine, so that complete messages were actually typed *via radio* between the seaplane flying among the clouds and the ground station below many miles away. As the operator in the seaplane ran his fingers over the teletype keyboard, which resembles that of the standard typewriter, radio impulses were sent out from the antenna of the seaplane, and these were picked up by the aerial of the land station and properly interpreted by the delicate relays and correlated mechanism, so as to cause the type bars of the receptor to respond each in their proper turn; the printed words reeling out of the machine on a paper tape. The same type of machine is also built regularly for use on telegraph circuits, in which a wider paper is employed, corresponding to the ordinary business letter dimensions.

As pointed out by Mr. H. Gernsback, the radio typewriter, as it will no doubt be known shortly, will fill a long felt want in the business world. A typist will sit down at one of the radio typewriters of the style shown herewith, as well as on our front cover, and simply spell out the letters in the usual manner on the keyboard of the apparatus. A vacuum tube transmitter will supply the source of high frequency currents, which will be caused to radiate from the antenna in the form of dots and dashes, but in a special code, each combination of dots and dashes corresponding to a letter of the teletype alphabet. Instantly, in view of the fact that radio waves travel through the ether with a velocity of 186,000 miles per second, the radio typewriter, let us say, in Chicago or San Francisco, will start clicking off the letters, and when the letter is finished, the operator at the sending end will give a special sign-off character or combination of signals, which will cause the receiving instrument to perforate and detach the finished letter from the continuous paper strip, the finished letter dropping into a basket, as shown in our illustrations.

Of course it is the best policy in any business transaction, whether large or small, to always keep a record of anything you may write to a second party, no matter how

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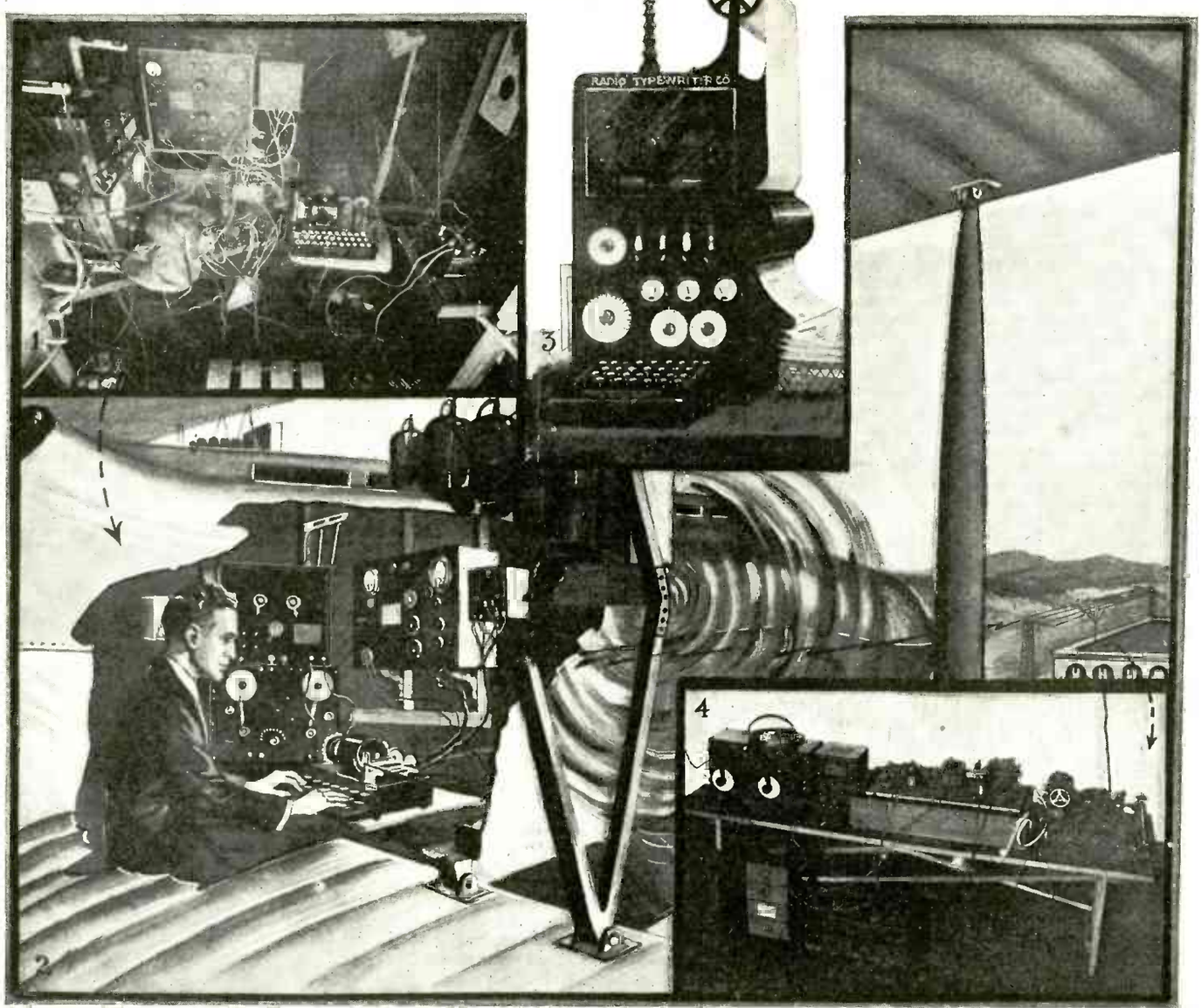
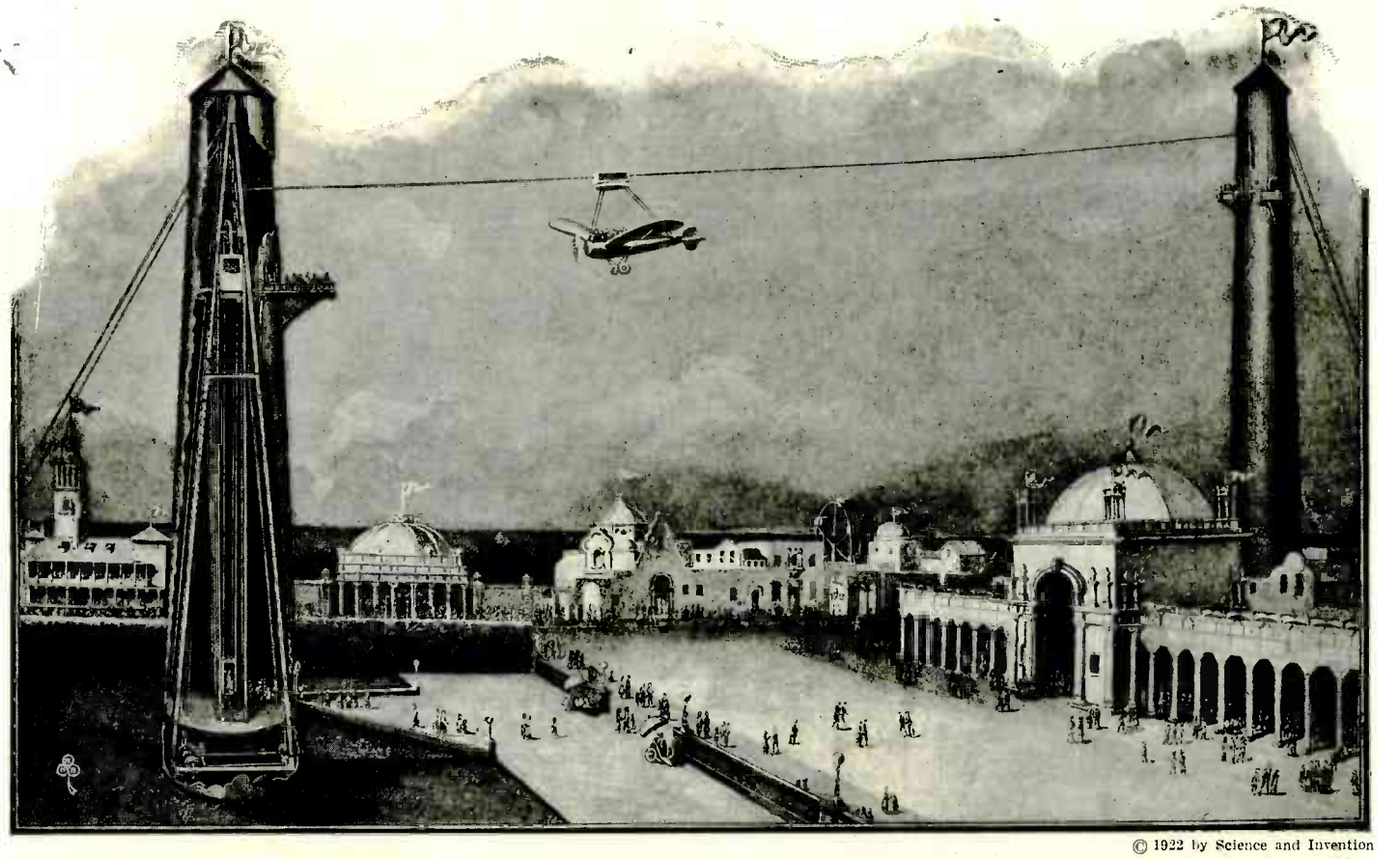


Yes, It Has Been Done—the Radio Typewriter Is Here at Last, and We Have to Thank the Radio Experts of the U. S. Naval Air Station at Anacostia, D. C., and Associated Engineers, Who Were Successful the Other Day in Actually Typewriting From a Naval Airplane, Shown in the Foreground, to a Land Station. Figs. 1 and 4 Are Official U. S. Naval Photos, Showing, Respectively, the Radio Typewriter Keyboard and Vacuum Tube Transmitting Set Installed in the Cockpit of the Seaplane and the Radio Typewriter in the Land Station, on Which the Paper Tape Reeled Off With the Printed Letters on It. Fig. 3 Is the Radio Typewriter Suggested by the Author and Mr. H. Gernsback, for Use in Business Offices of Tomorrow. The Radio Transmitter, of the Vacuum Tube Type, Is Incorporated in the Same Cabinet With the Typewriter Mechanism. The Letters Are Printed on a Wide Paper Roll, the Letters Being Perforated or Cut From the Strip at the End of Each Letter Automatically. This Marks One of the Most Astounding Feats of Applied Radio Science Since Marconi Transmitted His First Signals Across the Atlantic Ocean.

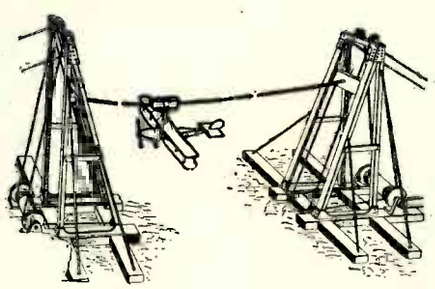


All the Thrills of a Real Airplane Trip Through the Skies Are Supplied by This Latest Invention, Comprising a Captive Airplane Which Travels Back and Forth on a Steel Cable, the Ends of the Cable Being Raised and Lowered as the Plane Approaches Either Tower. Passengers May Be Loaded from One Tower and Given a Ride to the Opposite End of the Cable and Return; or Where an Extra Long Cable Is Employed, Thus Giving a Longer Trip, Passengers May Be Simply Carried From One Tower to the Other Tower. The Plane Is Swung on a Revolvable Suspension Provided With Grooved Wheels, Which Travels Along the Cable

Captive Pleasure Airplane

AIRPLANE rides, or at least those in real honest-to-goodness planes that soar upward 1,000 feet or so, have not as yet come within the reach of the great fun-loving public, the cheapest trips in real airplanes being about five dollars. Mr. Frank Chapman has recently taken out a patent on the captive airplane here illustrated, and it is so designed that it should appeal to amusement park owners, as the cost of building or installing the machinery necessary for operating it, is not prohibitive. By simply lengthening the cable, a proportionately greater amount of pleasure is obtained from this pleasure thriller, as the longer the cable, the longer the ride; and other things being equal, that is, with regard to height of towers, etc., the faster the plane will travel.

Briefly considered, this scheme requires two substantial wooden or steel towers 50 to 100 feet high, each tower being equipped with a vertically rising and falling cradle or carriage, and a set of winches to raise and lower these carriages, which latter are used to raise and lower the two respective ends of the steel cable along which the plane *flies*. When the plane has been loaded with passengers from the platform at one of the towers, let us say, the cable-carriage is raised slowly, causing the plane to start traveling outward along it. By skillfully raising and lowering the carriage at one end or at both ends for that matter, the speed at which the plane travels along the cable, including the approach to the second tower, may be nicely controlled, and it is a simple matter to provide a brake to grip the cable, so as to be under the control of the pilot aboard the plane. Where a very long cable is used, passengers may be loaded at one tower, and discharged at the other end of the run; where the cables are not so very long, say 200 to 300 feet only, the pleasure seekers may be given a round-trip or a ten-cent ride possibly, the loading and unloading platforms being arranged as shown in our picture, all on one tower. It is usually the case that people do not like to go on one of these pleasure rides at amusement resorts, where they are discharged from the carriers at a point distant from the one at which they embarked for their ride.



From This Diagram Taken From Mr. Chapman's Patent, the Clever Arrangement for the Captive Airplane Amusement Scheme Becomes Evident. It Will Be Noted That the Length of the Cable Remains Constant and Under Practically the Same Tension, for When the Cradle at One Tower Is Raised and the Other Lowered, the Length of Cable Will Always Be the Same as Becomes Evident; When the Cradle at the Opposite End Is Raised and the Other One Lowered, the Cable Length Remains the Same. This Idea Is Adaptable to Home-Made Amusement Devices.

This idea is one of the best we have seen in several years, and as aforementioned, the construction cost is very small relatively speaking, and we have no doubt that many of our young scientific friends and embryo engineers will like to build one of these amusement airplanes in their back yard, while our country friends who have lots of ground at their disposal, can rig up a long cable or rope, so as to enjoy a real thrilling airplane ride.

For a home-made structure of this type, the cable-trucks or carriages can be raised and lowered by an ordinary block and fall, or an equivalent simple system of pulleys and ropes. The cable-carriage could be raised at the starting end for example, and then by releasing a detent hook, the captive airplane would sail down the cable, swinging along just like a real airplane in free space. The cable should not be raised too high before releasing the plane, unless a brake of some kind is rigged up, so as to co-act with the cable, in order to stop the plane as it approaches the second terminal station or tower. When the plane got up close to the second tower, a hook and chain could be made fast to the plane, so as to hold it, while the cable truck in this case is raised by pulling on a block and fall rope; after it had been raised sufficiently to give a downward slope to the cable, the detent hook could be released, and down the plane would fly again to the starting tower. For the home-grown variety of this amusement thriller, it is not necessary to be quite as elaborate as to details, as in the case of a commercial amusement park structure, and it is not necessary at all to arrange the body of the plane to pivot about, as the inventor has provided for in his patent. His idea has been worked out from the amusement park point of view, where seats are arranged in the plane, and of course owing to its design being made to resemble an actual airplane, naturally it would have to be reversed or turned end for end after each passage down the cable, unless the builder elects to disregard this feature.

The towers as well as the airplane itself, can be outlined with electric lights, the current for the lights on the plane being supplied from a storage battery. Note how the cable carriages at either tower are arranged to slide up and down in tracks placed at an angle, so that as one carriage moves up and the other down, the length of the cable is kept the same, i. e., no extra strain is placed on the cable. This is very important.

Poisonous Snakes, Snake Poisons and Their Antidotes

By DR. ERNEST BADE

DEEP rooted opinions are difficult to remove; like a hereditary disease do they pass from generation to generation. And so it is that even today the all too prolific vine "phantasy" entwines its branches with undiminished vitality about that class of animals, the reptiles, bringing in its wake a mythical fear. It is the unknown, the secret and the mysterious which has something gripping and intriguing about it, and it is just this tickling of the nerves which has become a necessity.

Of reptiles, the snakes are the most abhorred. But it is a relatively small number of snakes which, by the action of their bite, produce death through poisoning. Such dangerous snakes, making in all but a small group, are, as a rule, small in size. Of about 2,000 species less than 300 are poisonous.

It seems as if the presence of the poisonous fangs is an indication of the approaching decline of this reptile. It *is* a sign of its extinction, for with it, it can *partially* withstand the more highly organized mammal. And the use of this abominable device appears to have brought the reptile low, until it has degenerated to its present plane, for once, at the height of their development, gigantic reptiles roamed the earth.

The poisonous fang of the snake is used to master its prey, only in cases of necessity is it a weapon of offense. Where cases of poisoning occur, they can be traced back to an accidental meeting, the snake striking *blindly* thinking itself attacked; for snakes, as a rule, are exceptionally stupid creatures.

Just what the status of the poisonous snake is, and what its right in nature, cannot be clearly determined. Although a large number of rodents are annually destroyed, this does not at all compensate for the damage it does. Then, too, the harmless snakes take care of a far larger quantity of these pests.

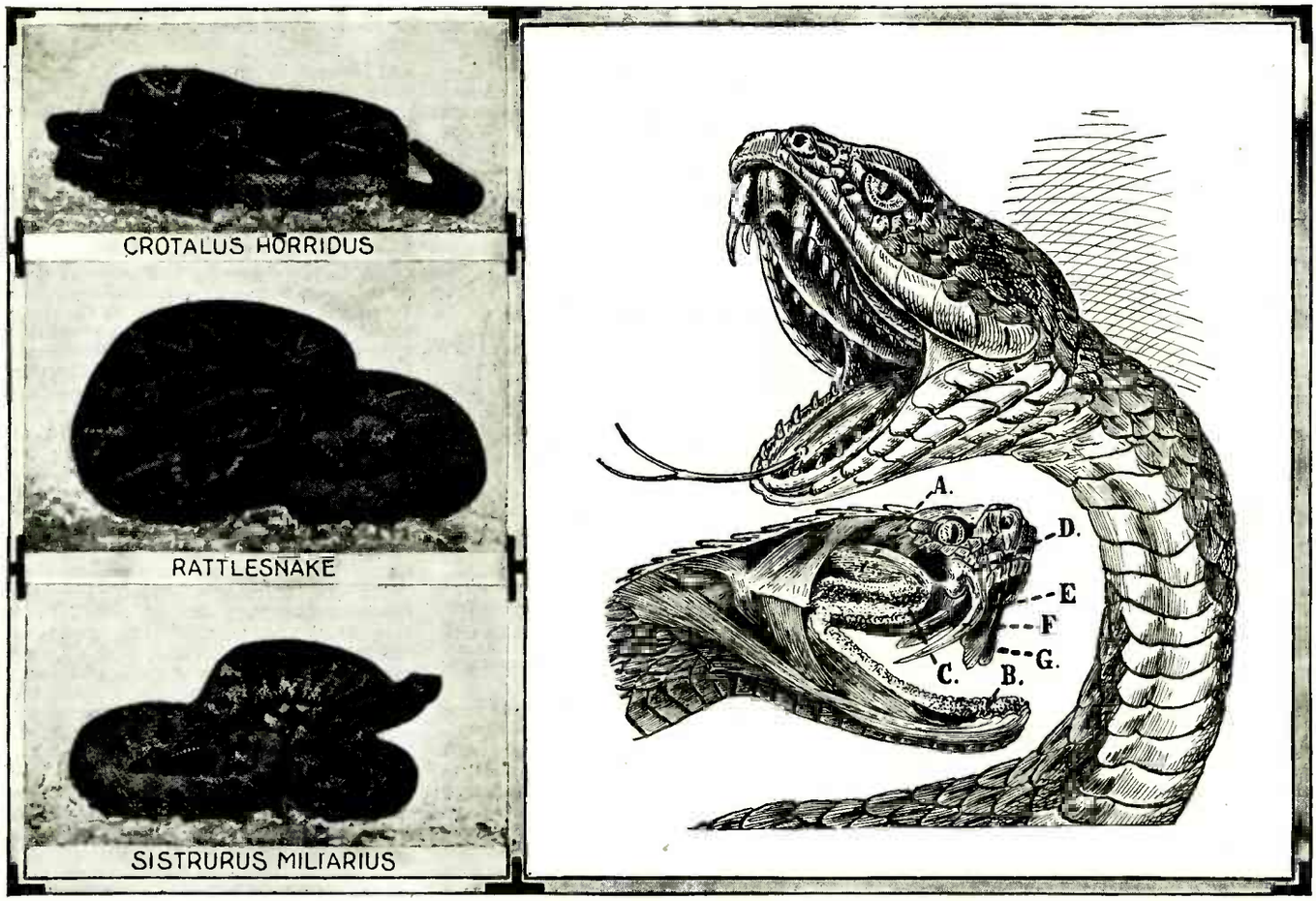
No poisonous snake jumps, and none pursues its attacker. In order to attack or to defend itself, each snake must coil itself, using the hind part of its body as a support, as, with a sudden jerk, the rest of the body is thrown forward. But each individual can only reach just half of its bodily length. Other poisonous snakes lift themselves upward when they believe themselves endangered, and, with the accompaniment of a spitting sound, they eject their poison in a colorless stream upon their enemy. When this fluid comes in contact with the juices of the body, very severe infections are caused. This is a peculiarity of the foreign *Naia haia, Sepedon haemachetes* and *Bitis gabonica,* although some other non-poisonous snakes are said to do the same.

In general, a snake poison cannot be considered as a destroyer of the blood corpuscles. Therefore it is not a plasma poison. Neither is it a stomach poison like those of many plants and inorganic chemicals. The specific action of each individual snake poison differs decidedly with the species ejecting the toxic juices. It is supposed to be nerve affecting in the cobra. Here the nervous centers of respiration are attacked leading to final suffocation. Other snake poisons kill by coagulating the blood. The effectiveness of the poison increases toward spring and decreases in intensity at times of fast. For this reason, every bite of a poisonous snake need not necessarily be attended with fatal consequences.

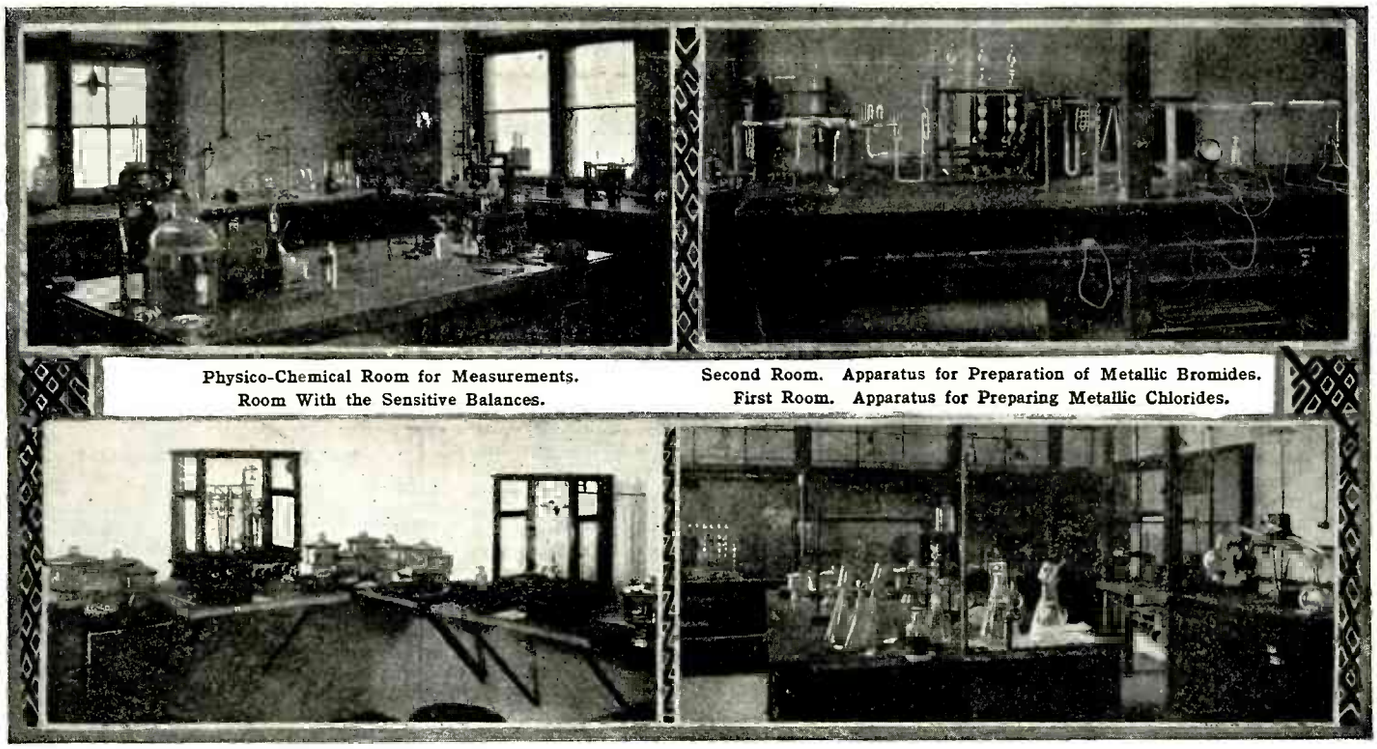
It is absolutely essential to prevent the spread of the poison introduced into the wound. This is best accomplished by stopping the flow of blood; that is, tightly placing a cord above the extremity so that the blood, infested with the poison, will not be pumped to the heart and to every other part of the body. Sucking out the poison from the wound is only possible when the lips are not cracked nor raw. Otherwise the wound is cut, burned or cauterized and a final addition of an internal irritant is given, especially strong alcoholic liquors.

The poison of the cobra is not resistant to chemicals. A 10 per cent. potassium or sodium hydroxide solution destroys its toxic properties in from 5 to 10 minutes. A solution of chlorine in water or a potassium permanganate solution requires quite a little more time in order to be effective. Mineral acids are far less active, and a concentrated solution of silver nitrate attacks it slightly. But when the wound is exposed to the rays of radium, the cobra poison is surely and quickly destroyed. Recently investigations have been carried on with serums and the

(*Continued on page* 595)



The Three Photos at the Left Show, Respectively, the Crotalus Horridus, Our American Rattlesnake, in the Two Upper Photos, While the Lower Picture Shows the Sistrurus Miliarius, or Ground Rattlesnake. The Line Drawing at the Right Shows the Fangs and Jaws of a Poisonous Snake: A—Biting Muscles; B—Salivary Glands; C—Poisonous Gland; D—Opening of Poisonous Gland; E—Upper Opening of the Poisonous Tooth; F—Auxiliary Poisonous Tooth; G—Pocket in Which the Poisonous Tooth is Imbedded Cut Open.



Physico-Chemical Room for Measurements. Room With the Sensitive Balances.

Second Room. Apparatus for Preparation of Metallic Bromides. First Room. Apparatus for Preparing Metallic Chlorides.

Laboratory to Determine Atomic Weights

Translated by Dr. T. O'CONOR SLOANE

THE building which held Liebig's own lecture room is still existent in Sophia Street, Munich. It contains an inscription on it telling of its association with the great chemist. The extent of the modern study of chemistry, and the building of state laboratories, and the requirements of the new age which the state fosters, cause people to forget the old lecture room of Liebig, but the tradition remains of the striving forwards and upwards, and just as formerly the rich scholar's life fills all space with its luster. The tearing down of the interior of the building and the installation of a laboratory for the determination of atomic weights has been going on for two years, and on September 23, 1921, Prof. Hoenigschmid opened the laboratory with a small industrious following, with a beautiful installation of elaborate vessels and apparatus constructed for atomic investigations, all set out in the honored hall. This day marks nothing less than the impressive establishment of the first German laboratory for atomic weight determinations. Its origin is to be attributed to Mr. Willstatter, Liebig's second great successor, who has secured for the Munich Chemical Institute a position of the first rank in the German Empire.

It is easy to recognize the importance of the laboratory from the changes introduced into Liebig's old lecture room. Who has not heard the name of the International Commission for Atomic Weights? This certainly is a bitter morsel for the German chemists. Its origin is due to the German chemists, as with many institutions which the old time Germany as a spiritual mixer brought about between the different nations. Certainly the honor and profit of its direction will not long be competed for; because in the atmosphere of war, filled with hate and iniquity, Germany was wrongly expelled from this Commission. Germany's practical and honored answer thereto was characteristic enough; in the year 1920 a German commission for atomic weights was organized, which, after the resignation of B. Oswald, gave the presidency to D. Hoenigschmid. This commission took up for its work the operations in the determination of atomic weights of recent years, and will bring together a table of the most reliable atomic weights for the general use of chemists in Germany. Now it stands in spiritual competition with the Allied and Associated Commission of Atomic Weights. Now prostrate Germany show your unbroken intellectuality. A comprehension of the meaning of the modern investigations of atomic weights is not of any interest to the laity, unless it takes upon itself in some measure to become acquainted with the fundamentals of the subject.

From what origin the word atom came we do not know, but we do know that 2,000 years ago, in the mouth of the Grecian philosopher, Democritus, it was the distinguishing word of a hypothesis, which says the divisibility of matter is not without limit; that it has its lower limitations; that all bodies with which we are acquainted are composed of inconceivably small invisible parts which constitute atoms. Then came a later conception by Dalton, the English chemist, of importance to chemistry, as it enabled him to elucidate experimental results by the atomic theory named from him. Chemical investigators have determined that in the formation of compounds from the elements, the chemical fundamental materials are always united in exactly identical relative weights. Thus, sixteen parts of oxygen can only unite with 200 or 400 parts of mercury, and with one or only two parts of hydrogen. Dalton simply accepted the theory that the atoms combined with one another in simple numbers, as one with one, and one with two, etc., and that the smallest relationship hitherto observed in which the elements come together, as 200 parts of mercury, and sixteen parts of oxygen, must give the relation of the weights of the atoms one to the other. These figures which tell in what relationships the fundamental materials of chemistry unite with sixteen parts of oxygen are called atomic weights. The influence of this all-important law is so great that up to the present day, all chemistry is bound up in the theory of the atomic weight.

No constancy of nature is so often and necessarily used in practical chemistry as atomic weights; they form the basis of any chemical analysis or chemical calculation, and in chemistry the same rule as in physics is played by the exact units of weight as of electric quantities. But the most urgent need for the very exact determination of atomic weights is to be found in pure science. For the figures of the atomic weights of the elements are perhaps the most important fundamental quantities in all physics, and forecast the earliest steps in the evolution of the world. They stand like dumb witnesses of the forming of the earth out of chaos. The understanding of man always is seeking for simplification and unity in these apparently invisible and unchargeable figures of weight of the ninety-two elements; their values run from 1 to 238, which will give us a corner-stone based on still more profound unity.

The English physician, Prout, as early as 1815, came out with a wonderful hypothesis, that the atoms of all elements came from the same original material, which he thought was hydrogen, and that the atomic weights, therefore, had to be very simple multiples of this same hydrogen. This speculation brought about the accurate estimation of various atomic weights, and this was done by Berzelius in the nineteenth century, by which it came out clearly that some of the atomic weights derived from hydrogen, such as that of chlorine, 35.5, were not integral numbers.

On the other hand, the arrangement of the elements according to their atomic weight and the bringing out of the so-called periodic system by Mendelejeff and Lothar Meyer, was a still more fortunate discovery. The cause of this made possible the prediction of new elements not yet found, and in more than one case the investigator really found the secret elements to fill predicted gaps in the system of the elements. The investigation of radio-active elements in their rela-

(*Continued on page* 595)

New Talking "Movie" Process

By EDWIN HAYNES

WHAT several inventors have attempted to do without success, Delmar A. Whitson, a Los Angeles electrical engineer, has accomplished—the development of a system of producing talking motion pictures by the employment of photography wherein there is positive synchronism between speech and action. While the paramount feature of the system is the manner in which light is influenced to make an accurate sound record there are three other novel features. In the new instrument, which is called the Photaphone, two devices are co-ordinated for the production of a photographic sound-record, termed respectively the octaphone and the photomagnetograph, and for the reproduction of the sound values from the film two other devices, the phototron and the multiphone.

The photo-sound record is made on a margin of the same film upon which photographs of the scenes and action are taken and at the same time; and, inasmuch as there is no time lag in either the process of producing the sound record or in the reproduction of the original sound values therefrom, synchronism between the two series of photographs is an inevitable result.

The inventor gave the name Photaphone to his device in contradistinction to an instrument called the Photophone invented by Alexander Graham Bell, and since adopted by others. As is well known, the Bell invention was not designed to produce a sound-record but to transmit sound to a distance by the use of a beam of light, an arc-lamp and a selenium cell.

THE OCTAPHONE

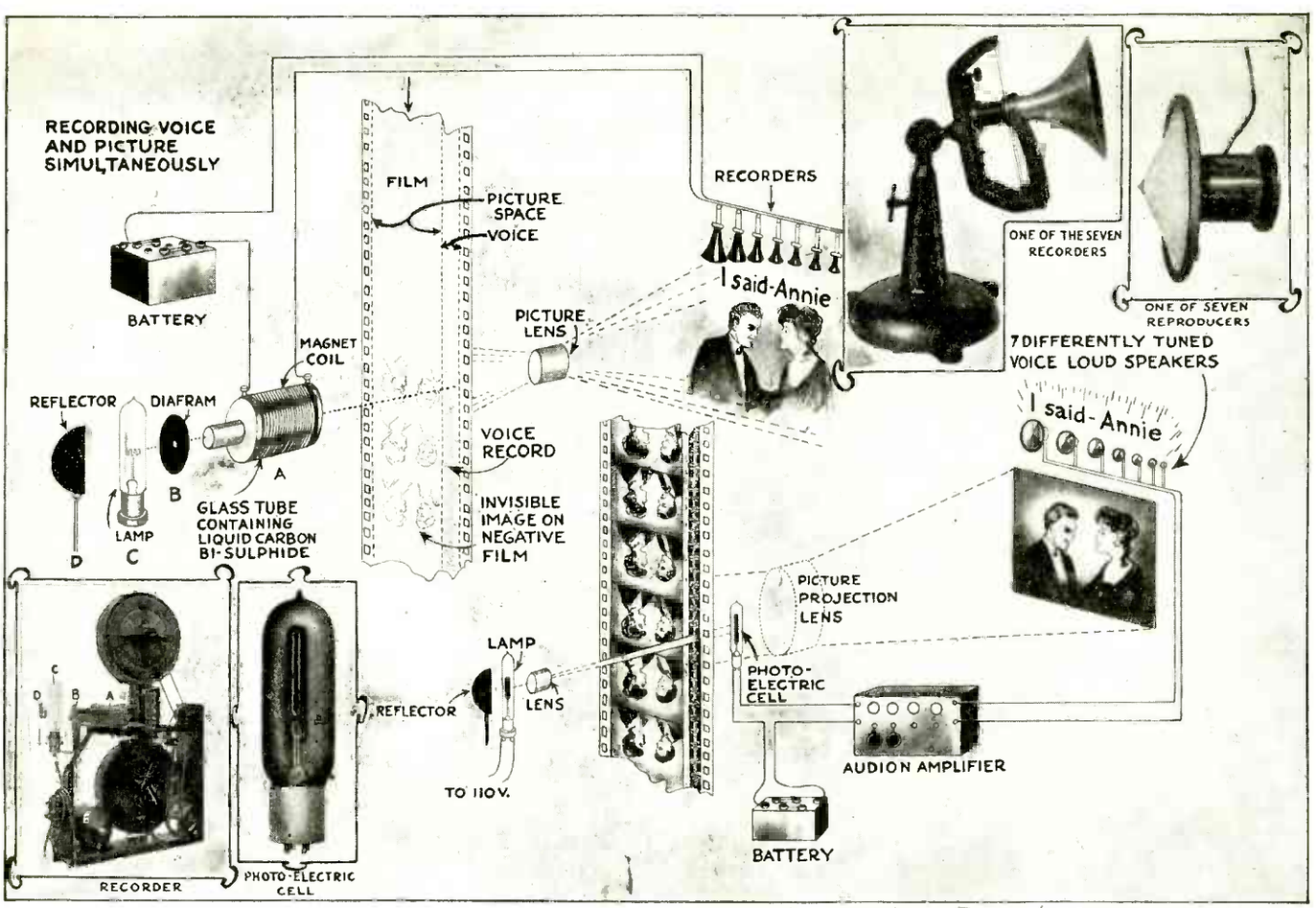
In the Photaphone system, the sounds to be photographed, instead of vibrating a single diaphragm, as in a telephone transmitter are made to impinge upon seven receptors, each tuned an octave apart from those immediately above and below, all of them connected in a single circuit and collectively designated an octaphone. Each receptor has a G-shaped magnet in a vertical position, across the poles of which are stretched two short pieces of piano wire, with a small metal disc, to serve as a sound target, imposed on the wires midway between the poles of the magnet. As is easily perceived this group of sound receptors involves what is known in acoustics as the sympathetic note principle, whereby the vibrations of a string on a musical instrument will cause a corresponding note to be sounded on another instrument near it without being actuated by any force other than the impact of the original sound vibrations.

When a single diaphragm is used as a receptor, as in the production of all mechanical phonograph records, it does not respond to all of the gradations of sound because of its natural limitations in consequence of which it functions only within the natural range of its period. Because of this restriction, many of the best qualities of speech or music are not recorded. By the employment of the seven receptors all sounds of whatever character, major or minor chords, their fundamentals and their overtones particularly affect one of the receptors by selection and contribute their full value. The several receptors acting in unison convert the sound waves into electric pulsations which are conveyed in combination to the recording instrument (photomagnetograph) which in its turn transforms them into equivalent light vibrations.

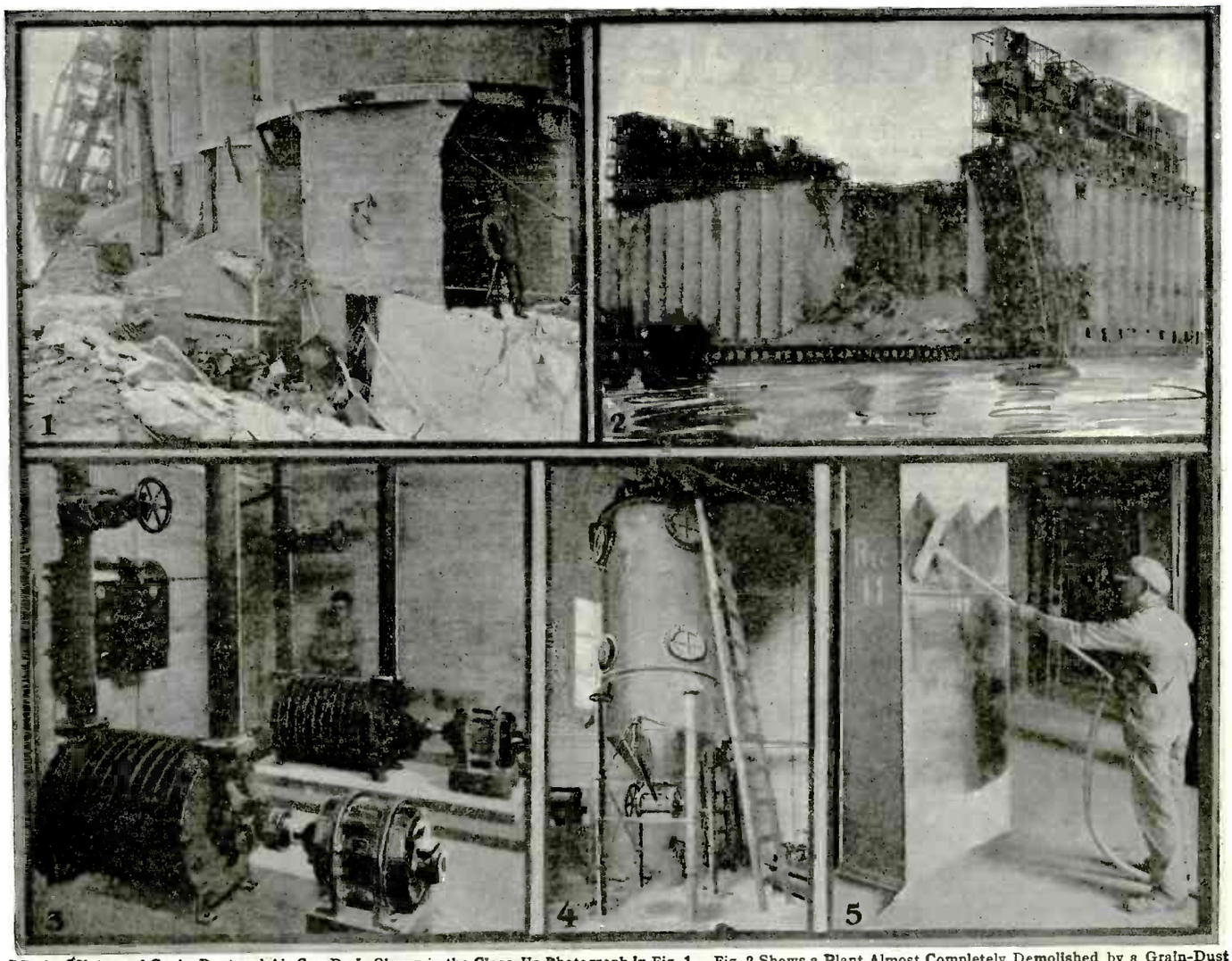
THE PHOTOMAGNETOGRAPH

In the recording instrument, or photomagnetograph, which serves the purpose of so manipulating a beam of light passing through it as to procure an accurate photographic sound-record, a radical departure is made from all previous devices designed to accomplish this result. It required twelve years of research and experimenting by the inventor to solve the problem. He tested many agencies. He experimented with the arc-light as a converter of electric pulsations into light vibrations, but found that any noise, such as the click of the camera made near the recording frame, would register on the photographing film, and that the heat of the arc-lamp, the chattering of the flame, or any noise in the vicinity of the arc caused it to vary and record imperfections. In a

(*Continued on page 601*)



The New "Talking Movie" Scheme Here Illustrated in Detail, Is That Perfected by Mr. Delmar A. Whitson of Los Angeles, Calif. Mr. Whitson Uses Seven Differently Tuned Voice Recorders, Each One Corresponding to a Certain Part of the Vocal Scale. These Voice Recorders Are Caused to Vary the Current Passing Through the Coil Surrounding a Glass Tube Containing a Suitable Liquid, Such as Carbon Bisulphide. When a Strong Beam of Light Is Flashed Through the Tube Surrounded by the Magnet Coil, the Magnetic Variations Are Caused to Act on the Beam of Light, So That It Records a Fluctuating Curve on the Film Beside the Pictures, Which Correspond to the Variations in the Voice or Music. When the Positive Film Containing the Voice Record Is Passed Before a Powerful Beam of Light, as Shown at the Right, the Light Variations Act on a Photo-Electric Cell, and This in Turn Causes the Amplified Voice Currents to Issue From the Vacuum Tube Amplifier, the Voice or Music Finally Emanating from a Set of Seven Separately Tuned Loud-Speakers in the Movie Theater. Each Loud-Speaker Has a Different Size Diaphragm Corresponding to a Certain Group of Frequencies.



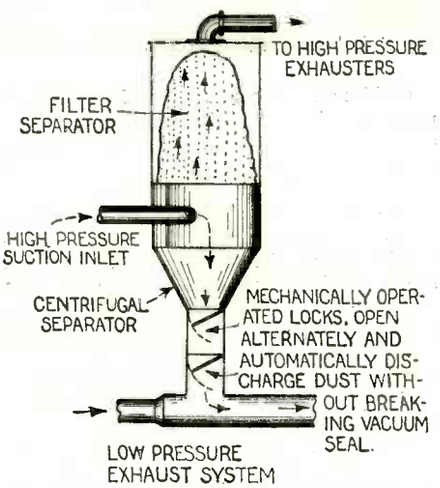
What a Mixture of Grain-Dust and Air Can Do Is Shown in the Close-Up Photograph In Fig. 1. Fig. 2 Shows a Plant Almost Completely Demolished by a Grain-Dust Explosion. Fig. 3 Is a View of Two of the High Pressure Exhausters Used in Freeing the Reconstructed Grain Elevator From Dust. Fig. 4 Is a Photograph of a Filter Separator, Which Removes the Heavier Grain and Dust From the Air Before Permitting the Air to Pass On to the Exhausters in Fig. 3. Fig. 5 Shows How Thoroughly a Wall Is Cleansed of Dust by the New Arrangement.

Preventing Dust Explosions

By JOSEPH H. KRAUS

DID you ever stop to consider the havoc wrought by exploding a mixture of dust and air? Of course, you will doubt that such a thing is possible; that only dust originating from sources inflammable of themselves would give an explosive mixture. But such is not the case. Aluminum dust is very explosive, as is rubber dust, when either is mixed with air. Neither of these substances is ordinarily inflammable. In less than a year several disastrous explosions have occurred in the United States and Canada, resulting in the death of nearly one hundred people, and the damage to property of over ten million dollars. Dust cannot be prevented, and in spite of the fact that many of the large industrial plants, particularly the grain elevators, are employing exhaust fans capable of removing the dust almost as quickly as it is formed at its source, still in a very short time the rafters, walls and floors of the entire buildings are covered perhaps to a depth of more than an inch with a thick layer of dust.

The photographs shown here were taken subsequent to the disastrous explosion which occurred at the Northwestern Elevator operated by the Armour Grain Company, at South Chicago. This elevator has a capacity of ten million bushels of grain and is built entirely of fire-resisting materials. The loss of grain and property was estimated at approximately $3,750,000, and while every effort was made to establish definitely the cause and point of origin of the explosion, as all in the elevator at the time were killed, it was impossible to investigate and determine the origin of the blast.



This Is a Detail Sketch of the Filter Separator Shown in Photograph No. 4 of the Illustration at the Top of This Page. Due to the Extremely High Degree of Vacuum Under Which This Filter Operates, It Is Necessary to Employ Locks for the Removal of the Heavier Dirt Without Breaking the Vacuum Seal. This Permits the Apparatus to Run Continuously.

Workmen were busy cleaning the plant, brushing down the walls, beams and ledges. Naturally during such work and in fact during the entire day that the plant is in operation, immense quantities of dust hovered in the air.

When a workman goes to one of these grain elevators he will see, literally speaking, a "snow storm" of dust falling constantly. In isolated parts of the plant where the walls are sealed to prevent these fine particles from coming through, the dust is nevertheless quite heavy.

A dust explosion is similar to a gas explosion, except that in the latter the flame passes from molecule to molecule, whereas in a dust cloud, it is propagated by means of the small particles of dust. In nearly every one of these explosions there is but a small puff followed by a terrific roar. It is evident that this first puff merely ignites the particles of the suspended matter in the air of the room. Nevertheless, this puff is sufficient to dislodge the dust on the walls and rafters, which falling at the time becomes again finely divided, filling the air. It arrives just in time to meet the flame of the first puff as this dies out, and then the terrific violence of

(*Continued on page* 603)

Flickerless Movies

SAMUEL BARDY, an inventor, of Philadelphia, has come to New York and exhibited to motion-picture theater owners a projection machine which throws a motion picture on the screen without flicker. F. H. Richardson, author of text-books on projection and internationally known as an expert, saw the machine set up in New York City, and said: "Demonstrations of the Bardy Projector have convinced me that Samuel Bardy has solved the problem of non-intermittent (continuously running film) projection, and solved it successfully.

"I had the projector slowed down until something like three pictures a second were passing the aperture. Aside from the fact that the motion was slowed until a close approximation of slow speed camera action was had, there was no visible effect at all. The projection was as perfect as at normal projection speed. Flicker was absent at any speed, of course, there being nothing to produce it."

Mr. Richardson's statement to the effect that a non-intermittent and non-flicker motion-picture projection machine had been successfully operated here, has been quoted far and wide and many theater owners have taken advantage of Mr. Bardy's invitation to see his work.

Thomas A. Edison said some years ago that the next great world-wide development of the motion-picture industry would come through the invention of a projection machine which would take advantage on the screen of every bit of light used. It seems that the Bardy model gets full, or nearly 100 per cent of light on the picture, and that the light is steady and constant. The ordinary movie projector loses about 60 per cent of the light due to the shutter. This machine has no arc carbons, no shutter, and no intermittent motion.

"I started in on this thing when I was twenty years old," said Mr. Bardy, "and it has taken me more than ten years to get the machine ready for this exhibition. But let me say now that my work was made possible by the loyal and unfaltering support of a small group of assistants with dauntless courage, also Philadelphians."

Bardy's patent was granted by the United States Government September 23, 1919. He feels that in the public exhibition of his projector at this time he is fully protected under the seal of his "Uncle Sam." It is said that literally thousands of inventors have been at work for years on non-intermittent, non-flicker motion-picture projection machines, but that none of them has ever been able to bring the machine to the point of actual use, as Mr. Bardy has done.

Besides putting a soft and perfectly lighted picture on the screen, the inventor makes the amazing statement that if he so desired he could sell his machine at one-third the price of the existing makes of standard machines.

The machine now being exhibited in New York uses a 400-watt incandescent light instead of the usual 1,000 watt arcs. The light is continuously projected through the film while the film is also continuously in motion, although the light is stationary. Without anything more, this would simply produce a streak upon the screen and no picture visible to the eye. To keep the projected picture on the screen from moving across the screen with the moving film, lenses are interposed, a number of lenses, eighty in all, placed in the rim of a wheel, revolving in unison with the moving film and of such size and shape and so ground that while the film moves the lenses come successively into place, and affect the rays of light in just such fashion that the image on the screen is in constant position, while the successive pictures on the film are passing in uninterrupted procession. In the new machines being designed for the market the number of lenses has been greatly reduced; one of the first models is a portable "home and office" projector, which takes standard size film.

The wheel with the lenses firmly fixed in the rim is the wheel that moves the film, the same piece of metal. The result is produced entirely by optics, by the deflecting power of the lenses. If the film is passed through slowly the animation is slow and if the film is run at high speed, the animation is rapid, but at all speeds the picture is equally continuous. There is no such thing as successive pictures on the screen. There is at all times a constant picture. The picture blends into the next without any intervening period of darkness. No matter how slow the machine is operated, one a second or one a minute, the eye cannot detect when one picture melts into the next. The editors saw this machine demonstrated at different speeds successfully. The Bardy projector means a great saving in electric bills, less wattage being consumed, besides the marked reduction in eyestrain.

Some of the unique features of the Bardy shutter-less movie projector are: Both the top and bottom film reels can be rotated by motor drive, so that the film can be rewound right on the projector without removal. The condenser is quite unique in that instead of immediately converging the light it projects it as a parallel beam through the film, where it is caught by a second element, and it then converges into the projection lens. There is very little chance of breaking or tearing the film, as there is no tension on it, except that due to the winding process, the film being fed through the lens chamber by a sprocket wheel, which engages the perforations present in

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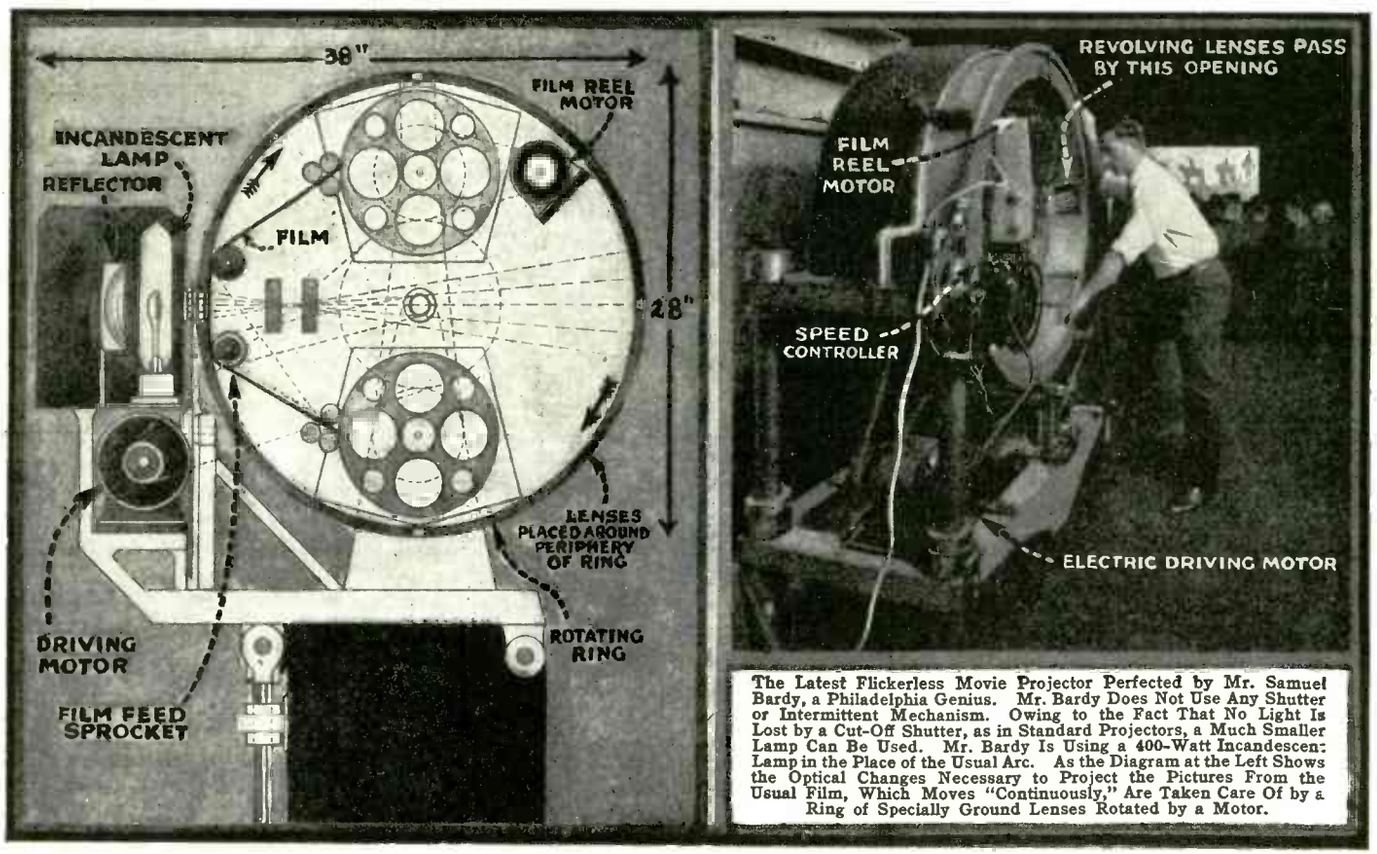
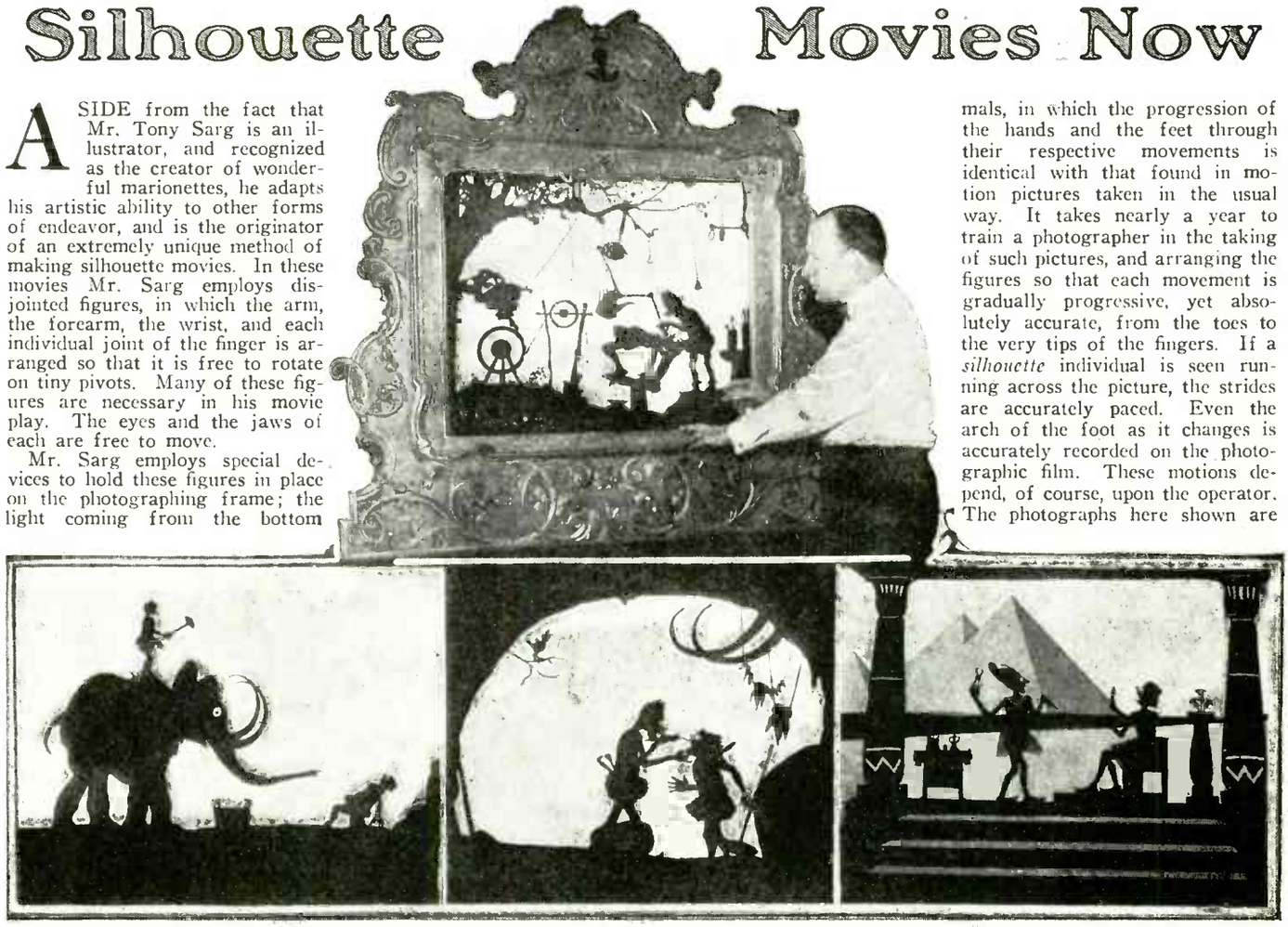


The Latest Flickerless Movie Projector Perfected by Mr. Samuel Bardy, a Philadelphia Genius. Mr. Bardy Does Not Use Any Shutter or Intermittent Mechanism. Owing to the Fact That No Light Is Lost by a Cut-Off Shutter, as in Standard Projectors, a Much Smaller Lamp Can Be Used. Mr. Bardy Is Using a 400-Watt Incandescent Lamp in the Place of the Usual Arc. As the Diagram at the Left Shows the Optical Changes Necessary to Project the Pictures From the Usual Film, Which Moves "Continuously," Are Taken Care Of by a Ring of Specially Ground Lenses Rotated by a Motor.

Silhouette Movies Now

ASIDE from the fact that Mr. Tony Sarg is an illustrator, and recognized as the creator of wonderful marionettes, he adapts his artistic ability to other forms of endeavor, and is the originator of an extremely unique method of making silhouette movies. In these movies Mr. Sarg employs disjointed figures, in which the arm, the forearm, the wrist, and each individual joint of the finger is arranged so that it is free to rotate on tiny pivots. Many of these figures are necessary in his movie play. The eyes and the jaws of each are free to move.

Mr. Sarg employs special devices to hold these figures in place on the photographing frame; the light coming from the bottom gives an absolutely perfect silhouette effect because the figures cut off that light. So perfect are these motion pictures that one often wonders whether living individuals are not used in the making of them, but Mr. Sarg has a system which he perfected in conjunction with Major Dawley, the originator of motion pictures of prehistoric animals, in which the progression of the hands and the feet through their respective movements is identical with that found in motion pictures taken in the usual way. It takes nearly a year to train a photographer in the taking of such pictures, and arranging the figures so that each movement is gradually progressive, yet absolutely accurate, from the toes to the very tips of the fingers. If a *silhouette* individual is seen running across the picture, the strides are accurately paced. Even the arch of the foot as it changes is accurately recorded on the photographic film. These motions depend, of course, upon the operator. The photographs here shown are taken from a Tony Sarg reproduction of a playlet called "The First Dentist." Notice the remarkable accuracy of the poses assumed by the silhouettes.



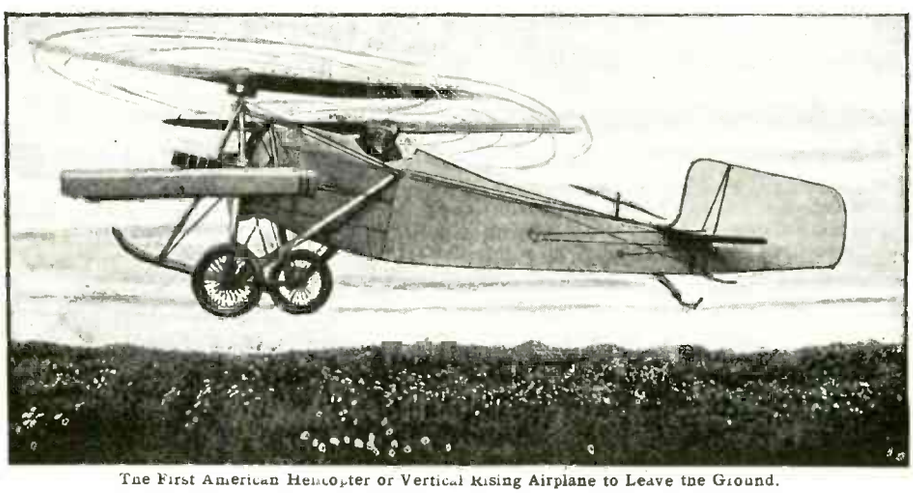
"Of All (Glad) Things of Tongue or Pen", We Believe These Silhouette Movies Devised by Mr. Tony Sarg, Well-Known New York City Illustrator and Marionette Creator, to Be About the Funniest and Most Amusing We Have Seen in Many Moons. Mr. Sarg Is Shown in the Upper Photo, in Front of the Miniature Stage Housing the Mechanism for Producing His Newest Silhouette Movies. The Movie Tale Here Portrayed, Is That of The Ancient Dentist.

Helicopter Completes First Flight

THE photo above shows the first American helicopter, piloted by an aviator, to leave the ground. This vertical rising aircraft is being brought to perfection by the noted inventor Emile Berliner, and his son Henry A. Berliner. This photo shows the Berliner helicopter in the course of its first official flight before members of the U. S. Naval Air Board at College Park, Md. The helicopter has been in operation for three months, and is in the final stages of perfection, it is believed by experts who have seen it. The Berliner machine has risen straight into the air more than ten feet in some cases. Forward flight is accomplished by tilting the propellers, at a slight angle, after the machine has risen from the ground.

There has been much trouble in developing this form of flying machine, which has many desirable features, especially from a military and naval point of view, in that it can hover in the air over a given spot for observation or bomb dropping operations. In view of the fact that no one has had any experience in flying such a machine, and as it has a tendency to descend very rapidly if the engine stops, practically all of the flights so far, have been within a short distance of the ground. It was a very unusual experience for Mr. Berliner and his son when they first got the machine off the ground, and then tried to cause it to move forward; in the first trials, the machine simply dived for the ground at a sharp angle and dug in. It requires a very nice degree of judgment to tell at just what angle the propellers need to be tilted, in order to propel the craft in a forward direction.

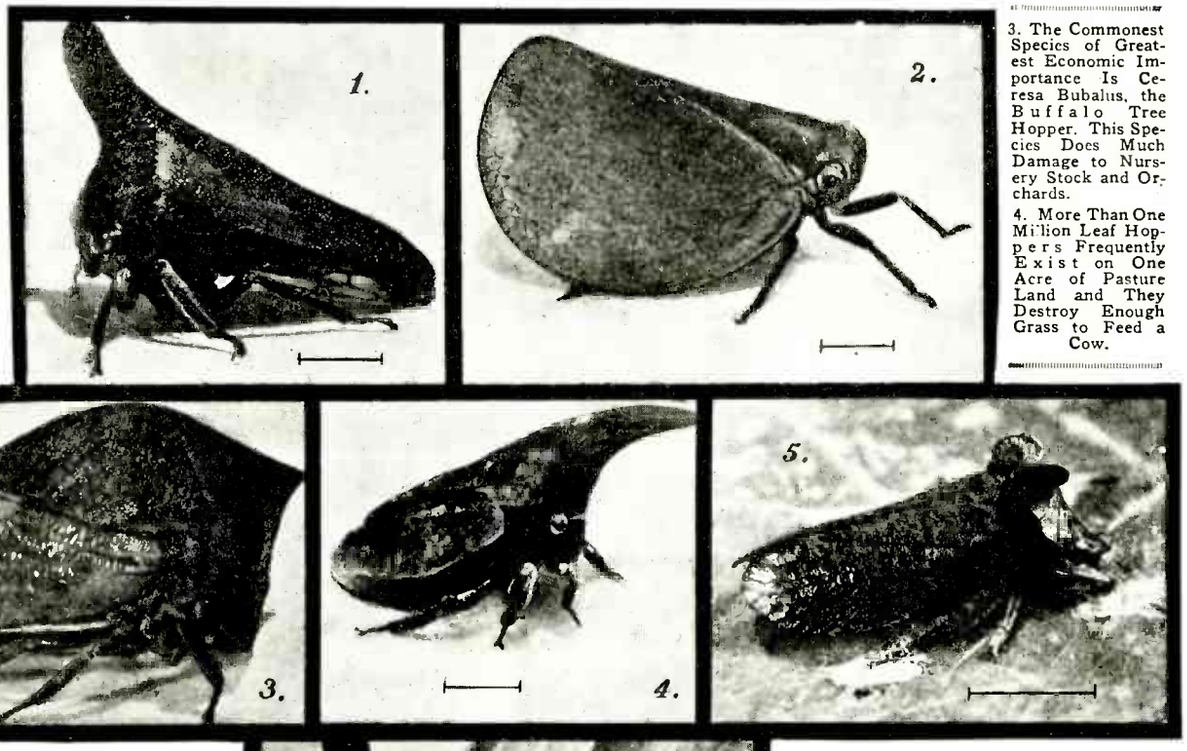
One of these helicopters was recently credited with an ascension of several hundred feet in Europe, the craft being guided by three cables spread well apart at the base on the ground, the airship being hauled down by winding up the cables by means of motors. One of the great problems in the designing of a perfect helicopter apparently lies in designing some attachment or feature in the machine, such that it will not dive earthward like a projectile, whenever the engine may fail.



The First American Helicopter or Vertical Rising Airplane to Leave the Ground.

Animal Monsters in Miniature

By Dr. E. BADE



1. Thelia Bimaculata Is a Tiny Leaf Hopper Just One-Fourth Smaller Than the Line. It Has a Curiously Shaped Horn Produced by the Middle Part of the Body.

2. All of the Tiny "Hoppers" Are Peculiarly Shaped. This Is Acanalonia Bivittata and Is About One-Fourth Shorter Than the Line.

3. The Commonest Species of Greatest Economic Importance Is Ceresa Bubalus, the Buffalo Tree Hopper. This Species Does Much Damage to Nursery Stock and Orchards.

4. More Than One Million Leaf Hoppers Frequently Exist on One Acre of Pasture Land and They Destroy Enough Grass to Feed a Cow.

5. Ledra Aurita Which Is Just as Long as the Line, Is Commonly Found on Veins, and Poplars, in Europe.

6. The Spittle Insects Are Curious Fellows. They Not Only Suck the Sap of the Grasses, But Also Eject It and Work It Into a Frothy Mass Which Protects Them from Drying Out. Aphrophora Quadrinotata Is Just Half as Long as the Line.

THE sun rises higher and higher into a cloudless sky. The atmosphere becomes dank, heavy and oppressive. Nature seems to brood. The meadow flowers nod. Only an occasional stalk of grass rocks back and forth as if put in motion by a fitful breeze. But there is no wind in the leafy tree tops. Suddenly there is a commotion in the grass. With a whirr of wings a grasshopper flies a short distance and alights with a jar, scaring many a tiny monster from the noontide meal.

Like specks of dust do the tiny *leaf* and *tree hoppers* fly in all directions and are gone before they are readily perceived. They are minute prodigies which, under the magnifying glass, become monstrous creatures provided with horns, thorns, spines and armor. It seems as if they have arrayed themselves against the world. In form they resemble some prehistoric animal of an age, long since passed—but lilliputian in size—so weird and dangerous is their appearance. Nature, indeed, must have been in a playful, fantastic, mood when it created these grotesque creatures. To-day they are out of place, out of style, in this age where other weapons are used in the battle of life. But who has not seen them, and observed their hidden life as they pass their existence, screened in the "jungle of the grasses" or dreamily, after a short life among the airy foliage of tree or bush, pass on to the hereafter?

These miniature armed knights in their cloak of green are practically unknown, although they are never rare where plants are found. They belong to the most curious division of the insect world, but the most striking forms are restricted to tropical and subtropical regions where they occur in countless numbers.

Under the extravagant formation of the first segment of the middle part of their bodies, the prothorax, the second and third segments are often hidden. This malformation is frequently of such extent that even the wings and the abdomen are concealed from view. This makes these leaf and tree hoppers the most curious creatures ever evolved by indulgent Mother Nature.

While walking through a grassy region inhabited by these dwarfed monsters, they are frightened from their daily task and let themselves down, for a moment, upon our clothes, where they appear to be tiny bars, streaks of greenish dust or an anther of a flowering grass. Some rapidly run a short distance, tense the muscles of their jumping legs and jump to another place with the aid of their wings, disappearing even before they have been fairly observed. Others run a few steps, stop, draw up the jumping legs and hop back into the grass whence they came.

On clear sultry evenings a light on the porch lures many of them away from their haunts. The light seems to blind them and it holds them within the magic circle of its rays. In the course of the summer one species follows hard upon the heels of another. One species predominates one month, another the next. And soon throughout the warmer parts of the year. It is almost inconceivable how many of these little fellows are hidden among the leaves, and how numerous they are among the grasses. Osborn says that the damage these creatures do to the plants of the fields is enormous, that these insects on one acre of grazing land destroy sufficient vegetation to feed a cow, and he figures that approximately one million of them inhabit one acre.

The life of the tree and leaf hoppers is intimately bound to the plant, and all the curious horns, bristles and thorns of these miniature monsters are not freaks of nature caused without rhyme or reason but adaptations of their environment. They are the final result of a long course of development giving their body an effective protective resemblance. When the creature is at rest or when it is busily sucking the sap, it becomes less easily distinguished from its environment, because of its color, its form, and its immobility, and appears a part of the plant upon which it happens to be.

Such apeing of plant-fragments or leaf-form, not only in color and marking, but also in outline of the body, is perfectly illustrated in this group of insects. And all those peculiar protuberances and unique shapes making these animals appear so monstrous, are always similar to some particular object, or are merely in general harmony with the environment, making the insects inconspicuous and sometimes directly invisible to the casual eye. But when such animals are taken out of their natural habitat they become so conspicuous that they are most striking and almost unique.

For propagation, the female bores or slits twigs or leaves in which the eggs are later deposited. The hatching larvae cast off their skin a number of times, meanwhile living upon the sap of the plants just like the

(*Continued on page* 614)

Scientific Problems and Puzzles

By ERNEST K. CHAPIN

NO. 2 OF A SERIES

THE PROBLEM OF THE HOIST

DURING the noon hour, one day, Pedro Wise, the shop genius, fixed up a hoist for the boys in the packing department. It was a pulley system, arranged as shown in Fig. 1, whereby the boys could seat themselves on a board and pull themselves up and down between the floor and ceiling.

"Now with this pulley system," he told one of the boys, "you need to pull with a force of only one-third your weight to hold yourself in any position above the floor. But suppose I pass the free end of the rope through a pulley attached to the floor and let you pull upward against your own weight. Will you be able to raise yourself, and, if so, with what force relative to your own weight will you have to pull?" (See Fig. 2.)

Of course we must consider that friction and the weight of the rope and pulleys are negligible.

PERPETUAL MOTION BY CAPILLARY ACTION

"The problem of perpetual motion," asserted Nate Peters, the veteran glass-blower, "is a nut that science some day will crack. What about this for a starter?" he asked a group of his shopmates as he exhibited to them a drawing of his idea. "You know how water will climb up a fine capillary tube? Well, all we have to do is to attach a return tube on the side and let the water flow back into the pan as fast as it creeps up. Simple, reliable, and certain, eh?" (See Fig. 3.)

MORE PERPETUAL MOTION

The most critical member of the group discussing Nate's perpetual motion scheme was "Horny" Steele. As "Horny" never believed in anything but himself, anyway, it was expected that he would have something cynical to remark. "The only perpetual motion device that I ever seed work is mi-lady's lower jaw," he drawled. "Still, that's a bright idea o' yourn, Nate, though it 'pears to me it's a shameful waste of glass when an ol' lamp wick, or even a piece of string, would do just as well. All you have to do is to hang the wick over a hook or something, letting the lower end dangle in a pan of water. Then, as the water soaks up the wick and passes over the hook it's bound to drip back into the pan again. I reckon my scheme will work if yourn will, Nate." (See Fig. 4.)

WHAT WILL THE DRAWSCALES READ?

A lad once took five spring drawscales, connected the hook of one to the ring of another until they were all strung together in a row, and then placed them face upward on a table. To each of the end drawscales he now attached a ten-pound weight suspended by means of a cord passing over a light pulley at the edge of the table. (See Fig. 6.) Now since there were two forces of ten pounds each exerted in opposite directions on the five scales he was astonished to find that the reading of each scale was—well, what do you think it was?

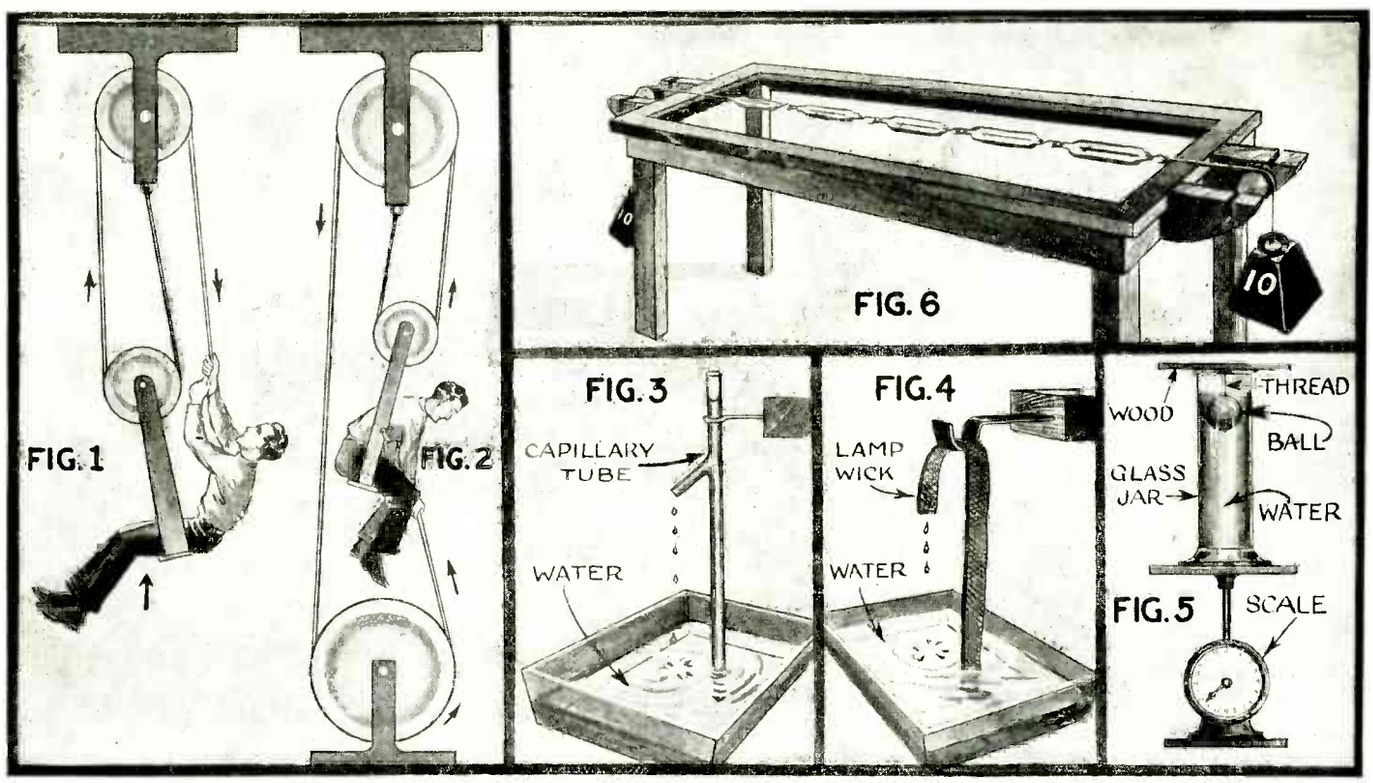
MAGNETIC ATTRACTION

Two boys were playing with a magnetic duck pond. With a magnet they attracted the light metallic figures here and there over the surface of the water. "The earth itself is a magnet," declared one of the boys to the other. "I should think that if a bar magnet were placed on a toy boat near one of the magnetic poles the boat would move toward the pole just as the ducks do toward our magnets." How about it?

WILL THE BALL GAIN OR LOSE WEIGHT?

In Fig. 5 we see a tall glass jar of water standing on the platform of an ordinary household weighing scale. Across the top of the jar rests a splinter of wood from which a small metallic ball is suspended just below the surface of the water. Now let us consider for a moment what is going to happen if we clip the thread that supports the ball, and let the ball drop downward through the water. The scale now registers the weight of the jar and contents, but what will it register as the ball speeds downward toward the bottom? Will the reading remain the same, or will it increase or decrease? If there is any change in the reading will the change take place quickly or will it develop only as the ball gains in speed? For those who wish to consider the motion of the ball mathematically let us suppose that the ball weighs 1 pound and sinks with a constant acceleration of 8.05 feet per second.

(*For answers to these puzzles, see page* **597.**)



Figs. 1 and 2 at Left Illustrate Two Problems in Pulleys and Ropes, Which You Will Find Interesting. Fig. 3 Shows a Capillary Pump. Do You Think This Pump Will Keep On Working Forever? Do You Think That the Lamp Wick Will Keep On Absorbing the Water and Dropping It Back in the Pan Forever, as Shown in Fig. 4? If the Thread Supporting the Ball in Fig. 5 Is Cut, Will the Scale Show an Increase or Decrease in Weight When the Ball Drops? Fig. 6. With Five Spring Balances Connected Together as Shown, and a Ten-Pound Weight Hanging on Either End of the Cord, What Is the Reading of Each Scale?

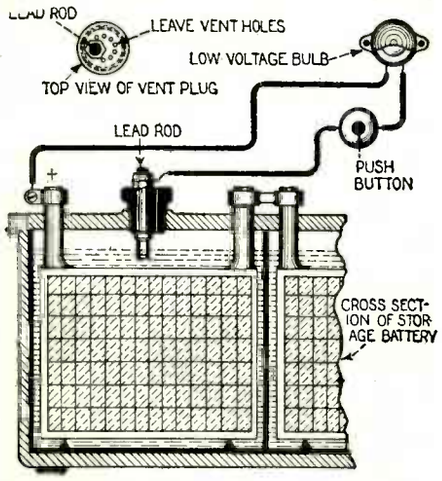
Sound-Determination Tests With Geophone

In connection with determining the distance that sounds from different mining tools can be detected with the geophone, a study has been made by the Bureau of Mines of the characteristics of sounds from mining machines as they are reproduced by the geophone. Twelve mining and carpentering operations were carried out on the coal about 200 feet away from a mining engineer equipped with the geophones. This engineer had had no previous experience with the instruments and did not know what tools were to be used except that they would be mining or carpentering tools. The engineer was able to name correctly nine of the twelve tools and was able to give an accurate description of the sounds from the other three. These tests prove the value of the geophone.

MOTOR HINTS

FIRST PRIZE, $25.00
LOW WATER INDICATOR FOR STORAGE BATTERY

The majority of storage battery breakdowns are caused by failure to keep the cells properly supplied with water. Consequently



The First Prize Idea This Month Goes to Clifton T. Foss for His Low Water Indicator, to Be Used in Conaection With the Car Storage Batteries. More Storage Batteries Are Ruined Every Year Than One Would Imagine Simply Because of Neglecting to Watch the Water Level in the Cells. It Is Imperative That the Water Cover the Plates at All Times. Pushing the Button Causes the Lamp or a Buzzer to Function if the Water Is at the Proper Level.

an indicator by which the height of the water may be easily determined should be of great value to the motorist. The instrument described herewith is placed on the dash and the exact condition of the battery can be ascertained by simply pressing a button.

The rubber vent plug of the cell at the positive end of the battery is drilled and fitted with a lead electrode as shown in the drawing The electrode should be of such a length that it will reach to within three-eighths inch of the top of the plates. The top of this electrode is fitted with a suitable connection.

A low voltage lamp is mounted on the dash, preferably as a regular dash lamp. Immediately below this is mounted a small flush push button. Connections are made as shown.

We have now created a small sub-battery whose positive terminal is the regular positive pole (lead peroxide) of the battery and whose negative is the recently added lead electrode. When the water is low the lamp will have a very faint glow, if any. If the water is high it will shine brightly. Do not stop up the vent holes, or the battery jar will explode, due to gas formed while charging.

Contributed by CLIFTON T. FOSS.

SECOND PRIZE, $15.00
THIEF-PROOF DISTRIBUTOR ATTACHMENT

This device is made from a piece of sheet brass or metal of any kind, and is designed, as shown in the figure, to fit over the distributor shaft, under the distributor arm.

The small arm carrying the contact point is pivoted so that it will swing freely and is insulated from the strip as shown. A small spring is fastened to the arm to hold it back against the fiber stop peg. The device is put in place and a wire connected from the strip in the top of the distributor arm to the arm of the device.

Now, when the motor is started it will run perfectly at a very low speed, but as soon as it is speeded up centrifugal force swings the arm over against the other contact point and the distributor is short-circuited. In this way the motor cannot be run above a certain speed. The speed can be adjusted by the tension of the spring.

NOTICE TO CONTRIBUTORS

KINDLY note a change in this contest. For the coming months we would like to receive from our contributors articles on the following subject:

ELECTRICITY ON THE CAR

We believe that there are hundreds of new electrical ideas that can be incorporated in the car that our readers would like to know of. What we are particularly interested in are novel stunts, new devices, new kinks, and new hints made possible by the electric current.

In order to win a prize the first requisite is that the device or suggestion be practical. The term PRACTICAL will be the keynote of this contest.

You will be more apt to win a prize if you will design the device yourself, and make a photograph of it, sending the same to us. Ideas are all right, but the reader wants to see that the device actually has been made, and WORKS.

The following prizes will be paid:

FIRST	PRIZE.....	$25.00
SECOND	PRIZE.....	15.00
THIRD	PRIZE.....	10.00

All other accepted articles which win no prizes will be paid for at the rate of $1.00. Each article submitted should not be longer than about one hundred to two hundred words.

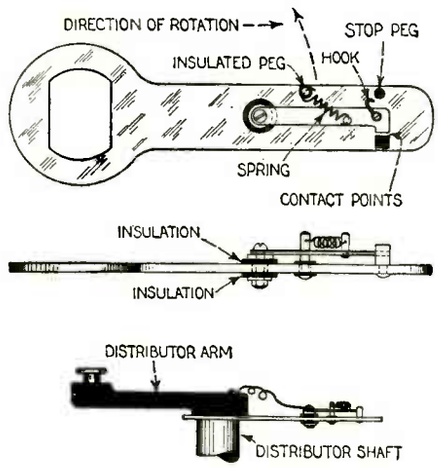
Address all manuscripts to EDITOR "MOTOR HINTS," care of this publication.

As the motor works perfectly at low speed, it is very perplexing to the average "crook," and he does not know where to look for the trouble.

When the car is to be locked the small hook is unhooked from the stop peg, and the device is ready for action.

Of course if it is desired to have the device controlled from the dash, it is only necessary to run the wires out to a secret switch on the dash. This, however, is not desirable as it is liable to be discovered.

Contributed by O. G. MCILVAINE.

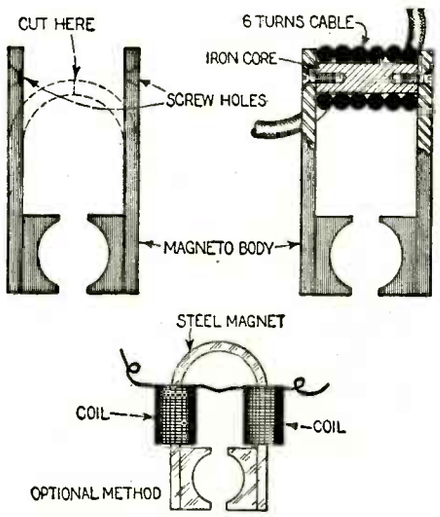


This Unique Thief-Trap Attachment for the Distributor Arm Permits the Car to Be Started, but After a Speed of About Three Miles an Hour Is Reached, Centrifugal Force Causes the Auxiliary Contact Arm to Swing Over Against the Second Contact, Thus Short-Circuiting the Distributor and Stopping the Engine.

THIRD PRIZE, $10.00
INCREASING HIGH-TENSION MAGNETO SPARK FOR STARTING

Many cars are still equipped with the "dual" magneto system, involving the use of dry cells for starting. This system is unsatisfactory, owing to the necessity of frequent battery renewals.

By employing the following method, the dry cells may be eliminated and the magneto operated as a strictly high-tension machine.



To Obviate the Use of an Auxiliary Battery for Use in Starting, and Where a Magneto Is Also Attached to the Car, It Is Possible to Momentarily Increase the Magnetic Flux Through the Field Magnets by Cutting Them as Shown, and Placing an Iron Core Between Them; Around This Core Several Turns of Heavy Starter-Motor Cable Are Wound. This Will Cause a Good Hot Spark Just as the Engine Is Started, the Powerful Starter-Motor Current Passing Through the Magnetizing Coil.

The magnetic flux will be increased 300 to 400 per cent. during the starting period when a strong spark is most needed. The magnets will be recharged on closed magnetic circuit every time the starting motor is operated, which will keep them always at their highest point of efficiency.

Remove magnets from magneto, heat, cut them at the middle and flatten into two straight bars. Drill and countersink a hole for ¼-inch screw in each bar at end where cut. Re-temper magnet bars by heating to a dull red and plunging into cool water. Fasten magnets together at top by an iron yoke or core, equal in cross-section to that of magnets, the length of which is equal to width of magneto body, and rounded at corners. Wind six turns of heavily insulated flexible cable on the core, of a size about equal to cable in starting motor circuit. Place magnets on magneto and connect coil in series with starting motor, so the entire starting current passes through it. It will be unnecessary to magnetize the magnets from any outside source.

Contributed by M. STANDISH.

FUEL TESTS SUCCESS

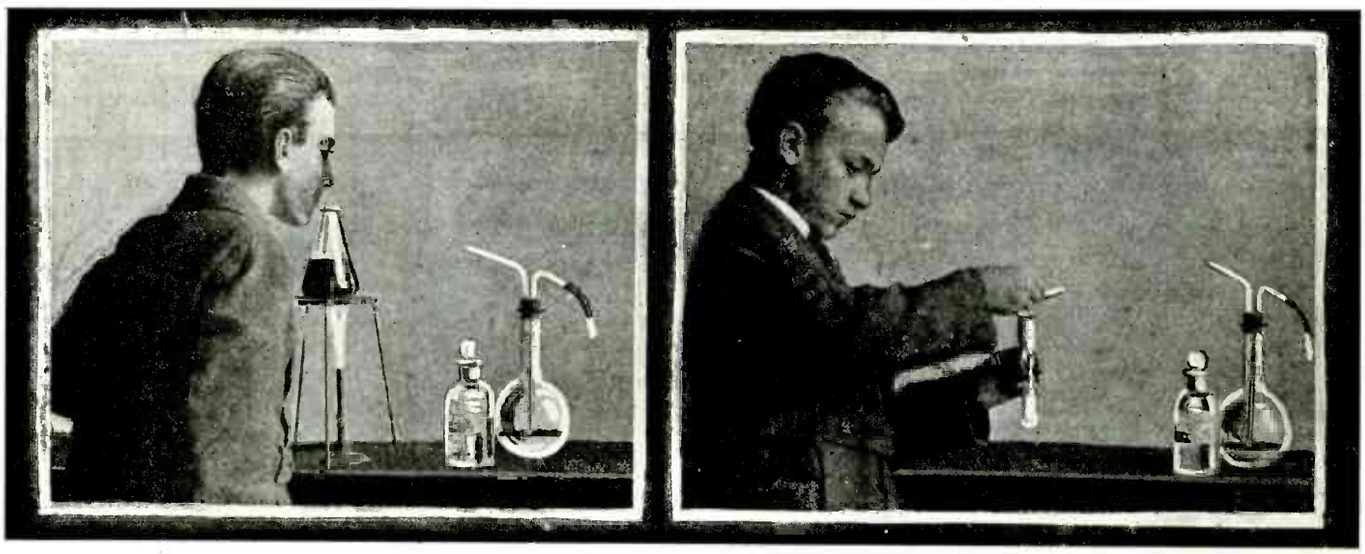
Perfection of a method of obtaining furfural from corn cobs, the new compound to be used as a fuel in automobile engines, and as a substitute for a wide variety of hard rubber, has been announced through the American Chemical Society by Dr. W. W. Skinner, assistant chief of the bureau of chemistry, United States Department of Agriculture.

Dr. Frederick B. La Forge and Gerald H. Haines of the bureau are credited with having made the successful experiments. As a fuel, it is said the new chemical compound cannot be used with the type of carburetor suited to gasoline. Plans are understood to be under way for the erection of a commercial plant to utilize the process at some point in the corn belt where raw materials are close at hand.

Practical Chemical Experiments

By Prof. FLOYD L. DARROW

QUALITATIVE ANALYSIS—SIXTH PAPER



Boiling a Mixture of Salts With Dilute Acid to Note the Odor of the Gas.

Testing for Hydrogen Sulphide by Holding a Filter Paper Moistened With Lead Acetate Solution Over the Escaping Gas.

IN this article we shall take up the procedure necessary for the determination of acid radicals. This is not quite so systematic a scheme as is that for the metals. It is not always possible to apply a group reagent to precipitate a certain number of radicals in the form of insoluble compounds, separate and identify each, and then to proceed with the filtrate for the detection of other groups. We may, however, determine the presence or absence of a certain group of radicals with some group reagent, and then by separate tests upon successive small portions of the original solution test for each radical.

It is important to observe that the regular analysis for the metals, which always precedes that for the acids, gives very definite indications as to the presence or absence of certain radicals. For instance, if silver has been found present in aqueous solution, it will be useless to look for chlorides, bromides, and iodides, for the silver salts of these compounds are insoluble. Again, if barium has been found, it will be a waste of time to look for sulphates, or for many other insoluble barium salts.

Group I. To this group belong those acids which are expelled or decomposed in gaseous form by boiling with dilute hydrochloric or nitric acids. They include carbonic, sulphurous, thiosulphuric, hydrosulphuric, nitrous, hydrocyanic, acetic acids, and, though not volatile, silicic acid.

In order to learn the tests it will be best to prepare a mixture of solutions of sodium carbonate, sodium thiosulphate (ordinary photographer's hypo), sodium nitrite, sodium acetate, sodium or ammonium sulphide, sodium silicate (ordinary waterglass). I have purposely omitted the salt of hydrocyanic acid because this acid and all of its compounds are deadly poisonous.

To a small portion of this solution add dilute hydrochloric acid and heat to boiling. Effervescence will, of course, take place, and in case of an unknown substance you must note the odor, but do so cautiously, for poisonous hydrocyanic acid or other poison might be present. In case of an unknown substance, too, if silver, mercurous or lead salts were present, they would not dissolve in hydrochloric acid, and nitric acid would have to be used instead. Occasionally a substance insoluble in either hydrochloric or nitric acid will be found. This would, of course, be in solid form. It must then be dissolved in aqua regia if possible. But the oxidizing action of aqua regia introduces some factors that would have to be taken into account in subsequent groups. Sometimes a substance insoluble in acids will be found. In that case fuse it on a platinum foil with four parts of sodium carbonate and boil the fused mass with water. Filter and test the filtrate for acids. If any metal of the first two groups except mercury should be present, fuse on charcoal instead of platinum.

Carbonic Acid. Many carbonates are easily decomposed with the effervescence of carbon dioxide upon the addition of dilute hydrochloric acid. A few will require concentrated acid or warming. Place the solid or solution in a test tube and add a little dilute acid. Have ready another test tube with 1 cc. of lime water. Then pour the escaping gas into the second test tube and shake vigorously. If carbon dioxide is present, a white precipitate results. In pouring the gas downward be very careful that none of the liquid of the first test tube is poured into the lime water.

When the effervescence is feeble, it will be necessary to fit the first test tube with a one-holed stopper and bent delivery tube dipping into the lime water.

Sulphurous and Thiosulphuric Acids. The salts of these acids, sulphites and thiosulphates, respectively, will both give sulphur dioxide upon warming with dilute hydrochloric acid. This gas may readily be detected by its characteristic odor. When poured, similarly to carbon dioxide, into a test tube containing purple potassium permanganate solution, the permanganate solution will be decolorized. This action at the same time oxidizes the sulphurous acid formed to sulphuric anhydride, which gives sulphuric acid, which may be tested for with barium chloride solution and dilute hydrochloric acid. When this latter confirmatory test is to be applied it will be necessary first to remove any sulphates from the original solution by the addition of barium chloride and then filtering.

So far in the tests for these two acids nothing has been said that would serve to distinguish them. If, however, a thiosulphate is present, the addition of hydrochloric acid will not only evolve sulphur dioxide, but will give a white or yellowish precipitate of free sulphur. In the absence of this precipitate the formation of sulphur dioxide may be taken as proof of the presence of sulphites. For additional proof pour a little of the original solution, from which you have precipitated any sulphates present with barium chloride, into potassium permanganate solution. If sulphites are present the permanganate solution will be decolorized and barium chloride and hydrochloric acid will give the characteristic test for a sulphate, the sulphurous acid having been oxidized to sulphuric by the permanganate.

Hydrosulphuric Acid. Hydrosulphuric acid is simply our old friend hydrogen sulphide. The salts of this acid, as you know, are the sulphides. All soluble sulphides and most of the insoluble ones will liberate hydrogen sulphide gas upon the addition of hydrochloric acid. This may be recognized by the odor and by the blackening of filter paper moistened with lead acetate solution and held in the escaping gas.

Any sulphide when fused on charcoal with sodium carbonate will give sodium sulphide. Place a mixture of the sulphide and carbonate on charcoal and fuse with the flame of the blowpipe. Then lay the fused mass on a silver coin and moisten with water. A black stain of silver sulphide will result.

When dissolved in aqua regia, sulphides are oxidized into sulphates and may then be tested for with barium chloride and dilute hydrochloric acid. This method may be employed in testing for sulphur in cast iron.

The sulphur present in coal may be detected by heating with sodium carbonate and sodium nitrate with free access of air until deflagration occurs and continuing the heating for some time. This oxidizes the sulphur into sodium sulphate and then by dissolving in water and applying the barium chloride test its presence may be shown. Since, however, illuminating gas always contains some sulphur, it will be necessary to use an alcohol lamp for this determination.

Nitrous Acid. If nitrites, the salts of nitrous acid, are present in concentrated form, as they would be in your prepared solution, the addition of strong hydrochloric acid will liberate reddish-brown nitrogen peroxide, which can best be seen by looking down into the test tube. Do not place the tube near the eye; look from a distance.

When a few drops of a metaphenylene-diamine-chloride solution are added to a solution of a nitrite which has been acidified with dilute hydrochloric acid, a yellow color will result either at once or upon standing.

be shown by scraping off the paraffin. This is the method employed in etching thermometer scales.

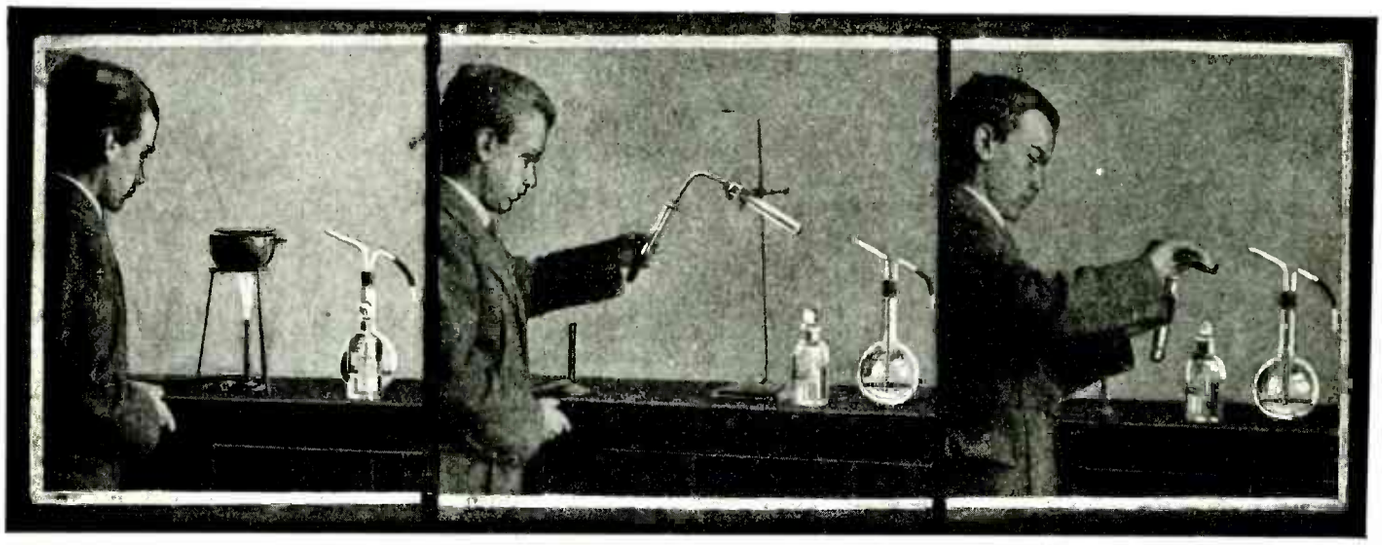
The calcium chloride mentioned as the group reagent is used in general analysis when complete solution of all the substances has been obtained and the metals are being tested for as well. This procedure will be described at the end of the group.

To a solution of oxalic acid add calcium sulphate solution and obtain a white precipitate of calcium oxalate. Calcium chloride may be substituted for the sulphate.

precipitate in a test tube and add one drop of ammonium hydroxide and a little silver nitrate solution. Upon warming, the silver nitrate will be reduced to metallic form and a mirror of silver will be formed on the walls of the test tube.

Since cream of tartar, acid potassium tartrate, is difficultly soluble in cold water, solution must be had with heat or better use tartaric acid itself.

General Procedure. In systematic analysis when the metals of any of the groups may be present, the procedure is as follows: When



Making the Tumeric Test for Boric Acid—Drying the Tumeric Paper on a Watch Glass Placed Over a Water Bath.

Testing for Sulphur Dioxide by Passing the Gas Into a Solution of Potassium Permanganate, Thereby Decolorizing It.

Making Test for Carbon Dioxide. CO_2 Passed Into Lime Water Forms a White Precipitate.

One of the most delicate tests in all chemistry is obtained by adding solutions of naphthylamine hydrochloride and sulphanilic acid to an acid solution of a nitrite. A rose color develops slowly in very dilute solutions. It is seen best by looking down into the test tube. Even so small an amount as one part in a billion may be detected by this test. It is much used in water analysis.

Acetic Acid. To a very small portion of the original solution, concentrated somewhat by evaporation if very dilute, add two or three cc. of ethyl alcohol in a test tube with an equal volume of cencentrated sulphuric acid, and warm gently. The fragrant fruity odor of ethyl acetate will result.

Silicic Acid. Although silicic acid is not volatile, it is placed in this group. If to a little of your original solution placed in a porcelain dish you add, drop by drop, concentrated hydrochloric acid silicic acid will separate as a gelatinous mass. If this is evaporated to dryness, moistened with concentrated hydrochloric acid, and then treated with hot water, the silicic acid will remain undissolved, forming a fine grit. If this is heated with a sodium carbonate bead on the end of a platinum wire effervescence will occur.

Group II. The second group of acids includes those whose calcium salts are insoluble. They are hydrofluoric, oxalic, phosphoric, boric, tartaric, arsenious, and arsenic acids. If the last two are present in any systematic analysis they will have been found in testing for the metals and need not be looked for here.

Hydrofluoric Acid. To practise the test for this acid make a thin paste of calcium fluoride and concentrated sulphuric acid in a lead dish. Have ready a glass plate on which you have melted a thin layer of paraffin and through which you have traced some letters or other design. Place the glass paraffin-side down on the dish and warm gently, but not enough to melt the paraffin. Hydrofluoric acid will be formed which will attack the glass and etch the design, as may

If oxalic acid or an oxalate is boiled with manganese dioxide and dilute sulphuric acid carbon dioxide will be formed which may be tested for with lime water.

Phosphoric Acid. To a solution of phosphoric acid or a sodium phosphate add ammonium chloride, ammonium hydroxide, and magnesium sulphate solutions. Upon shaking vigorously or rubbing the inside of the test tube with a glass rod a white crystalline precipitate of magnesium ammonium phosphate will form.

Also if ammonium molydate dissolved in nitric acid be added in large excess to the phosphate solution a canary-yellow precipitate will form upon gentle warming.

Boric Acid. To a solution of boric acid or borax add hydrochloric acid to acid reaction. Dip a piece of tumeric paper in the solution and dry it on a watch glass placed on a water bath. A very convenient water bath consists of a beaker of water placed over a Bunsen burner with the watch glass above. The beaker should have a lip for the escape of the steam. In the presence of boric acid the tumeric paper will turn reddish brown.

If the boric acid compound is in solid form place it in a porcelain dish and cover it with a mixture of concentrated sulphuric acid and alcohol. Upon setting fire to the alcohol a green flame will be obtained. Copper compounds must be absent, however. If their presence is suspected, first remove them by precipitation with hydrogen sulphide.

Tartaric Acid. This is the acid occurring in grapes and is present in the cream of tartar of baking powder. In a porcelain crucible place a little cream of tartar and heat over the Bunsen burner until it chars and gives the odor of burnt sugar.

To a solution of cream of tartar add calcium chloride solution and obtain a precipitate of calcium tartrate. Digest this with cold sodium hydroxide, dilute somewhat, filter and boil the filtrate. While still hot filter and wash the precipitate. Place the

the metals of the first five groups or magnesium have been found to be present, add sodium carbonate solution until an alkaline reaction is obtained, boil for several minutes and filter. Any acids present will pass into the filtrate as sodium salts. To the filtrate add dilute hydrochloric acid and boil to expel the carbon dioxide. Add acid slightly in excess of that necessary to liberate all of the carbon dioxide. Then add ammonium hydroxide to slight alkaline reaction. If the metals of the first five groups and magnesium were found in the preceding analysis to be absent, the preliminary work just described may be omitted.

In either case, add to a small portion of the alkaline solution calcium chloride solution. If no precipitate forms after standing for some time the acids of this group may be considered as absent, unless metals of the first four groups were present. In that case test for oxalic, phosphoric, and boric acids as already described.

If a precipitate forms, add acetic acid. If the precipitate dissolves completely, hydrofluoric and oxalic acids are absent. Tests for the other acids must be made, however.

If the precipitate dissolves only in part, tests must be made for all the acids of the group.

If the precipitate remains wholly unchanged, tests need be made only for hydrofluoric and oxalic acids.

In testing the hydrofluoric acid it is best to use some of the original solid substance under examination. The other acids will be found in the main filtrate obtained above. Before proceeding with the tests for the other acids, it is best to precipitate any metals as sulphides by passing hydrogen sulphide. Then filter and acidify the filtrate with acetic acid. This filtrate will contain the acid radicals to be tested for.

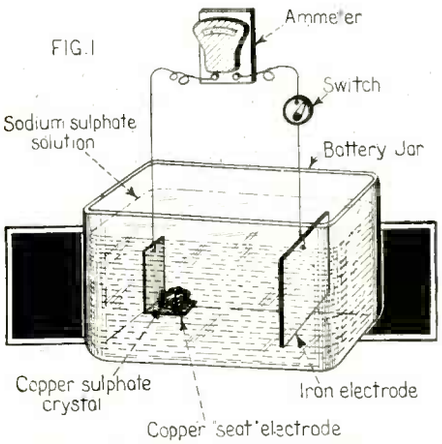
In the next article we shall complete the analysis of the acids and begin the systematic examination of various kinds of unknown substances.

Experimental Electro-Chemistry

By RAYMOND B. WAILES

PART 5—ELECTRO-MOTIVE CHEMISTRY; TYPES OF ELECTRIC CELLS

THE Daniell cell, as described in the last issue of this series, is an instance of a *displacement cell.* Here the zinc element displaces copper from the copper sulphate solution with the consequent liberation of heat and a resultant electro-motive force.



As Soon as the Crystal of Copper Sulphate Is Deposited on the Copper Saddle Electrode, Displacement of Copper Occurs, With the Formation of an Electric Current.

A very simple experiment showing that it is really the displacement of one metal from solution by another metal not in solution can be performed very readily. An iron electrode is immersed in a moderately strong solution of sodium sulphate (Glauber's salts) and connected with a sensitive indicating instrument. The remaining binding post of the indicating instrument is connected with a copper electrode bent in the form of a small seat or stirrup, and likewise immersed in the sodium sulphate solution. The iron electrode should be hung upon an iron wire while the copper electrode is supported by a copper wire.

Upon connecting the indicating instrument in the circuit by means of the switch, a very small non-lasting current is obtained. This should be neglected in the observations. If several crystals of copper sulphate are now dropped upon the copper seat, they will soon dissolve, and a current will be formed which flows through the circuit and actuates the sensitive ammeter.

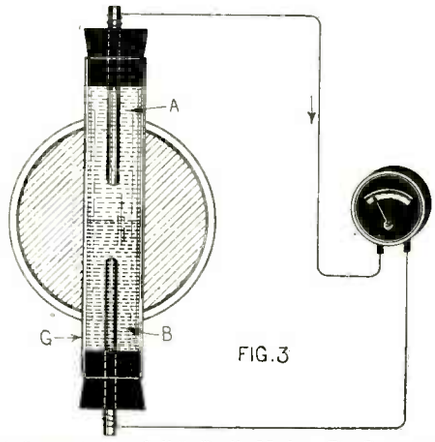
The copper sulphate crystals produce copper *ions* about the electrode, and these copper ions are displaced from the solution by the iron, the displaced ions becoming copper *atoms*, or ordinary copper metal, which plates out upon the copper saddle or seat.

The sodium sulphate solution affords sodium ions, it is true, but metallic iron will not displace sodium ions from solution, as can readily be seen by referring to the table of electro-motive series appearing in the last article of this series. Iron here is *below* sodium in the series, meaning that they will not cause a displacement in the instance stated. A glance shows that iron can displace copper from a solution of a copper salt, for it can be seen that iron is *above* copper in the series.

The following equation shows what has happened in the gravity cell:

$$Cu^{\cdot\cdot} + Fe = Cu + Fe^{\cdot\cdot}$$

The two suffixed periods after the first copper element (which is abbreviated Cu) imply that the metal (copper) is in the form of ions—is in solution. Iron is written Fe, and here is in the metallic or atomic state, as the absence of the suffixed periods shows. These two substances cast together as in the experiment cause a reaction, represented by the equality sign. Metallic or atomic copper is formed as evidenced by the abbreviation Cu. The iron goes into solution, or becomes transformed into ions as the two suffixed periods show.



A Concentration Cell Is Easily Made. The Reactive Constituents Are Solutions of Different Strengths or Concentrations.

The above is an instance of a displacement cell. In it two dissimilar metals were used. The following experiment shows that two dissimilar metals are not absolutely necessary for a displacement cell. The copper electrode in the previous experiment is to be substituted by a platinum disk. A small piece of platinum wire bent in the form of a spiral will serve as well as a disk, and is extremely inexpensive in contrast. A solution of sodium chloride (salt) should be used instead of sodium sulphate. When connected, no current is observed, but on placing crystals of *ferric* chloride upon the little flat platinum wire spiral, a current is produced. This reaction proceeds:

$$2Fe^{\cdot\cdot\cdot} + Fe = 3Fe^{\cdot\cdot}$$

Here the three suffixed periods indicate *ferric* iron, the Fe metallic iron (the iron electrode), and the $Fe^{\cdot\cdot}$ indicating *ferrous* iron. Although both ferric and ferrous iron are really iron in nature, they are more different than hard and soft water. The above is a case of a displacement cell with two similar metals taking part.

COMBINATION CELLS

There are types of electric cells which are termed *combination cells.* Here two elements are used, and during the reaction the elements, or atoms, are *both* reverted into *ions.* Figure 2 shows the apparatus. The fire-clay crucible acts as a semi-permeable membrane and contains several cubic centimeters of bromine and a salt solution. A rod of zinc is immersed in a solution of sodium chloride contained in a battery jar. The other electrode is a battery carbon dipping into the bromine in the fire-clay crucible containing the salt solution. On connecting the wires with the ammeter a current flows in the direction shown. This is due to the following reaction:

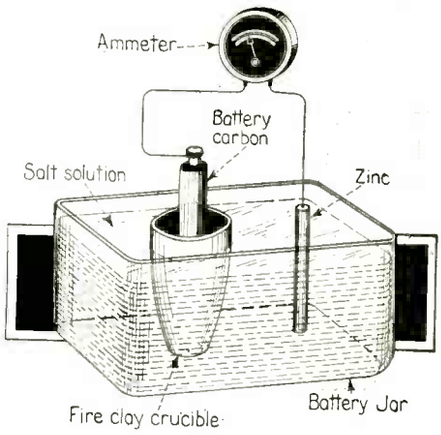


FIG.2

Two Elements Passing From Atomic to Ionic (Solution) Forms Can Produce a Current of Electricity. The Result Is a Combination Cell.

$$Zn + 2Br = Zn^{\cdot\cdot} + 2Br^{\cdot}$$

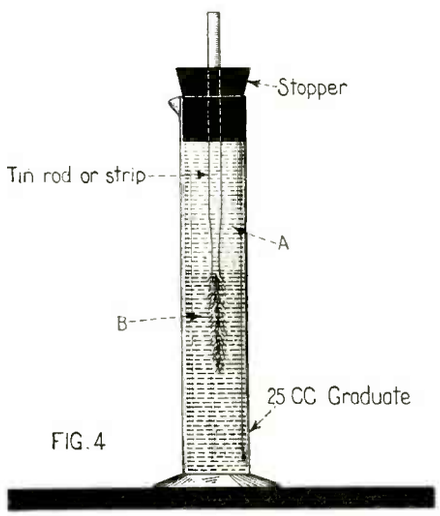
Here, Zn and Br represent atomic bodies, while $Zn^{\cdot\cdot}$ and $Br^{\cdot}$ represent ionic bodies, or bodies in solution. This type of cell is called a combination cell as evidenced by the similar atomic-to-ionic stages.

CONCENTRATION CELLS

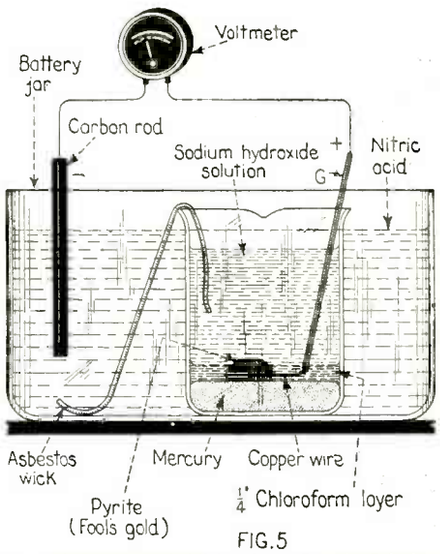
Instead of using two different metals as electrodes and a suitable electrolyte, solutions of different strengths can be used, these being connected to the ammeter by suitable electrodes.

Figure 3 shows this type of cell. The electrolyte B is made of 10 grams of cupric chloride in 20cc of water; electrolyte A is poured carefully on B, and is a more dilute solution of the same salt—5 grams of cupric chloride in 250cc water. Copper electrodes

(*Continued on page* 582)

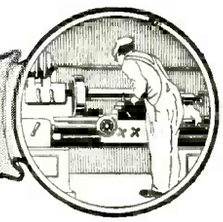


A Short-Circuited Concentration Cell. The Current Produced by Solutions of Different Strength Causes the Formation of the "Tin Tree."



Mineral Sulphides Oxidizing in a Caustic Solution Give Rise to an Electric Current. This Scheme Has Been Proposed Commercially. It Is the Change in Valence, or Chemical Combining Power of the Iron in the Pyrite, Which Causes the Production of Electricity in This Case.

THE CONSTRUCTOR



A Cuprous Oxide Photo-Electric Cell

By RAYMOND B. WAILES

MANY chemical reactions are accompanied by the emission of light or electricity. The operating of the cuprous oxide (copper oxide) photo-electric cell described here is caused by the chemical action

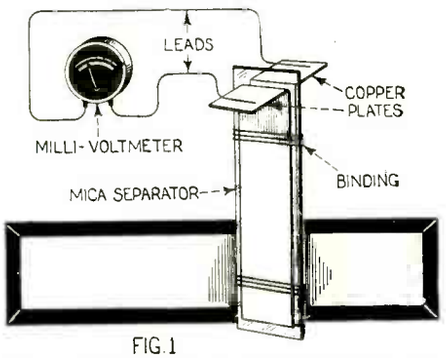


FIG.1

Fig. 1. Elements of the Photo-Electric Cell. The Terminals of the Cell Can Be Connected with Phones, Milliammeter, Voltmeter, or Relay as Desired.

of the oxide under the influence of light, with a consequent production of a current of electricity.

The selenium cell is a type of photo-electric cell. In the selenium cell circuit, a battery and an indicating instrument are connected in series with the cell, and actinic or light rays allowed to fall upon the selenium surface of the cell, which results in a lowering of the resistance of the whole circuit, thus operating the indicating instrument. The cuprous oxide cell does not require a battery in the circuit to operate the indicating instrument which is connected across its terminals. The action of the sunlight upon one of its sensitive surfaces is sufficient to generate an E. M. F. approximating 0.1 volt, the amperage depending upon the size of the plates. A test tube (8") cell is shown herewith giving about 0.003 ampere.

Figure 1 shows the construction of the cell. Two copper plates are cut to fit the glass vessel to be used as a container. An 8" test tube is satisfactory for experimental purposes, while a battery jar would make an excellent container for a cell capable of giving stronger outputs of current. A sheet of mica should separate the two copper strips. Binding with cotton thread makes a compact photo-electric element.

The copper sheets or electrodes should first be cleaned of grease and then immersed in rather strong nitric acid which causes a clean surface to form. The plates or copper sheets should then be highly polished with steel wool, and precautions taken to prevent contact with grease. Immersion of the strips in a strong caustic solution such as lye will remove initial grease.

The electrolyte is made up according to the following formula:

Copper formate, 2.5 grams.
Distilled water, 100.00 cc.
Formic acid (80%) 0.5 cc.

Fairly pure water may be used instead of distilled water. The formic acid is bought in aqueous solution. The amount added to the electrolyte is very important, for if too much acid is added, the cell will not function, as the thin film of cuprous oxide on its surface will be dissolved, if it ever forms, and the E.M.F. will be nil, for the cuprous oxide film is the starting point of the E.M.F. generation. If too little acid is added, the cupric oxide which forms when the cuprous oxide is acted upon by sunlight will not dissolve, making the cell inoperative. The exact amount of free formic acid which should be present is not difficult to ascertain, however.

The theory of the cell is as follows: When the brightly polished copper electrodes or plates are immersed in the above solution, a thin orange coat of cuprous oxide is deposited on the surface of the plates. When *one electrode* is exposed to the sunlight, or other strong light, *keeping the other electrode behind it, in the dark,* the cuprous oxide film is oxidized to cupric oxide by the action of the light, and this reaction gives rise to the E.M.F. generated. As soon as the cupric oxide coating forms, however,

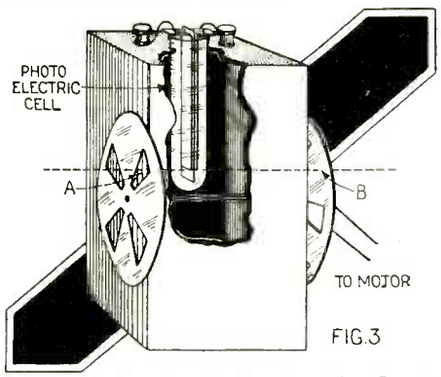


FIG.3

Fig. 3. The Housing for the Alternating Current Photo-Electric Cell. The Two Sectored Disks of Cardboard Are Mounted Upon a Common Shaft Driven by a Toy Motor.

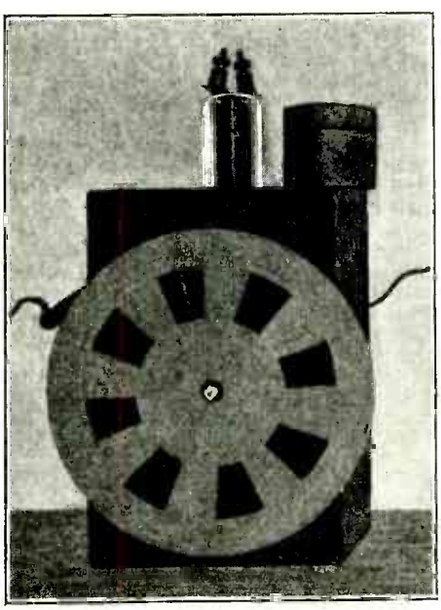


Fig. 4. The Completed Photo-Electric Cell with Its Housing. The Cardboard Cap Is Placed Over the Protruding End of the Cell When in Operation. The Cell Is Shown Here Withdrawn Slightly from the Sectored Housing.

the free formic acid which is in the solution *dissolves* it, and leaves a coating of pure copper, or, the bare copper electrode or plate is left. This undergoes the first step—becomes coated with cuprous oxide, as does

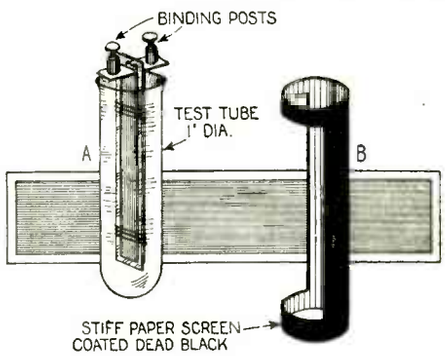


FIG.2

Fig. 2. A Completed Cuprous Oxide Photo-Electric Cell. No Battery Is Required with This Cell. Shielding or Exposing to Light Generates an Electric Current.

the plate when first immersed in the cell. The reaction proceeds as follows:

$$CuO + 2HCOOH = Cu(COOH)_2 + H_2O$$

cupric oxide + formic acid = copper formate + water.

It can be seen, therefore, that nothing in the cell is consumed. The cell will operate for a considerable length of time without attention. Loss by atmospheric evaporation is taken care of by the addition of water as required.

A simple cell of the cuprous oxide type is shown in figure 2. A 1" tube makes a suitable container for the element and the electrolyte. The element can be thrust through a rubber stopper to prevent evaporation.

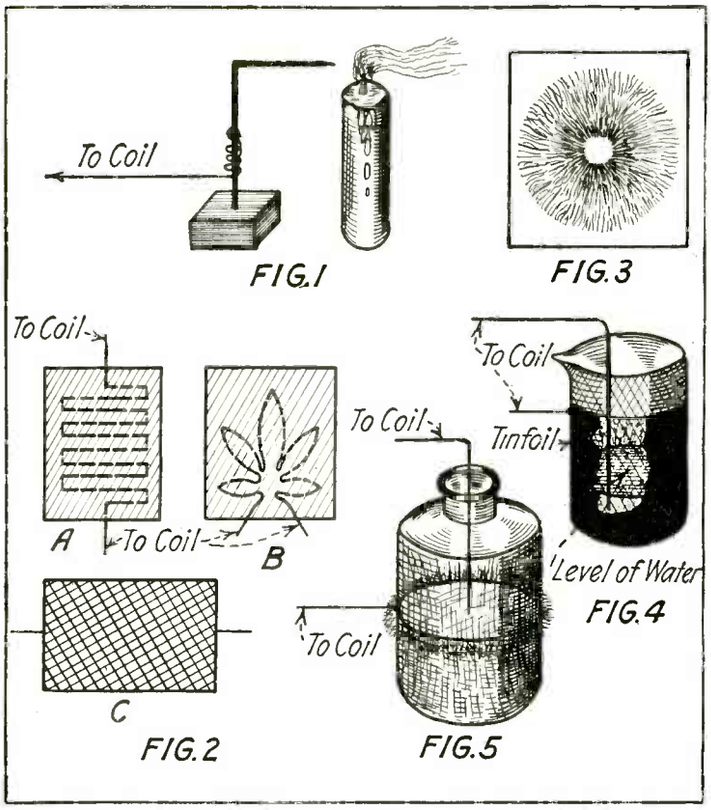
In figure 2, B, a stiff paper cap is shown. This can be used to slip over the cell, exposing one half of the whole element, or one copper plate as desired. On turning the paper cap another half revolution, the exposed plate will be darkened and the dark plate will become insulated, or exposed to the light. The paper cap should only be used for experimental tryouts on a rough scale. For alternating the insulation of each plate, the housing as described below should be used.

An Alternating Current Cell

The simple CuO cell described can be used to give an alternating current by employing the housing as shown in figure 3. A cigar box can be used. The sector rotors are of cardboard and mounted on a common axis. Sectors are cut in the two sides of the housing to correspond with the sectors of the rotors. The rotors should be so mounted that, when light enters in, say, opening in side A of figure 3, the rotor on side B should cover up the hole in the housing on that side. In other words, a line drawn through hole or sector A, should strike a *blank* sector at B, of the other rotor. The rotors should be driven by means of a small battery motor. Glass beads can serve as bearings. The photo-electric cell should be lo-

(*Continued on page* 598)

Experiments with a Spark Coil



Various Interesting Experiments Which Can Be Conducted with an Ordinary Spark Coil, Even a Small Sized One, are Shown in the Illustration at the Left. One of the Simplest and Yet Very Pretty Experiments is to Cover a Board or Bottle With Tinfoil, and Then Criss-Cross It With Knife Blade Marks, as Shown in Fig. 2C. When the Two Wires from the Secondary of the Spark Coil are Connected to Opposite Sides of the Tinfoil Board, a Multitude of Little Sparks Appear All Over the Tinfoil Covered Surface, Giving a Very Beautiful Effect in the Dark. If One Secondary Terminal is Grounded, and the Other Brought Near the Flame of a Lighted Candle, an "Electric Draft" Causes the Candle to Flicker, and in Some Cases to be Extinguished.

THE following is a series of spark coil experiments which I submit for the approval of all "bugs." The needed material can be had in nearly every household. The only apparatus required is a spark coil, and every experimenter that owns a sending set will have one.

EXPERIMENTS WITH FILINGS

On a glass plate sprinkle metal filings and connect the ends of the group of filings to the coil with two wires. The spark will pick out a path in a peculiar pattern. If powdered sulphur is mixed with the filings, and the experiment repeated, when the spark passes, it will blow the sulphur away from its path and thus clearly show the course.

Pass the spark through copper and steel filings and they will be attracted to one electrode, leaving a clear space around the other wire.

Ground one side of the coil and place a wire from the other side in the middle of a layer of filings. If the layer is large (about 3 x 4 inches) the filings at the very edge will be greatly agitated, but around the wire will be a circular space from which all filings will be repelled. If the layer is small (2 inches square), the filings will form a ring around the wire.

CANDLE EXPERIMENTS

Lengthen the gap till the limit of the passing of the spark is just reached. Bring a candle flame between the electrodes and the spark will bend out to the flame. If the sparks pass through the upper part of the flame they will appear as a white ball; through the lower part as a thin line.

Blow out the candle and bring it into the spark. It will be relighted.

Ground one secondary terminal and bring a wire from the other terminal near the flame of a lighted candle. When the coil is worked a draft, causing the candle to flicker, and in some cases to go out (Fig. 1), will be produced.

EXPERIMENTS WITH LUMINOUS DESIGNS

On a sheet of glass paste narrow strips of tinfoil in a continuous pattern. With a sharp knife make breaks at different points. Connect each end of the pattern to the coil and each break will be illuminated in the dark. The tinfoil can be pasted on in the shape of letters, clover leaves, etc. (See Fig. 2, A and B.)

Another very pretty effect can be secured by pasting a sheet of tinfoil over a pane of glass. When it is thoroughly dry score it across and across with a knife. Then connect opposite corners to the coil and the

(*Continued on page* 614)

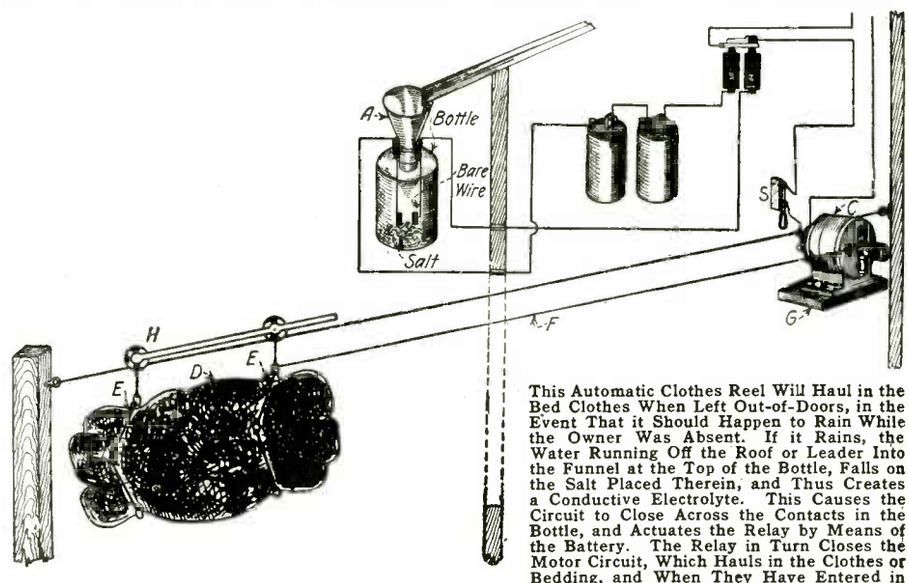
Automatic Clothes Reel

HERE is a device for airing bedding which will be found very useful in any household. The housewife can go out during the day leaving the bedding on the line, and in the event that it should rain while she is out no fear for the clothes need be felt, as they are automatically hauled into the house. Most of the material used in its construction will be found in the average household. A wire is attached to a screw rigidly secured into the wall of the house and passing through an open window to a distant pole. This wire is made as taut as possible. On the wire are mounted two pulley wheels held in a fixed relation with each other, by means of wooden straplings secured to either side of the pulleys. These straplings extend over a distance of about a foot and a half beyond the pulley in a direction toward the house, as shown in the accompanying diagram. Their purpose is to turn off the switch when the bedding is well within the four walls of the room.

A funnel is placed in the neck of a wide-mouthed bottle, which should, of course, be in an exposed location, and two wires bared at the end are inserted into the bottle. The wires are now led into the house and placed in series with a relay, which can be made from an old bell. The contact screw is merely twisted around and a contact-making spring is bent around the outer side of the contact screw. It will be evident, therefore, that whenever the circuit of the bell is closed the contact-making device will also complete its respective circuit, which in this event is the 110-volt power supply, to a motor fitted with a large drum and mounted upon the floor or the wall of the room. A cable leads from the motor to the cradle made of wires, which encircles the mattress.

The operation is as follows: No sooner does it start to rain, and when but a slight amount of rain has fallen, the water flows through the funnel into the bottle containing the salt. Immediately current passes across the wires operating the relay, which closes the circuit to motor C, mounted on the floor or upon a bracket. This causes the motor to wind up cable F, attached to cradle E, holding the mattress D and permitting the two pulley wheels held in a spaced relation by metal or wooden straplings H, to be drawn upward on the wire, until extension on H strikes switch S, turning off the current.

Contributed by CARL F. JOLLY.



This Automatic Clothes Reel Will Haul in the Bed Clothes When Left Out-of-Doors, in the Event That it Should Happen to Rain While the Owner Was Absent. If it Rains, the Water Running Off the Roof or Leader Into the Funnel at the Top of the Bottle, Falls on the Salt Placed Therein, and Thus Creates a Conductive Electrolyte. This Causes the Circuit to Close Across the Contacts in the Bottle, and Actuates the Relay by Means of the Battery. The Relay in Turn Closes the Motor Circuit, Which Hauls in the Clothes or Bedding, and When They Have Entered in Past the Window, the Rod H, Hits the Cut-Out Switch S, and Stops the Motor.

Print with Linoleum

LINOLEUM, a mixture of finely ground cork with linseed oil placed upon a coarsely woven fabric, and universally employed as a floor covering, is an ideal substance for the production of a block design or illustration. With but little skill drawings and monograms can be produced in quantities which are not only attractive, but which can easily be made without a press.

After securing a smooth piece of linoleum the design about to be reproduced must be drawn. This may contain figures, a landscape, letters, or be of conventional design. But this is not placed directly upon the linoleum. It must first be fixed upon tracing paper or any stiff transparent oil, not waxed, paper. The resultant drawing is then placed inverted upon the linoleum and the design transferred in its reverse position by interposing a piece of carbon paper.

When this has been accomplished, it is advisable to see which part of the design must be cut away and what parts must be left. Now all those parts which are to be printed are left exactly as they are, but all those parts which are not to be printed must be cut out. This will become self-evident when all those parts belonging to the design are colored black and those to be removed, white.

With a small *sharp* knife all black spaces are perpendicularly edged but great care must be taken that the knife does not go too deep, and that the cloth supporting the linoleum is not cut through. Then, with a side motion of the fingers, the white parts are cut out without undermining any of the inked parts. Smaller surfaces need only be slightly cut, a depth of about 1/32 of an inch being all that is necessary. The cut is now finished and can be used for printing on paper or cloth.

For this purpose a good grade of paper is taken, cut slightly larger than the design, and placed in a basin of water where it remains for about half an hour. By this process the paper loses its stiffness, and becomes soft, so that it can be more evenly pressed against the cut.

Ink must now be prepared. Upon a piece of glass, an old piece of an automobile windshield serves excellently, a small quantity of black oil paint, about the size of a pea, is placed. One drop of linseed oil is added, if the paint is not quite thin, and the oil and paint are thoroughly mixed. Then, with a small, flattened wad of cloth a small quantity of the paint is transferred to the cut. If it is put on too thick, the result will be a mass of blots.

Now one of the papers placed in the water is removed and quickly blotted between two sheets of blotting paper or the paper is quickly dried by placing it in contact with a dry clean rag. It must only be slightly moist, under no condition is it to be wet. Then it is carefully lowered upon the linoleum cut, another layer of dry paper is placed upon it, and is heavily rolled with the other hand. When the roller has gone over the design once, the paper is taken off.

If the print is slightly spotted white where it is supposed to be black, two things may be at fault. First, the pressure exerted on the roller may not have been adequate; secondly, insufficient ink may have been used.

The printed papers are carefully placed upon an old newspaper to dry, after which they can be pressed flat in a book, if so desired.

The use of such printed work is manifold. it can be used upon book markers, specialty post cards, patterns for borders, etc. Then too, one of these linoleum cuts mounted on a block of wood can be used for printing conventional patterns on table-covers, napkins, and other textile fabrics for the purpose of ornamentation.

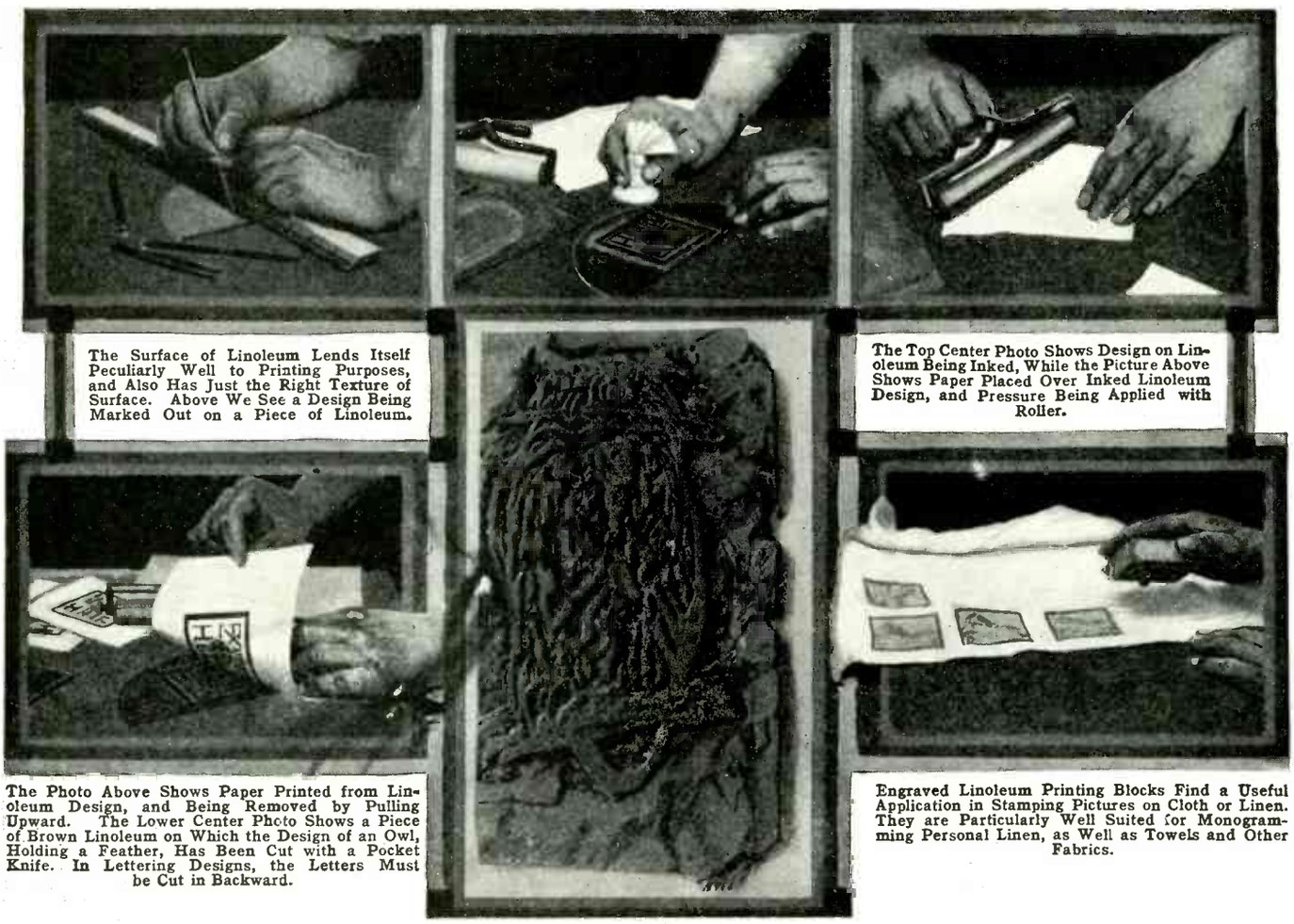
Here the finished cut is carefully mounted on a block of wood one inch in thickness and just as large as the design. This is securely fastened to it by means of a dozen, more or less, small brads. The surface is inked as before, but then the block is taken in the hand and, after placing it in the correct position over the textile, which requires patience and quite a little skill, it is firmly and evenly pressed upon it. The inks used for this purpose are, preferably, those classed as indelible, and before good pieces of linen are used or wasted, it is best to experiment on an old rag so as to be proficient in this method of printing.

Every print must be clear, sharp, and distinct, and this is only accomplished when the cut is *always uniformly inked* and when it is *always uniformly pressed* upon the cloth. Better results will, undoubtedly be gotten when a number of sheets of paper are placed below the cloth. Then it will produce a better and more even contact with the cut as it is pressed downward.

Very attractive combination patterns for borders, centers, and corners may be produced, and this with very little artistic skill. In fact, it is not at all necessary to draw original designs, they may be borrowed or copied from books, magazines, or illustrated art works.

As there is a potential statue in every piece of unhewn marble, so there is a hidden picture in every piece of linoleum. It is only necessary to know how to make it appear.

(*Continued on page* 615)



The Surface of Linoleum Lends Itself Peculiarly Well to Printing Purposes, and Also Has Just the Right Texture of Surface. Above We See a Design Being Marked Out on a Piece of Linoleum.

The Top Center Photo Shows Design on Linoleum Being Inked, While the Picture Above Shows Paper Placed Over Inked Linoleum Design, and Pressure Being Applied with Roller.

The Photo Above Shows Paper Printed from Linoleum Design, and Being Removed by Pulling Upward. The Lower Center Photo Shows a Piece of Brown Linoleum on Which the Design of an Owl, Holding a Feather, Has Been Cut with a Pocket Knife. In Lettering Designs, the Letters Must be Cut in Backward.

Engraved Linoleum Printing Blocks Find a Useful Application in Stamping Pictures on Cloth or Linen. They are Particularly Well Suited for Monogramming Personal Linen, as Well as Towels and Other Fabrics.

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $15.00; second prize, $10.00; third prize, $5.00.

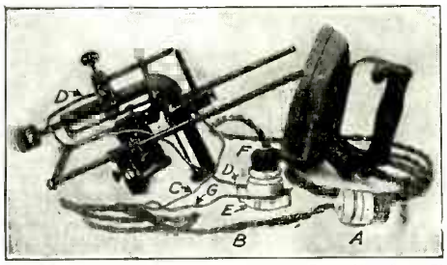
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize of $15.00 is awarded; for the second best idea a $10.00 prize, and for the third best a prize of $5.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $15.00

A "SAD IRON" RHEOSTAT

At first glance the relation between the arc lamp and the electric flat iron may seem somewhat obscure, but this relation is quite intimate, as you will see in a moment. The one has just what the other requires—electrical resistance.

This combination was suggested under stress of circumstances by the reputed "mother of invention." While making some



The Resistance of an Electric Sad Iron Renders It Suitable for Many Different Purposes Than That Originally Intended. For Example, the Iron Is Here Serving as a Ballast Resistance in Series With an Arc Lamp of the Stereopticon Type.

photo enlargements one evening, the 400 watt Mazda bulb I was using suddenly burnt out. I had no other bulb, but did have an old stereopticon arc lamp, but this seemed useless, for I had no rheostat and without this simple but necessary adjunct, one dares not switch an arc lamp on to a house circuit.

I was anxious to complete the work in hand and while pondering what could possibly be used as a temporary rheostat it seemed that an electric flat iron might pass enough current to serve the purpose. Accordingly the family iron was pressed into service, connections made as shown quite clearly in the photo and a workable light secured.

The photo shows the lamp removed from the lamp house the more easily to show connections, and while the arrangement may at first seem rather complex, it is really very simple. The plug (A) is screwed into a lamp socket and one strand (C) of the incandescent cord (B) run directly to the terminal of one lamp carbon. From the terminal of the other carbon a strand (D) is run to a porcelain receptacle (E). The other terminal of this receptacle is connected to the second strand (G) of the incandescent cord (B). When the plug (F) of the cord to the iron is screwed into the receptacle the iron is in series with the lamp which can now be lighted with no danger of blowing fuses and putting the house in darkness.

Contributed by

CLEMENT B. DAVIS.

SECOND PRIZE, $10.00

A PHOTOGRAPHIC DIFFUSION SCREEN

Now that soft-focus photographs are quite the vogue, and will continue to become more popular as time goes on, many photographers, both amateur and professional, are anxious to produce them. But as soft-focus lenses are difficult to operate and their price is from $25.00 to $100.00, this fact alone will keep many from purchasing a lens of this type.

However, no one need be discouraged from making delightful and artistic photographs of the soft-focus variety if he or she will take the trouble to make a diffusion screen, as described below.

Quite wonderful results can be obtained with such a screen, when the photographer has mastered the focusing and exposure.

To make the screen, first take a piece of flexible cardboard, and make a ring to fit closely over the lens on your camera, and wide enough so that it will stay in place. Next, procure a piece of fine black chiffon (the kind that is used for veils), and cut out a circle of it, somewhat larger than the cardboard ring.

Apply paste or glue to the outside of the ring, near the edge, and after laying the disc of chiffon over the ring, press firmly around the edge, making the chiffon tight and smooth. Finish by pasting another circle of cardboard over this, covering the ragged edge of the chiffon.

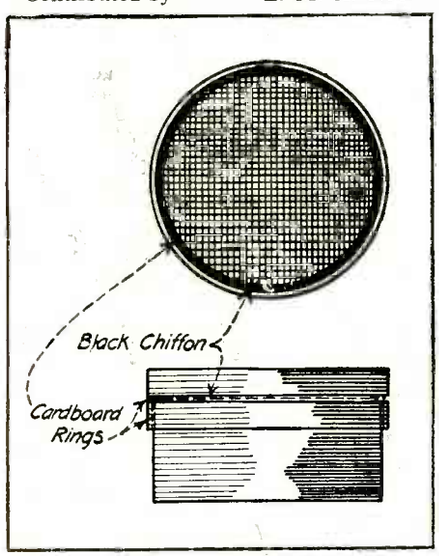
You now have a lens cap, with a chiffon screen, and the exposure is made through this screen. In use it is generally best to focus sharply, without the screen, then before exposing, place the screen over the lens, giving the exposure somewhat more time, probably half as much again as you usually do. If you are using a camera which has no ground glass, and are focusing with the distance scale, then of course the only thing you can do is to focus as accurately as you can with your scale, and expose with the screen in place over the lens.

Several experiments will give a good idea of the extra time of exposure.

Should you desire more softness, use two or more thicknesses of chiffon. (More chiffon means longer exposure.)

These screens give very fine effects on enlargements. The screen is used in the same manner as when taking the pictures; so when making the enlargement, focus sharply before exposing the paper, put the screen over the lens and expose.

Contributed by L. M. A. ROY.

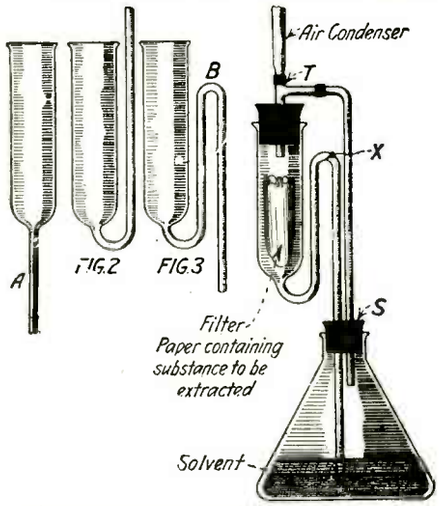


A Simple Photographic Diffusion Screen for Producing Those Much Desired Soft Effects in Portrait Pictures. It Is Made From a Couple of Cardboard Rings and a Piece of Black Chiffon in the Manner Illustrated Above.

THIRD PRIZE, $5.00

A SIMPLE EXTRACTION APPARATUS

A fruitless search through the supply houses for a Soxhlet tube compelled the author to make one from a large test tube, a



A Simply Built Chemical Apparatus Known as a Soxhlet Tube Is Here Shown. The Apparatus Can Be Employed for the Extraction of Various Ingredients in Seeds, Herbs and Roots, Which Should Preferably Be Macerated Before Being Placed into the Filter.

5/16-inch glass "T," two rubber stoppers and some glass tubing.

With a small, hot flame, the end of the test tube was blown out and a piece of 3/16-inch tube fused on to the opening. By heating at A, the tube is bent upward as in Fig. 2. Again bending at B, it is turned down as in Fig. 3. The bend B should be well below the top of the test tube.

Next fit the glass "T" into a rubber stopper and insert the latter in the test tube. Bend the end of a 5/16-inch tube, connect it with the arm of the "T" and pass the lower end of the two tubes through the stopper S. S fits into the top of the flask containing the solvent.

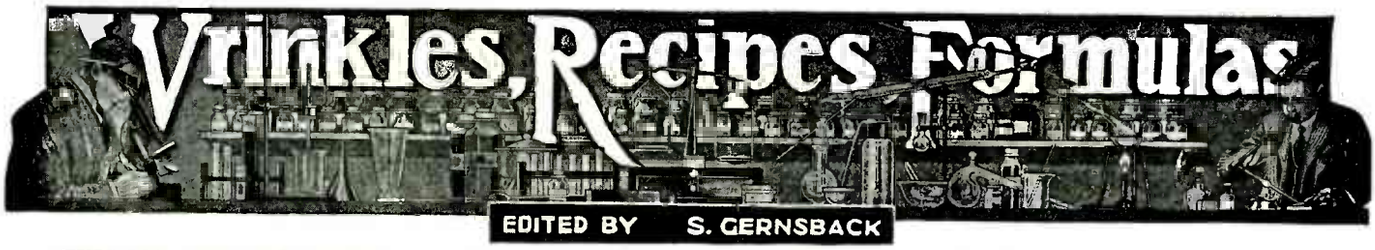
For a condenser, connect a 4-foot piece of half-inch glass tube to the free end of the "T."

Roll the substance to be extracted in a filter paper and push it down in the test tube. Fasten the apparatus firmly to a supporting stand and begin heating the solvent. The vapor from it passes up the air condenser, where it is chilled and liquefies and falls back as a hot stream into the test tube. When the solvent reaches the level X the extract is siphoned back into the flask and the operation begins over again, continuing automatically until the substance is thoroughly extracted.

Contributed by L. H. KIRBY.

NON-TAMPERABLE LETTER SEAL

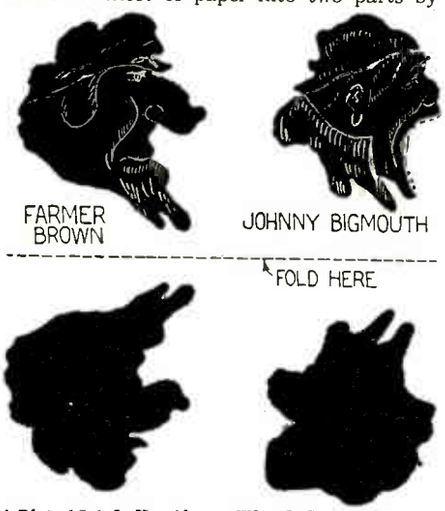
Steam will open envelopes closed with mucilage. A hot iron will open those sealed with wax. But any attempt to open a letter otherwise than by force which has been sealed by a small well moistened fish or medical wafer punctured by a needle and covered with sealing wax is frustrated.



THIS MONTH'S $5.00 PRIZE

HOW TO MAKE BLOT CARTOONS

The materials needed for these amusing pictures are a bottle of India ink, a bottle of white ink and two pens, also some paper. Divide a sheet of paper into two parts by



A Blot of Ink Is Not Always What It Seems to Be, as These Grotesque Drawings Demonstrate. The Two Blots of Ink Formed by Folding the Paper in the Manner Indicated, and Afterward Retouching With a Little Chinese White, Present a Novel Wrinkle in Making Free-Hand Drawings.

folding. On one-half make a blot from your India ink pen. Immediately fold over the other half of the sheet and press firmly on the blot. The blot will spread, leaving various queer shapes, which with white ink you can make resemble human faces, animals, etc. These cartoons are easily made and afford amusement for a large number of people. Anyone handy with a pen can develop cartoons and faces out of queerest shaped blots.

Contributed by
W. CLIFFORD HEALEY.

AN INTERESTING METHOD OF SEPARATING METALS FROM ORES

It is a well-known fact that for centuries an enormous wastage has taken place in the extraction of minerals from their ores, a varying percentage having been invariably abandoned because the cost of extracting it amounted to more than its value. For many years extensive experiments have been made with a view of securing this balance, not only from newly mined ores but from extensive accumulations of what has not been specially treated before.

A method now coming into general use is known as "mineral flotation." The apparatus comprises a tank in which water is violently agitated by means of a paddle. A small quantity of oil being added to the water, an oily froth or scum forms on the surface, and metallic particles, having a greater preference or adherence for oil, collect in the froth, the stony particles settling at the bottom of the tank, whence they are discharged. The froth containing the metal may be skimmed off, or allowed to accumulate until it overflows into a suitable receptacle. The process is applied primarily to the treatment of such ores as those of copper, zinc, lead, etc., but also to the treatment of precious metals, such as gold and silver.

Already seventy million tons of ore are treated annually in this manner.

Contributed by W. R. REINICKE.

THAT DAMP PATCH ON THE WALL

In not a few houses there is an ugly damp patch on the wall which regularly puts in an appearance when the weather becomes damp. Often enough professional aid does not entirely remove the trouble. In such cases the use of sodium silicate, or water-glass in syrup form (to be purchased at any druggist) is to be highly recommended. It will be needful to remove the paper from the area. A piece for patching should, of course, be available. Then, with a brush, go over the wall with water-glass. Give at least three coats, allowing each one to dry before applying the next. In course of time the water-glass hardens into a damp-resisting layer, which effectively keeps back all moisture. If the patch of paper is carefully put on there is no reason why it should show.

Contributed by W. R. REINICKE.

A SIMPLE AND EFFICIENT INDICATOR

The very common dye, "Congo Red," may be used as a very efficient indicator. Its reactions are just the opposite of litmus: i.e., an acid turns it blue, while an alkali turns it red. Moreover, it shows gradations in color, the blue being much more distinct with an active acid like nitric acid than with a relatively weak acid like acetic acid.

Dissolve a little of the dye in water till quite a deep color is obtained. Pour some of the solution into a saucer, and dip sheets of filter paper in it, soaking them thoroughly. Hang them to dry by one edge. Cloth and thread may be treated very successfully also. Cut the dyed paper or cloth into small strips for use.

This dye may be obtained in a large chemical store or supply house. It is much cheaper to make your own indicator by this method than to buy litmus paper. Several of the shades of red designated as "cardinal" of the various dress dyes, such as "Dyeflake," "Tintex," etc., on the market today, consist of the dye, "Congo Red."

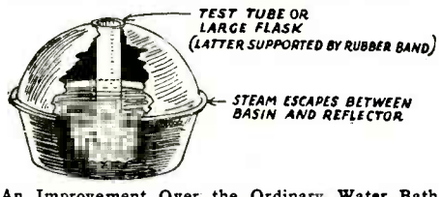
Contributed by JOHN BARRY.

AN IMPROVISED WATER BATH

An improvement over the ordinary water bath was made and a piece of junk utilized by using an old reflector upside down over the water basin, thus forming a hood. The reflector used was of pressed steel out of a Ford electric headlight.

The socket bushings were driven out, leaving a hole the right size to take ½-ounce and ¼-ounce test tubes, also small flasks. Another reflector was drilled larger for 1-ounce tubes and large flasks; the necks of the flasks were inserted from the bottom upward and held in place by placing rubber bands around them above the hood.

By using this method of suspension the flask is immersed in the water and touches the receptacle at only one unimportant place, thereby getting exactly 100° C. or 212° F. Besides, the water does not boil away as fast and the steam can escape readily as the hood only sits loosely on the basins—possibly for large flasks deeper basins may be needed.



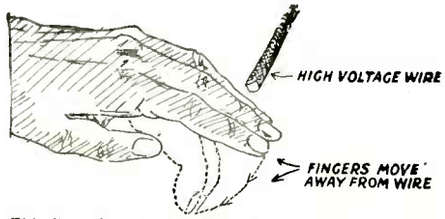
An Improvement Over the Ordinary Water Bath Made From an Old Tin Reflector, a Test Tube, and a Water Basin.

The liquid in the water baths can be composed of other mixtures and solutions so as to give either a higher or lower boiling point. This is especially valuable in the distillation of solutions having a low boiling point.

Contributed by C. R. MULLIN.

A SAFE WAY TO TEST WIRES

As long as there is juice, somebody will stick his hands on switches and wires to see if they are *alive*, and oftentimes after storms low tension wires will have *foreign currents* on them.



This Experimenter Suggests That in Touching Wires to See if They Are Alive or Not, That the Backs of the Fingers Should Be Touched to the Wire and Not Their Inner Surface, So That in Case a Shock Is Felt, the Natural Motion of the Fingers Will Be Away From the Wire Instead of Causing Them to Close Over It.

If you must try a wire to see if it is *alive*, use the BACK of your fingers. If the current is sufficiently powerful to cause the hand to shut the fingers will close AWAY from the wire and not on it. If this method is followed it will save disaster even on high tension voltage where a person would surely *grab* and cling to it.

Contributed by C. R. MULLIN.

WATER PYROTECHNICS

Fire and water, regarded by the ancients as elements, are generally supposed to be the direct antitheses of each other. However, in conjunction with chemical action, they exhibit many striking and even beautiful combinations.

A spectacular example is the action of a bit of metallic potassium which has been dropped into cold water. The metal immediately assumes the form of a white-hot fire-ball, which, liberating hydrogen and producing a purple flame, exhibits gyratory movements upon the surface.

On the contrary, if lumps of calcium phosphide be dropped into water, they sink to the bottom and give off bubbles of phosphine gas, which rise to the surface and spontaneously inflame. This gas may also be produced by heating phosphorus under strong caustic potash solution in a retort, the beak of which dips beneath the surface of water in a shallow pan. The retort must be filled with carbonic acid gas before the application of heat.

Phosphorus, melted under water heated nearly to boiling, ignites beneath the surface when bubbles of oxygen gas are passed over it through a metal tube. A piece of burning magnesium ribbon burns with undiminished brilliancy when plunged beneath the surface of boiling water.

A method of producing fire under water without the application of heat is as follows: Sprinkle a piece of moist phosphorus with powdered potassium chlorate and place in the bottom of a tumbler. Pour water gently down the side of the receptacle until the lump is just covered. Then pour a thin stream of concentrated sulphuric acid over the phosphorus and flashes of fire will be seen.

Contributed by CHAS. D. TENNEY.

Radio and the Telharmonium

By ROBERT STEWART SUTLIFFE

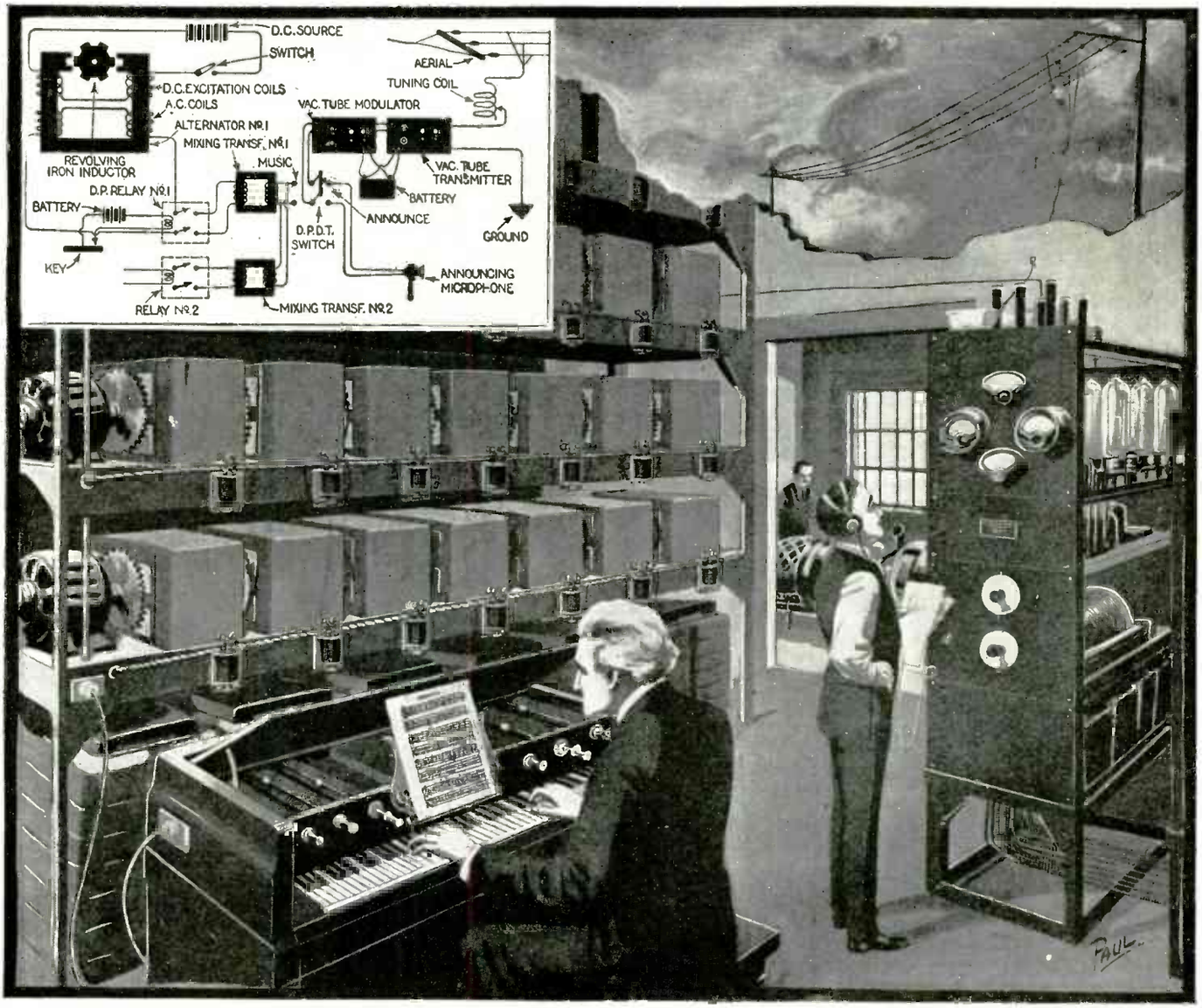
ABOUT 1908 the promoters of the Telharmonium lost over $1,000,000 in an effort to introduce commercially what proved a great artistic success, and for which there was a strong public demand.

The inventor of the Telharmonium, Dr. Thaddeus Cahill, may be likened to an analytical chemist, who takes a specimen of material whose composition has been secret, and, when he has divided it into its component parts, its make-up is no longer unknown, and were it not for patent rights, it would be available for world manufacture. Dr. Cahill did just this with music, for in 1907 he demonstrated that he not only had the formula for making musical sounds, but the machine to manufacture them as well.

The sound produced by means of a phonograph can hardly be termed manufactured sound, for it is not an original package, so to speak. It is more of a mechanical imitation of a musical sound in its entirety and it differs from the original more or less in its make-up due to such foreign noises as are caused by the needle, irregularities in the record, and other mechanical defects. Neither is the voice heard over the telephone wire an original sound; it is a re-creation, different in pitch and other qualities. The strings, reeds and brasses of musical instruments are the creators of music, and vocal chords the creators of spoken or sung sounds.

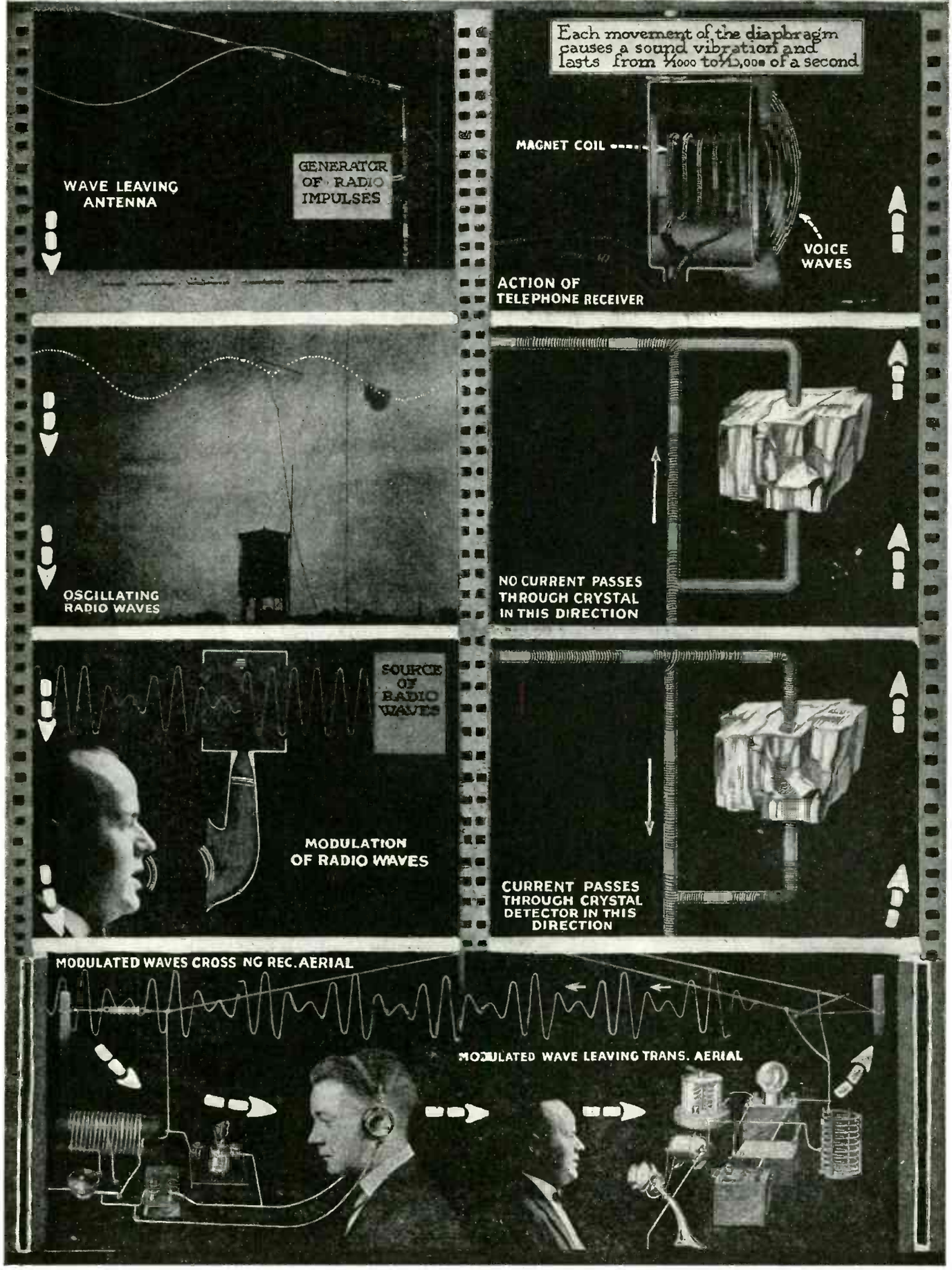
Dr. Cahill, instead of using the strings, reeds and brasses to produce music, used alternating electric currents at various frequencies. It is well known that musical sounds are made up of fundamental or basic vibrations and overtones or harmonics, and Dr. Cahill's first problem was to get a complete analysis of the vibrations of each note

(*Continued on page* 506)



About Fifteen Years Ago Dr. Thaddeus Cahill Perfected an Electrical Instrument for Producing Pure Music, the Like of Which Had Never Been Heard Before, and This Interesting Scientific Device He Called the "Telharmonium." As It Was Impossible to Distribute the Music Produced by the Various Alternating Current Generators of Different Frequencies Over the Regular Telephone System, Owing to Interference, and Due to the Prohibitive Cost of Installing His Own Distributing Wires Throughout a City, the Telharmonium Idea Died. Mr. Sutliffe Has Given Us an Excellent Idea—a Combination of the Telharmonium and the Radio Broadcast. The Various Notes Produced by the Alternators of Differing Frequencies Are Combined through the Medium of Mixing Transformers, and Finally Radiated from the Antenna of the Radio Broadcast Station. Those Who Heard the Original Telharmonium Declared That It Was the Most Wonderful and the Purest Music Ever Produced.

"MOVIE" EXPLAINS RADIO



"Movie" Explains Radio

By H. WINFIELD SECOR

THE thousands of people everywhere who have become suddenly interested in radio broadcasting, and who have acquired receiving sets in order to listen to the "music in the air," are usually quite puzzled as to how the whole thing works. In order to make the science of radiophone transmission and reception perfectly clear, as well as scientifically correct, Mr. J. A. Norling, a New York genius, has written and produced a new film story called "The Mystery Box." You will no doubt see this film at your local motion picture theater shortly. The writer, who was present at a special advance showing of the film story, which explains the mysteries of radio broadcasting, as well as the transmission and reception of radio signals in general, was very strongly impressed with the wonderful possibilities for using this film story of radio, in connection with the teaching of this subject in schools and colleges.

Like many other educational and popular scientific film stories, which have been produced in the past few years, the majority of the action scenes in "The Mystery Box," have been produced in the studio by artists. The successive actions of currents pulsating back and forth along the circuits were produced by photographing successively different drawings of the current pulses, indicated by the groups of cross lines on the wires, these electric current representations being drawn on transparent celluloid sheets. Thus by placing these sheets containing the current indications drawn on them in slightly different and progressive positions, over the master drawing containing the bare wire, ground, etc., the final result is that we see little current pulses moving along the wire—first in one direction, and then in the other, as the action proceeds.

This one-reel film story contains about 1,000 feet of film, and contrary to many of the so-called popular scientific films, it is unusually interesting, owing to the clever injection of a little comedy now and then, which helps to make the story more attractive to the lay audience. One thing is certain after seeing this movie, people will carry away with them a vivid and clear idea of how the oscillating currents set up in the antenna of the transmitting station, cause undulating waves to be whipped off or radiated out into the ether, these waves finally impinging on or striking the receiving antenna, in which corresponding oscillating currents are again set up.

Looking at the pictures on the opposite page and beginning with Fig. 1 at the top of the left-hand column, we see one of the first scenes from "The Mystery Box" movie. As we look at this picture, the eyes behold the unusual and startling phenomena of an oscillating current surging first upward, and then downward, along the antenna wire and ground connection from the generator. Presently, we note the ether waves being thrown off from the antenna, and the constant undulating motion of this wave gives a remarkably clear impression of just how wireless transmission is effected. The current surges in the antenna system passing to the ground are also shown.

The second photograph looking down the left-hand column, or Fig. 2, shows the antenna atop the radiophone broadcasting station of "WJZ" at Newark, N. J., and it is wonderful indeed to see this aerial in real action, as it were, the ether waves undulating and surging out from the antenna in a manner that leaves an indelible impression on the mind of the beholder. Several different methods of producing these waves are employed in the studio, and the effect is one of the most marvelous yet obtained in animated pictures. The exact methods of producing the continually undulating waves in this movie are a secret, and are certainly a credit to the producer.

One of the hardest nuts to crack in telling the story of the mystic radio waves via the theater movie screen, was to make clear to the lay mind how the voice air waves are caused to transform, or as the engineers call it, *modulate* the radio frequency oscillations or currents produced by the vacuum tube or other form of generator. The third picture from the top of the left-hand column, or Fig. 3, shows Mr. Norling speaking, and one of the leading radio engineers of New York City, when he first saw this motion picture, was frank to say that this was one of the cleverest popular scientific presentations of a technical subject that he had ever seen. As the speaker's mouth is seen to open and close to form the various words, the sound waves in the air are seen to pass into the mouthpiece. All the while a continuous stream of high frequency oscillations is passing out of the box labeled, "Source of Radio Waves," at the right of the picture. As these oscillations pass into the modulator compartment in the center of the picture, they are changed in form, with frequency absolutely unchanged, so as to correspond with the different sounds, as seen at the left of the photo. A brilliant and scientific illustration of what modulation actually means is thus given.

Figs. 4 and 5, the two lowermost photos which face each other, give one of the most interesting parts of the whole radio movie story. First animated scenes appear, corresponding to Fig. 5, or right-hand view, the sound waves from the speaker's mouth entering the mouthpiece of the microphone, and the oscillating currents set up through the vacuum tube, or audion, are seen to pass to the antenna. Presently, the modulated radio frequency waves in the ether are seen to whip off from the transmitting antenna at the right, and passing along, they finally impinge on the receiving antenna, seen in Fig. 4, lower left-hand picture. A typical crystal detector receiving-set with fixed condenser, detector and phones, is shown. Expanding rings seen emanating from the head phones worn by the young man in the picture, tell the story that sound waves are being heard by him. The oscillating currents set up in the receiving antenna and allied apparatus are seen surging back and forth through the circuit.

One of the most desirable and at the same time one of the hardest things to show in the reception and translation of the incoming radio impulses, is what takes place in the crystal detector, and which is usually Greek to the beginner in radio. The producer of this movie story thought this over for a long time, and finally solved the problem by showing first a close-up of the detector with its glass protective cover, and finally a very large close-up view of the galena crystal and the electrical action taking place through the same. Figs. 6 and 7, looking upward in the right-hand row of pictures, shows how well this part of the story has been handled. The wires in these two pictures show the oscillations flowing back and forth in the circuit connected with the detector, the wire shunting the detector being used in order to tell the story plainly. In the first picture, Fig. 6, it will be seen that when the arrow points downward. the current is able to pass through the detector; while in Fig. 7, where the arrow points upward, and the oscillation has reversed or is passing through the main circuit in the opposite direction, no current can pass through the crystal.

This property is possessed by a great variety of minerals and elements including silicon, iron pyrites, carborundum, and molybdenum. We have never seen anything clearer than this explanation of the crystal detector action, and the use of this film in schools should certainly prove well worth while, even where radio is not one of the subjects given, but simply where a general science film is presented, say once or twice a week, before the physics class, etc. We are quite certain that nothing more timely and interesting has been presented than this story of how radio transmission and reception takes place.

But when we have perceived at last how the crystal detector really does its work, we have not learned all of our lesson, and finally we come to the last part of the picture, Fig. 8, the upper right-hand picture in the present group, where the uni-directional pulses or currents of like directions, which the detector has permitted to pass from the telephone receiver circuit, are seen to come in through the flexible wires connected with the receiver, and pass around its magnet coil, as the picture shows. Nothing finer has ever been done in animated motion pictures, we believe, than this explanation of how the radio telephone receiver translates pulsating electric currents into sound waves once more; these sound waves affecting our ears, so that we actually hear the voice of the speaker at the transmitting station. As we look at the receiver we see the uni-directional current pulses surging around the wire of the coil, and the diaphragm moves back and forth in a manner which a student will never forget. At every vibration of the diaphragm sound-waves are seen to issue forth from the hole in the receiver cap, and even those who have no scientific knowledge of radio at all, can understand at last just how the human voice is hurled forth through the ether for miles and miles, and finally picked up on a wire stuck up in the air, and caused to reproduce the human voice once more at that point.

The first part of the story is made attractive by the introduction of a *radio bug*. He hops around over the condensers, tuning coils and other apparatus in a radio supply store window, and finally a boy comes along and stops in front of the window. He is stung by

(*Continued on page* 610)

Feature Articles in October "Radio News"

Some Recent Developments of Regenerative Circuits. By Edwin H. Armstrong.

Construction of a Super-Regenerative Receiver. By Kenneth Harkness.

Is the Radio Amateur Doomed? By Armstrong Perry.

A Novel Short-Wave Regenerator. By Arthur W. Lambert, Jr.

Construction of a High-Voltage Storage Battery. By E. L. Hall and J. L. Preston.

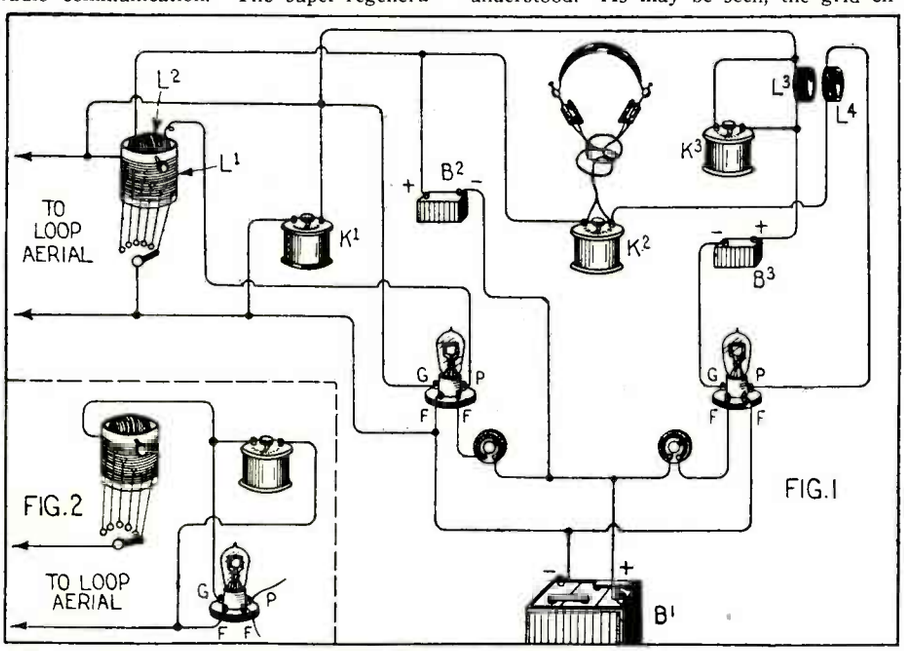
The Universal Receiver. By John R. Meagher.

New Developments in German Radio. By Dr. Alfred Gradenwitz.

The Super-Regenerative Audion Circuit

By ROBERT E. LACAULT

MAJOR E. H. ARMSTRONG, well known by his contributions to the art of wireless transmission, has recently made public his last invention, which undoubtedly will in the future revolutionize radio communication. The super-regenerative circuit which he described in detail before the Institute of Radio Engineers and the Radio Club of America is particularly efficient on short wave lengths. In fact, its efficiency greatly increases as the wave length decreases, thus making possible the amplification at radio frequency of wave lengths as short as twenty meters, a thing practically impossible with the present-day systems. The other advantages of the new circuit are—great selectivity and with a slight modification, elimination of spark signals and statics which sometimes cause so much trouble.



The Latest Idea in Radio Receiving Circuits Is the Armstrong Super-Regenerative Scheme, One Form of Which Is Illustrated in Fig. 1 Above. The Circuit Shown Requires But a Single Storage Battery and Two Vacuum Tubes, and Gives Much Greater Amplification Than the Ordinary Cascade Circuit Employing a Similar Number of Audions. The Loop Aerial May Be Connected to the Circuit Either in Parallel with the Primary of the Vario-Coupler L^2L^1, or Else It May Be Connected in Series with the Primary of the Vario-Coupler, as Indicated in the Diagram Fig. 2

The great amount of amplification is obtained by regeneration, that is, by the same process used in any regenerative receiver, combined with a system which prevents the tube from oscillating while it amplifies to its full capacity. Those familiar with regenerative circuits know that when the plate variometer or feed-back coil is turned slowly the intensity of the signals increases until the tube starts oscillating, distorting the signals entirely. With the super-regenerative circuit it is possible to increase the amplification enormously, since the tube does not oscillate when the feed-back effect is increased beyond normal limits.

Of course, this advantage is had only with careful tuning, and the manipulation of the various elements of the circuit requires a little patience in order to obtain best results. In the circuits shown on this page are shown one oscillator tube and one amplifier tube. The oscillator producing oscillations of a certain frequency varies periodically the resistance of the tuned grid circuits of the amplifier tube. During half of the cycle the resistance is reduced to less than zero, consequently the signals are tremendously amplified, but the tube starts to oscillate. At this instant, before these oscillations can build up to any extent, the resistance of the grid circuit is increased, during the other half of the cycle, reducing the amplification but stopping the oscillations.

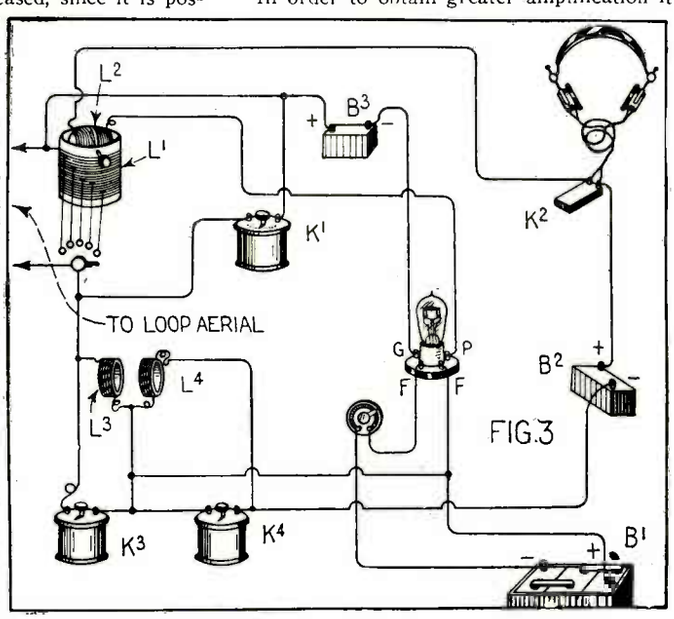
By referring to Fig. 1 this may easily be understood. As may be seen, the grid circuit of the oscillator tube is connected to the filament through the grid circuit of the amplifying tube; consequently when, during half a cycle the grid of the oscillator is positive, a current flows through this circuit increasing its resistance. During the other half cycle no grid current flows and the resistance of the circuit becomes normal. Now, if the coupling between the feed-back coil and the grid circuit of the amplifier is tightened, signals are amplified in the usual way with the advantage that the amplification is enormously increased, since it is possible to tighten the coupling beyond what would be the oscillating point in an ordinary regenerative receiver. The oscillations which tend to take place are stopped periodically at a frequency, which is regulated by the operator.

From this explanation it is easy to understand that with a low frequency of variation the amplification is greater, as the resistance of the grid circuit of the amplifier is reduced during a longer time at each cycle, while with a higher frequency of variation in the resistance, the amplification is not quite so great but the quality of the signals is improved, particularly when receiving telephony, as practically new oscillations can start.

The super-regenerative circuit is especially adapted to loop aerial reception. A suitable loop may be constructed in different sizes. If a 4-foot square loop is built, six turns of wire should be wound on it and spaced about half an inch apart. On a 3-foot loop, ten to twelve turns will give the same range of wave lengths as the 4-foot loop. If it is desired to use a smaller size a frame two feet square may be wound with twelve or fourteen turns, also spaced one-half inch apart; the best wire to use is some ordinary lamp cord, No. 14 or larger. For the reception on the shorter wave lengths it is well to provide a tap in the middle of the winding so that amateur stations working on 200 meters may be tuned in. The loop aerial may be connected to the circuit either in parallel with the primary of the vario-coupler, as shown in Fig. 1, or in series with it as illustrated by the diagram, Fig. 2.

The hook-up, Fig. 1, is a practical circuit which has been tried out and is now used by the writer. All the instruments should, if possible, be mounted on a board or panel and the variable condensers and couplers fitted with long handles or vernier adjustments. In the diagram, L1, is the primary of a vario-coupler and, L2, the secondary coil rewound with about eighty-five turns of finer wire in one layer. Coils L3 and L4 are two duo-lateral coils, Nos. DL 1250 and DL 1500 respectively. The tuning condenser, K1, is an ordinary .001 MF variable condenser and K3 a combination of two condensers, one .002 MF fixed in parallel with a .001 MF variable, giving a variation of .001 MF between .002 MF and .003 MF. The telephone condenser, K2, is similarly composed of three capacities in parallel, two .002 MF fixed and one .001 MF variable. B1 is the A battery, B2 the B battery, the voltage of which depends upon the kind of tube used, and B3 a small grid battery of two to ten volts.

In order to obtain greater amplification it



The Diagram Fig. 3 at Right Shows How One Vacuum Tube May Be Made to Serve as a Detector and Amplifier at the Same Time. In This Case Amplification, Production of Oscillations and Detection, Are All Accomplished by the Single Vacuum Tube. Quite Close Tuning Must Be Done in This Case of Course, But the Current Consumption and the Cost of V. T.'s Is Enormously Reduced.

is advisable to use power tubes such as the radiotrons UV 202 or Western Electric V. T. 1 or V. T. 2's, the latter being best. With such tubes from 80 to 200 volts may be used on the plates, the amplification being directly proportional to the plate voltage.

When tuning a super-regenerative circuit the oscillator should be adjusted to a certain frequency; to start with, the condenser K3 may be set to half its value, so that the total capacity is about .0025 MF. The condenser K2 should be set also to about half of its value and the coil L3 and L4 coupled tight, making sure that the coil L4 is properly connected so that the tube oscillates. The adjustment of the condenser K1 and of the coupling of L2 can only be made during actual reception, unless a wave meter is available. If the set is tuned on a broadcasting station the loop should be turned so that the plane of its turns lies in the direction of the station to be received, and the number of turns on the coupler varied at the same time as the condenser K1, the feed-back coil L2 being loosely coupled to L1. Once the signals are heard the tuning may be improved and the condensers K2 and K3 varied, as well as the coupling of L3 and L4, for best audibility.

It is possible to make one vacuum tube perform several functions at the same time by using the circuit of Fig. 3. In this case amplification, production of oscillations, and detection are accomplished by one tube, which, of course, must be controlled very carefully in order to obtain results. In this circuit L1 and L2 represent the same vario-coupler as used in the circuit of Fig. 1 and L3 and L4 have also the same value. The variable condensers shunting these large inductances have a value of about .0025 MF and may consist of fixed and variable condensers in parallel as explained previously.

In order to eliminate the audio frequency hum a filter circuit is used in Fig. 4, between the receiver and the telephones. This is composed of two fixed non-inductive resistances R and R1 of 12,000 ohms each, two condensers, K2 and K5, of .005 MF capacity and a choke coil with an iron core having a value of 100 millihenries. The resistances and choke coil are standard telephone equipment and may be procured from firms handling such apparatus. The tuning of such a circuit is extremely critical, and verniers are necessary for the fine adjustment of the condensers and couplings in the oscillating and amplifier circuit.

Although as much amplification may be obtained from this circuit as from the one using two tubes, it is not advisable to start experimenting with it before results have been obtained with the circuit of Fig. 1, and as a matter of fact it should be remembered that the single tube circuit is not really practical on account of the difficulties in tuning.

The most practical circuit to be used when it is desired to operate a loud speaker is the one shown in Fig. 4, in which is included a one-stage audio frequency amplifier. The values of inductances and capacities are the same as in Fig. 1, except that the oscillator is capacity-coupled, a .001 MF variable condenser, K4, being connected in series with a 5 millihenry inductance L6 between the grid and plate of the oscillator. In this case the coils need not be mounted close together, but on the contrary, should be placed at right angles or sufficiently far apart from each other. The transformer TR may be any standard audio-frequency transformer and the voltage of the battery B4 depends upon the voltage applied on the plate of the last tube.

An extra B battery, B5, of 80 to 200 volts should be used for greater amplification. It is with this circuit that Major E. H. Armstrong received very loud signals on a small loop inside of steel frame buildings during the demonstrations he gave recently. Signals from amateur stations in Ohio have been heard in New York City with this same set and the writer heard plainly several broadcasting stations located in Pennsylvania and Washington, D. C., on a similar set.

In conclusion, I would recommend to any-one attempting to use a super-regenerative circuit to be patient and build a set in such a way that bad contacts do not exist; the instruments should be properly spaced on a board or panel and experiments carried out for a while before an attempt is made to crowd the set into a cabinet.

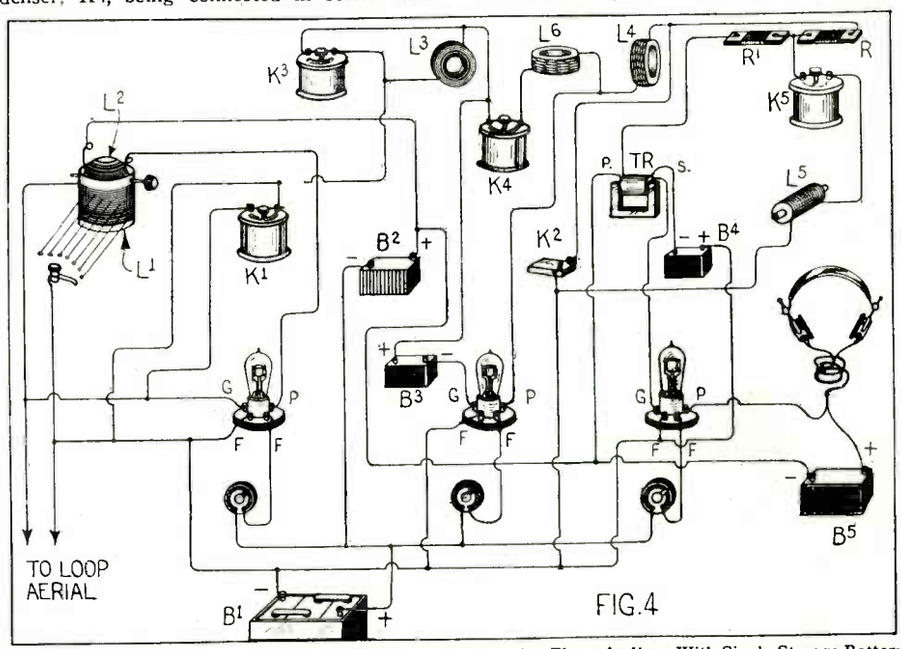


Fig. 4 Above Shows a Super-Regenerative V. T. Circuit Employing Three Audions With Single Storage Battery for Lighting the Filaments, and Designed Especially for Operating a Loud-Talker, or Where a Greater Range Is Desired When Using a Pair of Phones. The Values of the Inductances and Capacities Are the Same as in Fig. 1, Except that the Oscillator Is Capacity-Coupled. Full Details Are Given in the Accompanying Text. The lead from K^3 and L^3 should go to left binding post of condenser K^1.

Dr. de Forest Solves "Talking Movie" Problem

Dr. Lee de Forest has solved the secret of the *talking movie* with perfect synchronization. With or without accompanying pictures, he can photograph sounds, vocal or instrumental, on an ordinary moving-picture film and from the same standard film reproduce the photographed sounds.

This invention is not confined to *talking movies*. It consists primarily of photographing sounds on a standard moving-picture film and then reproducing the sounds from this film. By a simple mechanical device it is possible to photograph ten consecutive *sound-paths* on one strip of film. A thousand feet of film can, therefore, hold 10,000 feet of photographed sound-paths, which, by an equally simple mechanical device, can be run off continuously, making it possible to deliver a grand opera or a political oration lasting one and one-half hours—or any other variety of sounds.

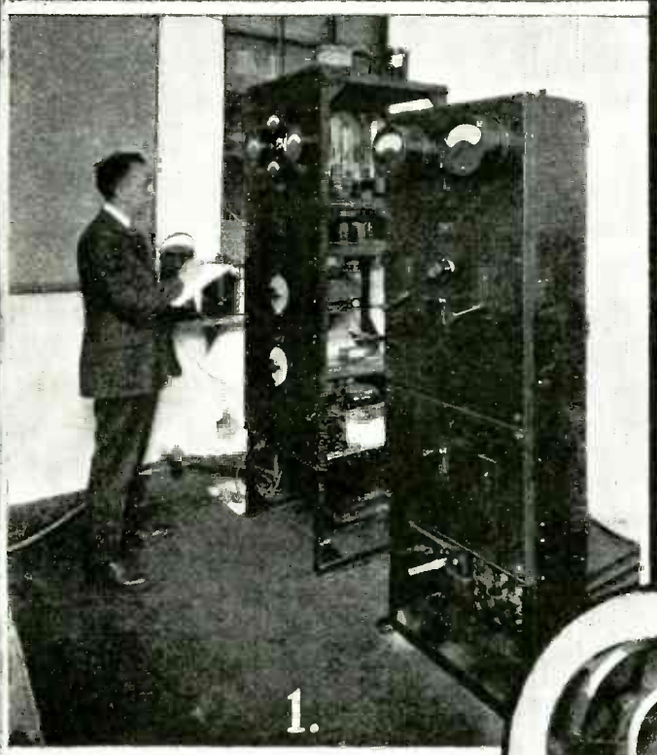
The ordinary standard moving-picture film is used as well as the standard moving-picture camera and the standard moving-picture projecting machine. Dr. de Forest's basic invention is what he calls the *photion*, a simple-looking glass tube with a bulbous end about two and one-half inches long. This *photion* tube is fitted inside of a standard moving-picture camera, above and somewhat to the right of the objective. The secret of the photion tube is that without any filaments it generates a sufficiently powerful violet light under electrical excitation to photograph sounds as transferred through a slit only two-tenths of a millimeter wide on a swiftly moving motion-picture film.

The sounds of a voice or voices, instruments or orchestra are picked up by a converter specially invented by Dr. de Forest for the purpose. It is like the microphone of a telephone, only very much finer. The ordinary microphone was too crude, Dr. de Forest explained. The converter turns the sounds into telephonic currents. From the converter these currents pass into Dr. de Forest's *audion* amplifier (intensifier), well known to wireless telegraph and telephone "fans," from which intensive electric currents pass to a high-frequency generator, whence they pass to and excite the photion tube fitted into the moving-picture camera. The photion thereupon generates the intense violet light, which is modulated or controlled by the voice, individual instruments or orchestra, and is photographed through a two-tenths of a millimeter slit on the standard moving-picture film.

The film is not only standard in size, but travels at the ordinary motion-picture speed. When you look at the developed picture in a *phonofilm* you see the stereotyped film perforated on both sides, except that on the right-hand side, between the picture and the perforations, there is a track two millimeters wide, with almost miscroscopic hairlines, which constitute the moving picture of the sounds as turned into electric current and photographed on the motion-picture film.

The positive of this phonofilm, which may be purely a moving picture of sounds alone, or a moving picture with accompanying photographed sounds, is then put through the ordinary movie projecting apparatus equipped with a *photo-electric* cell fitted on top of the projector. The photo-electric cell converts the swiftly moving photographed sound record on the film into very weak electric currents which are passed through an audion amplifier whence they pass to something very like a gigantic telephone or wireless telegraph earpiece, whence the identical sounds emanate that were previously photographed.

"WBAY" N.Y. CITY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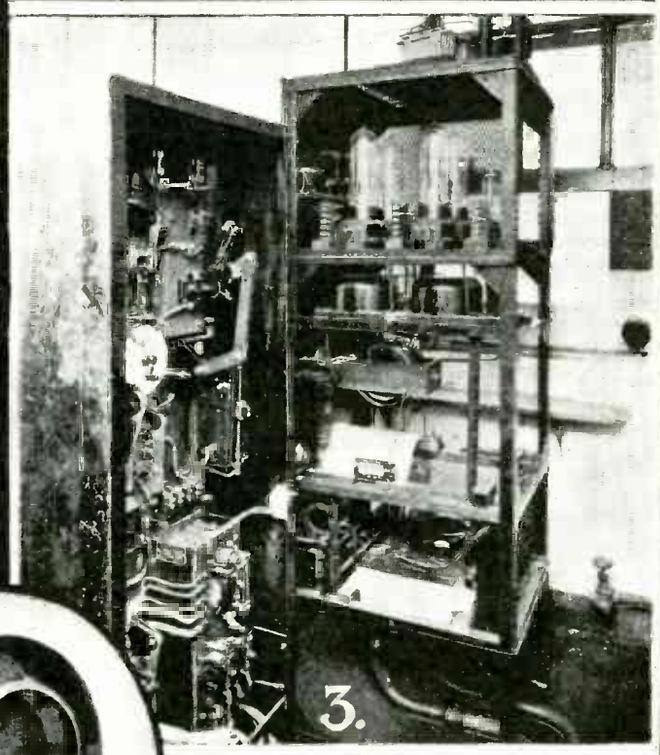
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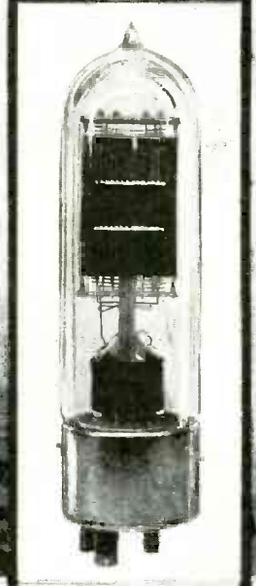
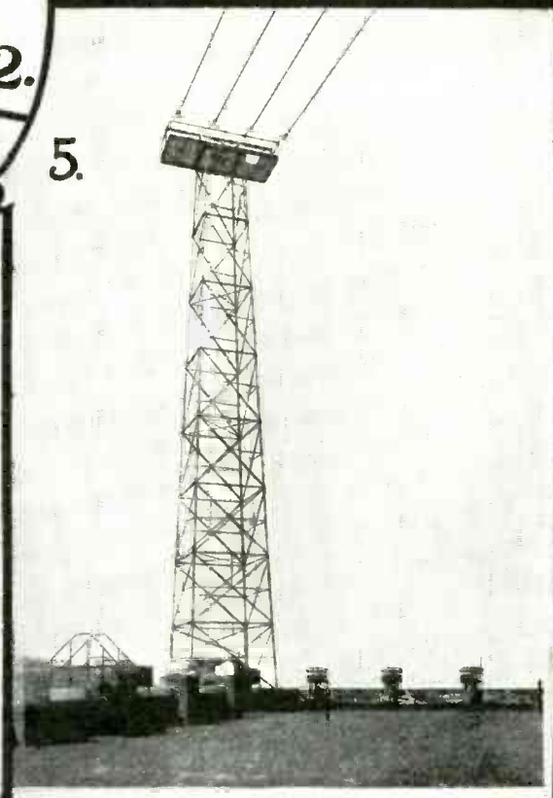



5.

In Fig. 1 We See a Front View of the Power Switchboard, by Means of Which the Motor-Generators Are Controlled, and Also the Control Board for the Transmitting Power Tubes. Two Dials on This Panel Control the Frequency and Antenna Power of the Transmitter.

Fig. 3 Gives a Rear View of the Panel Shown in Fig. 1, and Gives a Very Good Idea of the Complexity of the Controls Necessary for Successfully Operating a Large Broadcasting Transmitter. In the Top Compartment of the Transmitting Panel Are Shown the Four 250-Watt Power Tubes, and the 50-Watt Voice Amplifier. The Insert Shows a Close-Up of One of the 250-Watt Tubes.

The Special Type of Microphone Used by "WBAY" Is Shown in Fig. 2. This Is of the Double Cup, Carbon Grain Type, and Is Fully Described in the Text.

A View of the Antenna and Towers Is Given in Fig. 4, and the Great Height of the Latter Becomes Evident. The Tops of the Towers Are Over 475 Feet Above the Street.

In Fig. 5 a Close-Up of One of the Towers Is Shown. The Towers Are Designed to Stand Up Under a Pressure Equivalent to That of a One Hundred Mile an Hour Gale. Platforms Are Provided at the Tops of the Towers for the Protection and Convenience of Workmen When Repairing the Antenna.

"WBAY"—Latest New York Broadcasting Station

By A. P. PECK

ON August 3 the broadcasting station of the American Telephone & Telegraph Co., at 24 Walker St., New York City, was officially opened. This station operates on a principle somewhat different from that employed in the average broadcasting station, inasmuch as it is used as a toll broadcasting station; that is, the right to use this station is leased to various companies who conduct entertainments and broadcast items of general interest to the radio public for advertising purposes. The management of this station, coded as WBAY, supervises all the programs and nothing is broadcasted which the officials of the company do not believe will interest the listeners to the greatest possible extent. Hence, instead of belittling this marvelous game of radiophone broadcasting by commercializing it, the company has made a great stride towards better broadcasts.

It is obvious also that a manufacturer or other advertiser wishes to place his goods or whatever else he is advertising, before the public in as interesting a way as possible, and therefore he will see to it that the programs will be of interest to anyone who may be "listening in."

The reason that a broadcasting station was considered as a necessity by the American Telephone & Telegraph Co. was because when radiophone first became such a feature in the lives of the people of the United States, many inquiries came to this company regarding the purchase of apparatus suitable for broadcasting purposes. They were, however, unable to supply this demand at any but an exorbitant cost at that time and therefore they set about perfecting broadcasting apparatus. This necessitated standardizing and improving the apparatus and the most natural development for them was to erect a broadcasting station of their own. There was also a great demand from the various owners of radio receiving sets for a broadcasting station which would give programs of real value. The officials of the company decided that the way to do this was to commercialize broadcasting because of the reasons mentioned above.

The studio or microphone room represents the acme of utility and beauty combined. The walls of the studio are specially insulated with felt and hung with two-colored draperies which give a very pleasing effect to the eye. By means of the felt insulation echo is reduced to an absolute minimum and all of the power of the voice of the speaker or the sound of the musical instruments is transmitted directly to the microphone and no reflection is caused by the walls which would produce unpleasant results in the receiver.

The studio is luxuriously furnished in very good taste and on the floor is found a thick felt rug which deadens all sounds of persons moving about the room while the station is in operation. Several chairs are provided in this room where visitors who are interested in the inside workings of a broadcasting station are accommodated while the station is transmitting.

In the next room there is a very comfortable reception and lounging room where if any of the artists so desire they may retire between their selections.

When one first enters the studio there is a great impression of silence. Absolutely no echo is heard as one moves around the room and silence seems so great that it actually depresses one until he becomes used to it.

In the studio is found a grand piano with a player attachment and a collection of the very latest rolls. There is also a phonograph which is used to broadcast the newest pieces of "canned" music. The piano is also used for accompanying the various singers and orchestras which perform at the station.

The microphone used in this station is of a unique type recently developed by the American Telephone & Telegraph Co. engineers. Anyone who has had any engineering experience with single cup, carbon button, or carbon grain transmitters knows that there is a certain amount of distortion due to the unequal rise and fall of the resistance of the transmitter as the diaphragm vibrates. This, however, has been overcome in the new type of microphone which employs two carbon grain cups. A cup is situated on each side of the diaphragm and the two are connected together through a repeating coil with a split primary winding. This may be very clearly seen from the accompanying diagram of the circuit used by this station. This type of transmitter has been found to reduce distortion in the microphone circuit to a mini-

(*Continued on page* 612)

New Filament Compression Rheostat

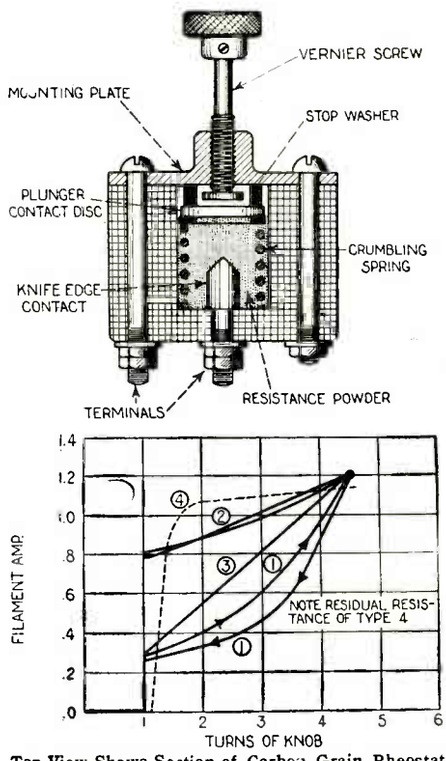
THE new compression rheostat here shown is for filament control of vacuum tubes. It is of the type in which the resistance of the circuit is varied by the contact resistance of a powdered resistor enclosed in a compression chamber operated by a plunger and screw.

Because a powder would crowd or pack when once compressed into a given space and would tend to remain in the "wad" shape and therefore cause the release of pressure to open the circuit at the surface of contact between the plunger and wad, a means for breaking up the wad is supplied in the form of a spiral spring which is compressed with the powder upon application of the plunger pressure. When pressure is released on the wad and spring the latter opens up and crumbles up the wad—thus restoring the original high resistance gradually and effectively.

In order to make the resistance element act with gradual change the screw with knob is used. Further, in order to be able to cut out all resistance when the compression is complete, a short-circuiting switch is included in the outfit. This switch consists of a knife edge at the top of the center terminal as shown in the sketch and as the compression increases the plunger contact approaches the edge and finally strikes it, thus making metallic and positive contact. See cut.

The compression of the powder alters the resistance gradually and owing to the nature of the construction, the short-circuit is approached gradually and not with a sudden fall of resistance. The approximate characteristic is shown in the accompanying graphic curves.

The characteristic may be made almost any range and may be made to start at any desired value instead of an infinite value. See Curve No. 2. In other words, the design of the resistance element may be made



Top View Shows Section of Carbon Grain Rheostat for Audion Filament Control. The Graphic Curves Below Show:

1—Characteristics of New Rheostat with Standard Detector Tube Filament and Approximately 25-Ohms Resistance at Start.
2—Same with More Conducting Resistance Medium.
3—Ideal Characteristics for Uniform Regulation.
4—Characteristics of Another Make of Carbon Compression Type Rheostat. Note Residual Resistance. Note: Data Only Approximate, Actual Action Approaches Curve 3.

to suit any purpose provided the watts lost are kept within the limits of the proportions of the individual design.

Owing to the powdered nature of the element the same is practically indestructible. By mixing the conducting material with non-combustible material to regulate the resistance, the element becomes practically non-combustible. Further, the inclosing of the same insures safety from contact with outside inflammable material and further insures the non-inflammability of the same.

In order to open the circuit the screw is opened up with gradual increase of resistance thus insuring, automatically, the braking of a small current instead of a large one. This is not always possible in the carbon pellet type of compression resistance where an explosion is not an uncommon thing owing to the powdering of the pellets and the consequent packing of the same and the following opening of an arc in contact with the powdered carbon with air as the supporting medium.

Naturally, in controllers using the plunger arrangement, the use of a screw is not essential to operation, a sliding plunger lever-operated is also desirable for quick action.

In order to open the circuit entirely, particularly when the starting resistance is desired to be of some initial value instead of infinite with gradual decrease, the plunger may be made to stop at the desired initial resistance and a contact outside of the resistance material proper be broken. A stop is therefore provided to prevent the plunger from opening beyond the desired stopping point.

A rheostat is preferably inclosed because of the safety factor to surrounding media. Also, the retaining walls or body should be made of a refractory or other non-combustible material—particularly where momentary

(*Continued on page* 610)

Radio for the Beginner

By ARMSTRONG PERRY

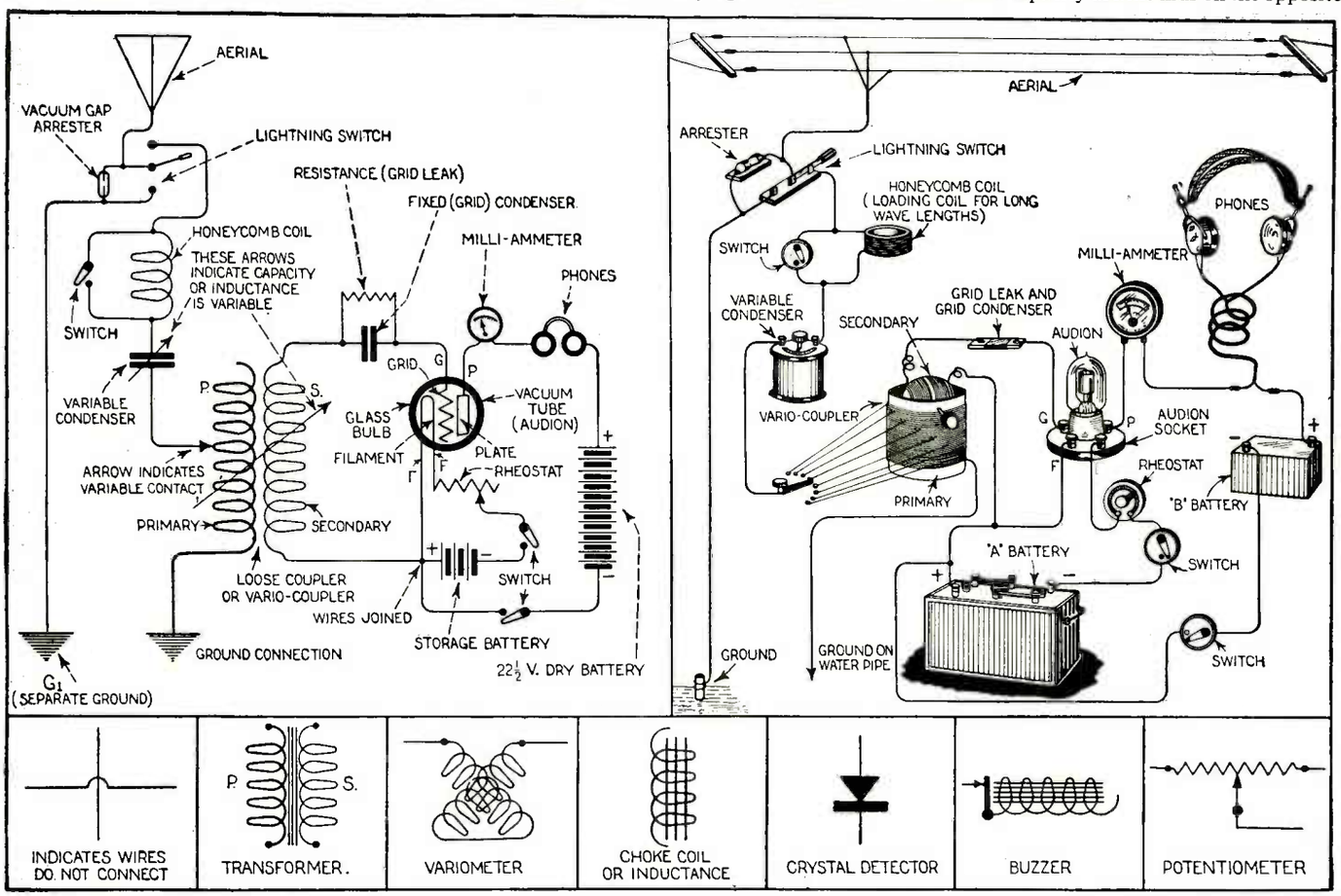
NO. 8—HOW TO READ A RADIO DIAGRAM

WRITING, they tell us, was begun by some prehistoric man who made pictures of things that he wanted to bring to the attention of someone who was too far away to talk to. The making of radio diagrams is only going back to the same simple and easy method for conveying the idea of one man to others.

The primitive pictures, as fast as they became well enough known to be standardized, were simplified so as to save time and finally lost their resemblance to the objects they represented. Just so radio diagrams are made as simple as possible, the diagrammers like a square coil of wire but with less than the number of turns to be used, full data being given in the accompanying description.

Coming down from the aerial we encounter connections. The straight lines leading from one symbol to another mean wires, of course. They show the pathway for the electric currents just as lines on a map show roads. Frequently the line from the antenna leads to an arrow point that touches a coil. Such a point always means an adjustable contact. On the apparatus it may be a switch, a slider or a row of binding posts, but on the diagram it is always an arrow point unless a specific piece of apparatus for varying the connection both ends. While such an open circuit is not adapted to the sort of a current we use for lighting or for running motors, it is a complete circuit for radio purposes, the aerial, the earth and the air forming a condenser, which passes energy the same as any manufactured condenser. The energy from the radio waves goes down the aerial, through the receiving apparatus, into the ground, up through the air and into the antenna again, then around the circuit in the opposite direction, and so on.

A coiled line in a radio diagram almost invariably means an inductance coil. Inductance and capacity are the kids on the opposite



"How Can I Read Radio Diagrams?"—That Is the Problem With Which All Radio Enthusiasts Are Confronted Sooner or Later in Their Careers. Mr. Perry's Article, Together With the Accompanying Drawing, Should Make This Matter Very Clear. The Perspective Diagram Showing the Actual Apparatus and the Connections Thereto at the Right, Is the Counterpart of the Schematic Diagram Shown at the Left, and the Apparatus Is Placed in the Same Position in Both Cases, So as to Make it Easy for the Student to Learn Just How the Radio Expert Indicates Each Individual Instrument in a Diagram. The Seven Small Diagrams at the Bottom of the Illustration Show Some Further Methods of Indicating Radio Instruments Which Are Not Shown in the Larger Diagrams. Once You Learn These Symbols Thoroughly, You Will Be Able to Read Practically Any Radio Blueprint.

taking it for granted that the imagination of the reader will make him see in his mind's eye the object which the symbol represents, even though the resemblance is no stronger that that of a Coney Island portrait to the Rube who posed for it.

For example, the symbol put into a diagram to represent an aerial sometimes looks like a pitchfork. The triangle at the bottom of the sign indicates the spreader and bridle and the tines show the wires of the flat top. Or the wires may be omitted, leaving only the triangle standing on its peak like a Y. M. C. A. badge. If a particular kind of aerial is intended to be used with the hook-up shown by the diagram, it is shown by a particular symbol. The "inverted L" and "T" types are diagrammed about as they look. The coil aerial, which we used to call a loop antenna before the Bureau of Standards straightened out our terminology, is drawn is shown. If the line simply runs straight into another line, that means a fixed connection. A dot sometimes makes this more definite. Where it is necessary to run a wire in a diagram over another wire with which it is not connected at the point of crossing, a half circle is made to indicate that the wire in which it is placed turns out to get around the other wire.

The line leading from the antenna usually goes rather directly down to a triangle made of parallel lines that grow shorter and shorter from base down to apex. Such a triangle always represents the earth or ground connection. To persons who have gone just far enough into the study of electricity to realize that it always flows around and around a circuit like a horse on a race track and never merely from point to point like a bullet going from gun to target, it is a bit confusing to see the aerial circuit open at ends of an electrical teeter that must be balanced nicely—we call it tuning—if the currents that go into a radio receiver are to come out in the form of sounds. Capacity we get from condensers. When two coils are placed side by side in a diagram it means that they furnish induc*tion* as well as induc*tance*. That is, they not only produce changes in the currents that pass through themselves but also use them for setting up currents in each other. That is how radio currents are passed from one piece of apparatus to another without any metallic connection. An arrow passing diagonally across both coils means that the effect of one on the other can be easily changed by sliding one in and out inside the other as you open or close a telescope; by turning one coil inside the other; or by some other means. In the case of honeycomb coils, often diagrammed the

(*Continued on page* 604)

RADIO BROADCAST

THERE are so many broadcasting stations which have forwarded information, that we regret we have only space enough to print a very few. Those stations which have been courteous enough to submit photographs will find that the photos will be published in due time. The stations listed on this sheet will not be published in the next issue. We would suggest to our readers that the map locations indicated on this page are for the special supplement map given free with the May issue of SCIENCE AND INVENTION. At a great expense this list of the stations has been practically completed as far as commercial broadcasting stations are concerned. We will present our readers with additional information on the new stations as it is brought to our attention. Address all communications to Editor Radio Broadcast, c/o SCIENCE AND INVENTION MAGAZINE, New York City.

NEW BROADCASTING STATIONS NOT LISTED IN THE JULY, AUGUST OR SEPTEMBER ISSUES OF THIS MAGAZINE

Call Letters	Name	City and State	Wave Length	Map Location
KDPM	Westinghouse Elec. & Mfg. Co.	Cleveland, Ohio	360	L-41
KDZT	Seattle Radio Association	Seattle, Wash.	360	C-6
KDZW	Clawde W. Gerdes	San Francisco, Cal.	360	O-3
KDZX	Glad Tidings Tabernacle	San Francisco, Cal.	360	O-3
KDZZ	Kinney Bros. & Sipprell	Everett, Wash.	360	C-6
KFAC	Glendale Daily Press	Glendale, Cal.	360	S-6
KFAD	McArthur Bros. Mercantile Co.	Phoenix, Ariz.	360	U-12
KFAE	State College of Washington	Pullman, Wash.	360	D-10
KFAJ	University of Colorado	Boulder, Colo.	360	O-19
KFAF	Western Radio Corporation	Denver, Colo.	360	O-20
KFAN	The Electric Shop	Moscow, Idaho	360	D-10
KFAP	Standard Publishing Co	Butte, Mont.	360	F-14
KFAQ	City of San Jose	San Jose, Cal.	360	P-4
KFAR	Studio Lighting Service Co.	Hollywood, Cal.	360	S-5
KFAS	Reno Motor Supply Co.	Reno, Nevada	360	N-6
KFAT	S. T. Donohue	Eugene, Ore.	360	F-5
KFAU	Boise High School	Boise, Idaho	360–485	H-10
KFAV	Cooke & Chapman	Venice, Cal.	360	R-4
KFAW	The Radio Den	Santa Ana, Cal.	360	T-6
KFBA	Ramey & Bryant Radio Co.	Lewiston, Idaho	360	E-10
KFBB	F. A. Buttery & Co.	Havre, Mont.	360	D-18
KFBC	W. K. Azbill	San Diego, Cal.	360	V-7
KFBD	Clarence V. Welch	Hanford, Cal.	360	Q-5
KFBE	Reuben H. Horn	SanLuis Obispo,Cal.	360	R-4
KFBF	Buttle School of Telegraphy	Butte, Mont.	360	F-14
KFBG	First Presbyterian Church	Tacoma, Wash.	360	C-6
WCAB	Newburgh Daily News	Newburgh, N. Y.	360	K-47
WCAC	John Fink Jewelry Co.	Fort Smith, Ark.	360	T-29
WCAD	St. Lawrence University	Canton, Ohio	360	M-41
WCAE	Kaufman & Baer Co	Pittsburgh, Pa.	360	N-42
WCAG	Daily States Publishing Co.	New Orleans, La.	360	AA-34
WCAH	Entrekin Electric Co	Columbus, Ohio	360	O-40
WCAJ	Nebraska Wesleyan University	University Pl., Nebr.	360	N-27
WCAK	Alfred P. Daniel	Houston, Texas	360	AA-28
WCAL	St. Olaf College	Northfield, Minn	360	J-30
WCAM	Villanova College	Villanova, Pa.	360	M-47
WCAN	Southeastern Radio Tel. Co.	Jacksonville, Fla.	360	X-43
WCAO	Sanders & Stayman Co.	Baltimore, Md	360	N-46
WCAP	Central Radio Service	Decatur, Ill.	360	O-34
WCAQ	Tri State Radio Mfg. & Supply Co.	Defiance, Ohio	360	M-38
WCAR	Alamo Radio Electric Co	San Antonio, Texas	360	AB-25
WCAS	Wm. Hood Dunwoody Industrial Institute	Minneapolis, Minn.	360	H-30
WCAT	South Dakota School of Mines	Rapid City, So.Dak.	485	J-22
WCAU	Philadelphia Radiophone Co	Philadelphia, Pa.	360	M-47
WCAV	J. C. Dice Electric Co.	Little Rock, Ark.	360	U-31
WCAW	Quincy Herald & Quincy Electric Supply Co	Quincy, Ill.	360	O-32
WCAX	University of Vermont	Burlington, Vt.	360	G-48
WCAY	Kesselman O. Driscoll Co.	Milwaukee, Wis.	360	K-35
WCAZ	Robt. E. Compton & Quincy Whig General	Quincy, Ill.	360	O-32
WCX	Detroit Free Press	Detroit, Mich.	360-485	L-39
WDAA	Ward-Belmont School	Nashville, Tenn	360	S-37
WDAB	H. C. Summers & Son	Portsmouth, Ohio	360	P-40
WDAC	Illinois Watch Co.	Springfield, Ill.	485	O-33
WDAD	Wm. L. Harrison	Lindsborg, Kansas	360	Q-26
WDAE	Tampa Daily Times	Tampa, Fla.	360–485	AB-42
WDAF	Kansas City Star	Kansas City, Mo.	360	P-29
WDAG	J. Lawrence Martin	Amarillo, Texas	360	J-22
WDAH	Mine & Smelter Supply Co.	El Paso, Texas	360	X-17
WDAI	Hughes Electrical Corp.	Syracuse, N. Y.	360	J-45
WDAJ	Atlanta & West Point R.R. Co	College Park, Ga.	360	V-39
WDAK	The Courant	Hartford, Conn.	360	K-49
WDAL	Florida Times-Union	Jacksonville, Fla.	360	X-43
WDAN	Glenwood Radio Corp.	Shreveport, La	360	X-30
WDAO	Automotive Elec. Co.	Dallas, Texas	360	X-26
WDAP	Mid West Radio Central, Inc.	Chicago, Ill.	360	M-35
WDAQ	Hartman Rikes Electric & Machine Co.	Brownsville, Pa.	360	N-43
WDAR	Lit Bros.	Philadelphia, Pa.	360	M-47
WDAS	Samuel A. Waite	Worcester, Mass.	360	J-49
WDAT	Delta Electric Co.	Worcester, Mass.	360	J-49
WDAU	Slocum & Kilburn	New Bedford, Mass.	360	K-50
WDAV	Muskogee Daily Phoenix	Muskogee, Okla	360	T-28
WDAX	First National Bank	Centerville, Iowa	360	N-31
WDAY	Fargo Radio Service Co	Fargo, No. Dak	360	F-27
WEAA	Fallian & Lathrop	Flint, Mich.	360	K-38
WEAB	Standard Radio Equipment Co.	Fort Dodge, Iowa	360	L-29
WEAC	Baines Electric Service Co.	Terre Haute, Ind.	360	P-36
WEAE	Virginia Polytechnic Inst.	Blacksburg, Va.	360	R-42
WEAF	Western Electric Co.	New York, N. Y.	360	L-48
WEAG	Nichols-Hineline-Bassett Laboratory	Edgewood, R. I.	360	K-50
WEAH	Wichita Board of Trade & Lander Radio Co.	Wichita, Kansas	360–485	R-26
WEAI	Cornell University	Ithaca, N. Y.	360	K-45
WEAJ	University of South Dakota	Vermillion, So. Dak.	360	L-27
WEAK	Abercrombie, Julius B.	St. Joseph, Mo	360	O-29
WEAM	Borough of North Plainfield	No. Plainfield, N. J.	360	M-47
WEAN	Shepard Co	Providence, R. I.	360	K-50
WEAO	The Ohio State University	Columbus, Ohio	360	O-40
WEAP	Mobile Radio Co	Mobile, Ala	360	Z-36
WEAQ	Young Men's Christian Assoc.	Berlin, N. H.	360	G-49
WEAR	Baltimore American & News Publishing Co	Baltimore, Md	360	N-46
WEAS	Hecht Co.	Washington, D. C.	360	O-45
WEAT	John J. Fogarty	Tampa, Fla.	360	AB-42
WEAU	Davidson Bros. Co.	Sioux City, Iowa	360	L-28
WEAV	Sheridan Electric Service Co.	Rushville, Nebr.	360	L-22
WEAX	T. J. M. Daly	Little Rock, Ark.	360 485	U-31
WEAY	Will Horwitz, Jr.	Houston, Texas	360	AA-28
WEAZ	Donald Redmond	Waterloo, Iowa	360	L-31
WFAA	A. H. Belo & Co.	Dallas, Texas	360-485	X-26
WFAB	Carl F. Woese	Syracuse, N. Y.	360	J-45
WFAC	Superior Radio Co	Superior, Wis.	360	F-31
WFAD	Watson Weldon Motor Supply Co.	Salina, Kansas	360	E-26
WFAF	H. C. Spratley Radio Co.	Poughkeepsie, N. Y.	360	K-47
WFAG	The Radio Engineering Laboratory	Waterford, N. Y.	360	J-47
WFAH	Electric Supply Co.	Port Arthur, Texas	360	AA-30
WFAJ	Hi-Grade Wireless Instrument Co.	Asheville, No. Caro.	360	S-41
WFAK	Domestic Electric Co.	Brentwood, Mo.	360	
WFAL	Houston Chronicle Pub. Co.	Houston, Texas	360–485	AA-28
WFAM	Times Publishing Co.	St. Cloud, Minn.	360	AA-28
WFAN	Hutchinson Electric Service Co.	Hutchinson, Minn.	360–485	J-30
WFAP	Brown's Business College	Peoria, Ill.	360	N-34
WFAQ	Missouri Wesleyan College & Cameron Radio Co.	Cameron, Mo.	360	P-29
WFAR	Hall & Stubbs	Stanford, Me.	360	
WFAS	United Radio Corp.	Fort Wayne, Ind.	360	N-38
WFAT	The Daily Argus Leader	Sioux Falls, S. Dak.	360	K-27
WFAU	Edwin C. Lewis	Boston, Mass.	360	J-50
WFAV	University of Nebraska	Lincoln, Nebr.	360–485	N-27
WFAW	Miami Daily Metropolis	Miami, Fla.	360	AD-45
WFAX	Arthur L. Kent	Binghamton, N. Y.	360	K-46
WFAY	Daniels' Radio Supply Co	Independence, Kan.	360	R-28
WFAZ	South Carolina Radio Shop	Charleston, So.Caro.	360	V-44
WGAC	Orpheum Radio Stores Co	Brooklyn, N. Y.	360	L-48
WGAD	Spanish American School of Radio-telegraphy	Ensenada, P. R.	360	
WGAF	Goller Radio Service	Tulsa, Okla.	360	T-27
WGAH	New Haven Electric Co	New Haven, Conn.	360	K-49
WGAJ	W. H. Gass	Shenandoah, Iowa	360	N-28
WGAK	Macon Electric Co.	Macon, Ga.	360	V-40
WGAL	Lancaster Elec. Supply & Cons. Co.	Lancaster, Pa.	360	M-46
WGAM	Orangeburg Radio Equipment Co.	Orangeburg,So.Caro.	360	V-43
WGAN	Cecil E. Lloyd	Pensacola, Fla.	360	Z-37
WGAR	Southwest American	Fort Smith, Ark.	360	T-29
WGAS	Ray-Di-Co Organization	Chicago, Ill.	360	M-35
WGAT	American Legion, Dept. of Nebr.	Lincoln, Nebr.	360	N-27
WGAU	Marcus G. Limb	Wooster, Ohio	360	N-40
WGAW	Ernest C. Albright	Altoona, Pa.	360	M-44
WGAY	North Western Radio Co.	Madison, Wis.	360	K-33
WGAZ	South Bend Tribune Co	South Bend, Ind.	360	M-37
WGV	Interstate Electric Co	New Orleans, La.	360	AA-34
WHAA	State University of Iowa	Iowa City, Iowa	360	M-31
WHAB	Clark W. Thompson (Fellman's Dry Goods Co.)	Galveston, Texas	360–485	AA-29
WHAC	Cole Bros. Electric Co.	Waterloo, Iowa	360	L-31
WHAD	Marquette University	Milwaukee, Wis.	360	K-35
WHAE	Automotive Electric Service Co.	Sioux City, Iowa	360	L-28
WHAF	Radio Electric Co.	Pittsburgh, Pa.	360	N-42
WHAG	University of Cincinnati	Cincinnati, Ohio	360	P-38
WHAH	John T. Griffin	Joplin, Mo.	360	R-29
WHAI	Radio Equipment & Mfg. Co.	Davenport, Iowa	360	M-33
WHAJ	Bluefield Daily Telegraph and E. K. Kitts	Bluefield, W. Va.	360	Q-42
WHAK	Roberts Hdwe. Co	Clarksburg, W. Va.	360	O-42
WHAL	Phillips Jeffery & Derby	Lansing, Mich.	360	K-38
WHAM	University of Rochester	Rochester, N. Y.	360	J-44
WHAN	Southwestern Radio Co.	Wichita, Kansas	360	R-26
WHAO	Frederic A. Hill	Savannah, Ga.	360	U-45
WHAP	Dewey L. Otta	Decatur, Ill.	360	O-34
WHAQ	Semmes Motor Co	Washington, D. C.	360	O-45
WHAR	Paramount Radio & Elec. Co.	Atlantic City, N. J.	360	N-48
WHAS	Courier-Journal and Louisville Times	Louisville, Ky.	360–485	Q-37
WHAT	Yale Democrat-Yale Telephone Co.	Yale, Okla.	360	T-27
WHAU	Corinth Radio Supply Co.	Corinth, Miss.	360	U-35
WHAV	Wilmington Electrical Specialty Co.	Wilmington, Del.	360	N-47
WHAW	Pierce Electric Co.	Tampa, Fla.	360	AB-42
WHAX	Holyoke Street Ry. Co	Holyoke, Mass	360	J-49
WHAY	Huntington Press	Huntington, Ind.	360–485	N-37
WHAZ	Rensselaer Polytechnic Inst.	Troy, N. Y.	360	K-48
WHB	Sweeney School Co.	Kansas City, Mo.	360–485	P-29
WIAA	Waupaca Civic & Commercial Assoc.	Waupaca, Wis.	360	H-35
WIAB	Joslyn Automobile Co.	Rockford, Ill.	360	L-34
WIAC	Galveston Tribune	Galveston, Texas	360	AA-29

Call Letters	Name	City and State	Wave Length	Map Location
WIAD	Ocean City Yacht Club	Ocean City, N. J.	360	N-48
WIAE	Mrs. Robert E. Zimmerman	Vinton, Iowa	360	L-32
WIAF	Gustav A. De Cortin	New Orleans, La	360	AA-34
WIAG	Matthews Electrical Supply Co.	Birmingham, Ala	360	V-37
WIAH	Continental Radio & Mfg. Co.	Newton, Iowa	360	M-30
WIAI	Heer Stores Co	Springfield, Mo.	360	R-30
WIAJ	Fox River Valley Radio Supply Co.	Neenah, Wis	360	H-35
WIAK	Journal-Stockman Co	Omaha, Nebr.	360–485	M-28
WIAL	Standard Service Co	Norwood, Ohio	360	P-39
WIAN	Chronicle & News Pub. Co.	Allentown, Pa	360	M-46
WIAO	School of Engineering of Milwaukee & Wisconsin News	Milwaukee, Wis	360	K-35
WIAP	Radio Development Corp	Springfield Mass	360	J-49
WIAQ	Chronicle Publishing Co	Marion, Ind	360	N-37
WIAR	J. A. Rudy & Sons	Paducah, Ky	360	R-35
WIAS	Burlington Hawkeye & Home Electric Co.	Burlington, Iowa	360	N-32
WIAT	Leon T. Noel	Tarkio, Mo.	360	Q-26
WIAU	American Trust & Savings Bank	Le Mars, Iowa	360	L-28
WIAV	New York Radio Laboratories	Binghamton, N. Y.	360	K-46
WIAW	Saginaw Radio & Electric Co.	Saginaw, Mich	360	J-38
WIAX	Capitol Radio Co.	Lincoln, Nebr.	360	N-27
WIAY	Woodward & Lothrop	Washington, D. C.	360	O-45
WJAB	American Radio Co	Lincoln, Nebr	360	N-27
WJAC	Redell Co	Joplin, Mo.	360	R-29
WJAD	Jackson's Radio Engineering Laboratories	Waco, Texas	360	Y-26
WJAE	Texas Radio Syndicate	San Antonio, Texas.	360	Z-25
WJAF	Munsey Press	Muncie, Ind.	360	N-37
WJAG	Norfolk Daily News (Huse Publishing Co.)	Norfolk, Nebr.	360	M-26
WJAH	Central Park Amusement Co.	Rockford, Ill.	360	L-34
WJAJ	Young Mens Christian Association	Dayton, Ohio	360	O-39
WJAK	White Radio Laboratory	Stockdale, Ohio	360	P-40
WJAL	Victor Radio Corp	Portland, Me.	360	G-51
WJAM	D. M. Perham	Cedar Rapids, Iowa.	360	M-32
WKAA	Republican Times and H. F. Paar	Cedar Rapids, Iowa.	360	M-32
WKAC	Star Publishing Co.	Lincoln, Nebr.	360	N-27
WKAF	W. S. Radio Supply Co.	Wichita Falls, Texas	360	V-25
WOC	The Palmer School of Chiropractic	Davenport, Iowa	360–485	M-33

Additions and corrections in the list appearing in the July, 1922, issue of SCIENCE AND INVENTION:

CORRECTIONS

KGO, Altadena Radio Laboratory is in Pasadena, not Altadena, Cal.
WEAW, Arrow Radio Laboratories, Anderson, Ind., listed as WMA.
WDAW, Georgia Railway & Power Co., Atlanta, Ga., listed as WGM.
WBAG, Diamond State Fibre Co., at Bridgeport, Pa., instead of Bridgeport, Conn., as listed.

ELABORATED LIST GIVING TIME AND NATURE OF BROADCAST (Continued)

Call Letter	Name	City	State	Wave Length
KDZI	Electric Supply Co. Lectures, music, vocal and instrumental talent, news bulletins, special features every day except Sundays 4.30-5.30 P. M., and Monday, Wednesday and Friday 8 to 9 P. M. Sundays 11 A. M. to 12.30 P. M. sermons. Consistent range 200 miles. Maximum 500.	Wenatchee,	Wash.	360
KDZK	Nevada Machinery & Electric Co. Music, vocal and instrumental talent, special features on Monday, Tuesday, Thursday 7.30-8.30 P. M., and Wednesday, Friday, Saturday 8-9 P. M. Sundays 8-9 P. M. sermons.	Reno,	Nevada	**360**
KFAF	Western Radio Corp. Weather, lectures, market and stock reports, music, vocal and instrumental talent, baseball scores, news bulletins and special features daily except Thursday and Sunday 8-9 P. M. Rocky Mountain time. Consistent range 150 miles. Maximum 1,500.	Denver,	Colo.	360
KOE	Spokane Daily Chronicle. Lectures, music, vocal and instrumental talent, and special features every day except Sunday 8.30-9.30 P. M. Consistent range 50 miles. Maximum 360.	Spokane,	Wash.	360
WAAK	Gimbel Bros. Weather, lectures, market and stock reports, music, vocal and instrumental talent, baseball scores, news bulletins hourly on the hour from 9 A.M. to 7.15 P.M., thereafter to close of program one o'clock, broadcast commencing at 1.25 instead. Consistent range 150-200 miles. Maximum 900 miles.	Milwaukee,	Wis.	360
WAAO	Radio Service Co. Music, bedtime story, baseball scores, news bulletins every day except Sunday 7.15-8.00 P. M. Consistent range 40 miles. Maximum 90.	Charlestown,	W. Va.	360
WBAH	Dayton Co. Lectures, music, vocal and instrumental talent, special features every day from 1.00 to 1.30, 3.00 to 3.30, 5.00 to 5.30, and 9.20 to 9.40. Also 7.50 to 9.00 P. M. on Wednesday, and 11.00 to 11.30 A. M. on Saturday. No program on Sunday. Consistent range 500 miles. Maximum 1,000. Central standard time.	Minneapolis,	Minn.	360
WBAJ	The Marshall-Gerken Co. Lectures, music, vocal and instrumental talent, sermons, baseball scores, news bulletins, special features, and bedtime stories every day except Sunday 12.30 to 2.00 P. M., and 6.30 to 7.30 P. M. Eastern standard time.	Toledo,	Ohio	360
WBAM	I. B. Rennyson. Lectures, music, and news bulletins. Times of broadcasts irregular. Central time.	New Orleans,	La.	360
WBAN	Wireless Phone Corporation. Lectures, music, market reports, etc., daily, hourly on half hour from 10.30 A. M. to 9.30 P. M. Eastern time. Maximum distance heard 250 miles.	Paterson,	N. J.	360
WBAP	Wortham-Carter Publishing Co. Weather, lectures, market and stock reports, music, road conditions, vocal and instrumental talent, baseball scores and news bulletins daily except Sunday 11-11.30 A. M., 2-2.30 P. M., 3.30-4 P. M., 6.30-7 P. M., 8-8.30 P. M., 10.30-11 P.M. Sundays 2-2.30 P. M., and 3.30-4 P. M. sermons.	Fort Wood,	Texas	360-485
WBAQ	Myron L. Harmon. Lectures, music, vocal and instrumental talent, baseball scores, news bulletins, special features every day except Sunday 5.30-6 P.M., and 8-9 P. M. Saturday 10.30-11.30 P. M. Sunday sermons 2 P. M. Central standard time. Consistent range 100 miles. Maximum 1,075.	South Bend,	Ind.	360
WBAU	Republican Publishing Co. Weather, market and stock reports, baseball scores, news bulletins, special features daily. No regular hours of broadcasting.	Hamilton,	Ohio	360
WBAV	Erner & Hopkins. Weather, lectures, music, vocal and instrumental talent and news bulletins Monday 6.30-9 P. M., and Wednesday 4.45-6.00 P. M. Consistent range 100 miles. Maximum 1,800.	Columbus,	Ohio	360
WBAX	John H. Stenger, Jr. Weather, lectures, market and stock reports, music, vocal and instrumental talent, sermons, news bulletins and baseball scores Tuesday, Thursday and Saturday at irregular intervals between 7.30 and 10.30 P. M. Eastern standard time. Consistent range 200 miles. Maximum 800.	Wilkes-Barre,	Pa.	360

(To be continued in the next issue—Save these, as they will not be repeated)

Radio Oracle

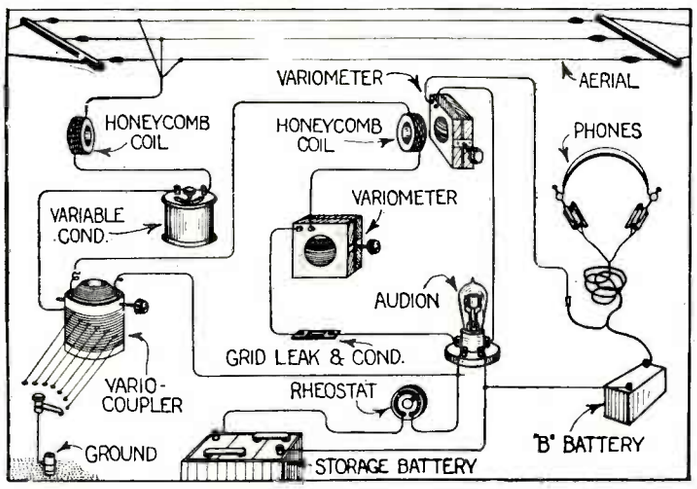
In this Department we publish questions and answers which we feel are of interest to the novice and amateur. Letters addressed to this Department cannot be answered free. A charge of 25c is made for all questions where a personal answer is desired.

LOADING A SHORT-WAVE REGENERATIVE CIRCUIT

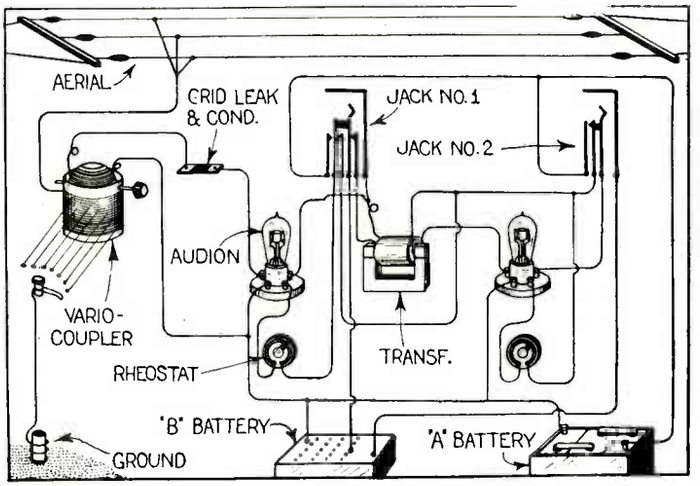
(56) D. Alexander, Vancouver, B. C., Canada, asks for:

Q. 1. A circuit diagram showing how to load a short-wave regenerative set, consisting of a vario-coupler and two variometers, to longer wave lengths, using honeycomb coils.

A. 1. We are giving a circuit diagram herewith as requested. Two honeycomb coils of the size required to load to the wave length desired, are used. You will note that the coil connected in the grid circuit is placed in inductive relation to the plate variometer.



A Very Simple Method of Loading a Short Wave Regenerative Tuner to Longer Wave-Lengths Is Shown Herewith.



[The Connections of Filament Control Jacks on a Detector and One-Step Amplifier Set Are Shown Herewith.]

SET DOES NOT WORK

(57) W. L. Browning, Hernando, Miss., asks:

Q. 1. Why he cannot hear the music from a station 25 miles away using a three-step amplifier.

A. 1. There must be something radically wrong with your set if you are unable to hear a station 25 miles away with a detector and three steps of audio frequency amplification. There are many reasons why some sets do not work properly, any of which might apply to your particular case.

We would advise that in order to secure best results, and at the same time gain a little knowledge of radio, you follow this procedure. Dismantle your set completely, and connect up your tuner with the detector alone. Find by experiment just what plate voltage your detector tube works best on (usually 18 to 22½ volts), and also how to adjust the filament current for best results. This outfit alone should enable you to hear the broadcasting station 25 miles away clearly and quite loud. After you get the set operating to its greatest efficiency, add one step of audio frequency amplification. Now go through the same procedure again, paying particular attention to the adjustment of the filament current, and the tuning controls. After you learn to adjust this set correctly, you are ready to add the second step. Study the entire outfit thoroughly, and learn to operate it to its greatest efficiency and then add your last step of amplification.

This set should give you a range of about 800 miles, and maybe more under favorable conditions.

METHOD OF TAPPING A COIL

(58) L. P. Bayha, Los Angeles, Calif., asks:

Q. 1. In winding a coil, must the whole length of wire be run into the tube and then brought out again where a tap is made?

A. 1. In winding a coil it would be extremely impractical to run the entire length of the wire into the hole and then out again, and however, this is quite unnecessary. All that you need to do is to make a loop in the wire and push the loop through the hole, having the loop long enough to reach to the end of the cylinder. The loop should be bared and soldered where it passes through the hole in the tube.

Q. 2. I have a crystal receiving set and a two-wire aerial 60 feet long and 50 feet high, but do not receive any signals. Can you help me?

A. 2. Your antenna seems to be O. K., providing all connections are soldered. The next thing you should look to is the crystal in your detector. Never handle it with your fingers, and keep it perfectly clean and free from dust. It may be that the crystal you are using now is not sensitive. This may very easily be determined by the use of a buzzer test. We advise you to use a buzzer for all testing, because it may save hours of waiting to hear signals, when in reality your detector is not adjusted to a sensitive spot. We would advise you to look over these things and if you still do not get results, write again, giving full particulars.

PLATE VOLTAGE QUERY

(59) Leon E. Bracht, Miles City, Mont., asks:

Q. 1. Can 60 volts be used on the plate of a detector tube?

A. 1. If you use a hard detector tube, it will be perfectly correct to use 60 volts on a plate. However, if a soft tube is used, the plate voltage delivered to it should be variable up to about 22½ or 35 volts for best results.

RANGE OF AUDION SET

(60) DeReid A. Bryson, Adamsville, Pa., inquires as to:

Q. 1. How far a single audion bulb set will receive.

A. 1. With a single vacuum tube detector you might possibly be able to receive radiophone over a distance of 100 miles, although your consistent range would probably be not more than 75 miles.

Q. 2. What size wire should be used in winding a vario coupler?

A. 2. No. 24 wire would be about the correct size to use.

Q. 3. Could I add two steps of amplification to my one tube set later, if I want to?

A. 3. You could add one or two steps of amplification to the above mentioned set at any time you so desire.

A BUNSEN BURNER DETECTOR

(61) C. S. Cherpeck, Chicago, Ill., asks:

Q. 1. Can two electrodes suspended in a Bunsen burner flame be used as a detector of radio waves?

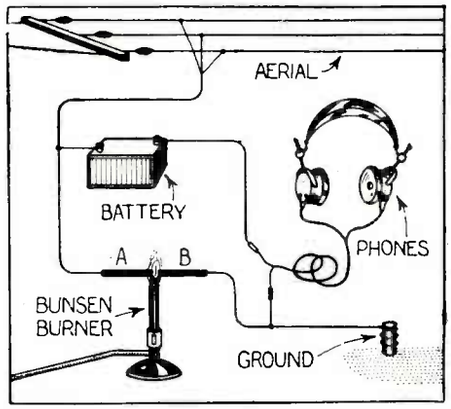
A. 1. It is possible to do so, and the arrangement represents one of the earliest types of audion detectors. However, you will not get results which will compare even with a poor crystal detector. One of the members of our staff tried this experiment in New York City, and by employing six stages of amplification was able to hear Brooklyn Navy Yard, at a distance of not more than two miles!!!

Q. 2. Cannot the manufacturers of vacuum tubes guarantee their product against burning out for a certain length of time?

A. 2. We do not see how it is possible for a manufacturer to guarantee audion bulbs, because the tubes are often mistreated and burned out through no fault of the manufacturer. However, you will usually find that standard makes of vacuum tubes will give excellent results and be quite free from imperfections which will cause the filament to burn out quickly.

Q. 3. Is it possible to manufacture vacuum tubes for sale?

A. 3. Not unless you secure a license from the patentee. To do so otherwise would invite the trouble of a law suit.



One of the Earliest Experimental Types of Audion Detectors. The Electrodes A and B Are Placed in the Flame of a Bunsen Burner, and Adjustment Is Secured by Bringing Them Closer Together, or Separating Them Slightly.

FILAMENT CONTROL JACK CIRCUIT

(62) Philip Stier, Richmond Hill, N. Y., requests:

Q. 1. A circuit diagram of a vario coupler, a detector and one step of amplification, using filament control jacks on both tubes.

A. 1. We are giving the circuit requested herewith.

HOWLING

(63) Geo. A. Abell, Lebanon, Ky., asks:

Q. 1. Why his transformer coupled amplifying set howls continuously.

A. 1. There are many reasons why howling is experienced in amplifying sets. Sometimes this is due to the capacity between the wires connecting the amplifying transformers. They should be placed as far apart as is consistent with good workmanship and also at right angles to each other. Also the grid and plate circuits should be separated as much as possible. The grid leads may be too long, and they should be kept as short as possible. If the howling still persists, be sure that the core of the transformer is not loose. If it is found to be loose, wind the same with tape.

You might also try reversing the leads of the transformers, placing all transformers at right angles to each other, grounding the filament circuit and shielding the transformers with grounded aluminum plates.

VARIO COUPLER OR LOOSE COUPLER?

(64) Achille Labelle, C. Terrebonne, Quebec, Canada, inquires as to:

Q. 1. Which is best for short-wave work; a vario coupler or loose coupler?

A. 1. Either a loose coupler or a vario coupler may be used, but we would advise a vario coupler, inasmuch as it is easier to handle.

RADIO OR AUDIO FREQUENCY?

(65) Lawrence Junior Denmire, Montrose, Iowa, asks:

Q. 1. Which type of amplification is best, radio or audio?

A. 1. The question of which amplification is best, radio frequency or audio frequency, is not fair, inasmuch as each form of amplification has its own specific purpose. Radio frequency amplifies weak, distant signals to an extent where they can be properly detected by the detector, while audio frequency amplification amplifies the signals after they have been detected. From this you can see that where greater receiving distance is desired, radio frequency should be used, and where greater strength of signals is desired, audio frequency should be used. The most efficient sets use both types of amplification.

Q. 2. What kind of a set should I use to receive from Pittsburgh with?

A. 2. To receive from the broadcasting station at Pittsburgh, we would advise the use of one step of radio frequency amplification, a detector and two steps of audio frequency amplification. This should enable you to receive concerts on a loud talker, providing, of course, the set is operated correctly.

Q. 3. Is an outdoor aerial directional, and should it be level or sloped?

A. 3. An ordinary "T" type outdoor aerial is not very directional; refer to Armstrong Perry's article in August issue for directional effect of inverted "L" and loop antennæ; it does not make much difference whether the antenna is sloped slightly or level.

TOO HIGH A PLATE POTENTIAL

(66) Walter F. Elder, Lynden, Wash., asks:

Q. 1. Will too high a voltage on the plate of a vacuum tube injure the same?

A. 1. The life of a vacuum tube will be greatly reduced by applying too high a plate potential.

Q. 2. Could a 50-ampere-hour storage battery be used on the filament of an audion?

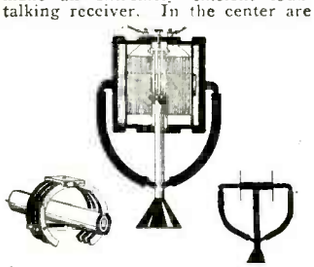
A. 2. A 50-ampere-hour storage battery may well be used for lighting the filaments of vacuum tubes, providing the voltage is correct.

LATEST PATENTS

Telephone Receiver

(No. 1,417,479, issued to Sigmund Honig)

Theoretically, this device should make an extremely efficient loud-talking receiver. In the center are

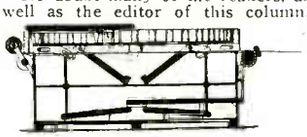


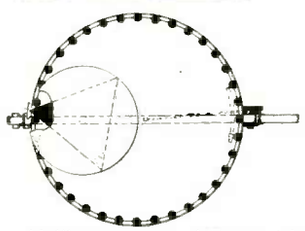
three permanent magnets secured to two semi-circular pole pieces, arranged as shown in our illustration. A circular fibre tube separates the pole-pieces. At either end of the device a diaphragm is to be found, which, due to the right and left hand threads on the casing, may be drawn toward or pushed away from the magnetic pole-pieces. When a current is sent into this receiver, the diaphragms vibrate. The outward vibrations cause the air columns in the tubes to flow in one direction. When the diaphragms are drawn inwardly, the air columns through the fiber tubes are disturbed. Both air columns being of the same length, cause the vibrations to meet and reenforce themselves, giving the effect of four receivers in one.

Spiritualistic Communication Apparatus

(No. 1,420,956, issued to Sunker Abaji Bisey)

No doubt many of the readers, as well as the editor of this column,



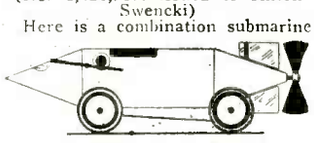


would like to see a coherent spiritualistic message received on an instrument of this nature. It is fraud proof, and that, unfortunately, limits its usefulness. A round table is provided with a series of upright pegs, between which pegs are the triggers for type, which is beneath a table. Here and there bars without type are to be found, which are to act as the spacings between words. A planchette having a freely moving top, rests on a triangular surface provided with three legs. The points of this piece are concealed by the top, and as the planchette moves around on the table, these points project between the upright pegs, pressing upon the triggers, and causing in that way a message to be typed.

Combined Land and Water Vehicle

(No. 1,420,783, issued to Anton Swencki)

Here is a combination submarine

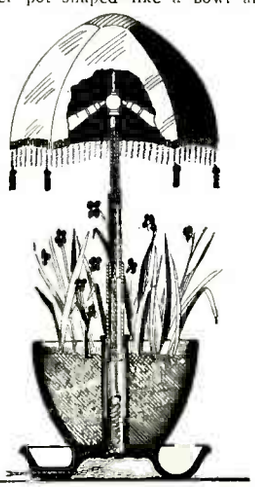


and automobile. Essentially it consists of a large water-tight, torpedo-like body, provided with suitable doors and windows. The motor inside drives the rear wheels when the clutch is thrown forward. All actions are then regulated the same as in an ordinary automobile. When it is desired to make this device operate in water, the clutch is thrown to the rear. This disengages the motor from the rear wheels and engages the propeller. Steering rudders are used to regulate the course in water, and diving planes permit the vehicle to submerge.

Electric Flower Lamp

(No. 1,419,152, issued to Henry L. Lansing and Janet R. Kohls)

This is a unique combination. A flower pot shaped like a bowl and

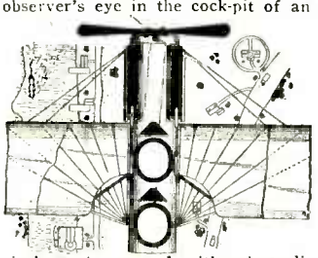


filled with soil has flowers growing within the same. It arises from the center of a basin provided with an annular groove, into which any excess moisture from the soil may drain by means of suitable passages. In the center of the flower pot is a vertical sleeve forming an integral part of the pot, extending from the bottom of the same to a level somewhat above its top. This sleeve is the first link of a telescopic column, at the top of which are mounted lamps and a suitable canopy. An electric cable passes through the base. It will be seen that the plants growing in the pot will receive light and heat from the lamps.

Drift Sight

(No. 1,419,335, issued to David L. Webster and Henry N. Russell)

Preferably at the trailing edge of the airplane wing, an iron brace on either side immediately below the observer's eye in the cock-pit of an



airplane, is crossed with wires dividing the area below into sectors. The continuation of these lines are painted upon the wings of the airplane. When the observer desires to determine the drift of the plane, he picks out an object on the ground, and then without permitting the plane to roll, steers the airplane so that this object will maintain its same sight location between or beneath the sector until he passes over. The difference between this and the true compass direction, gives the drift reading.

Violin Bow Attachment

(No. 1,421,510, issued to Gustave M. Loth)

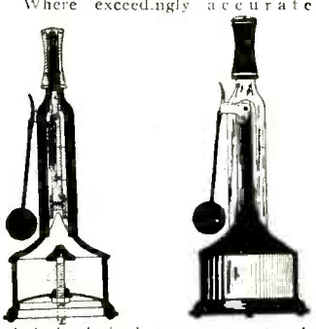
With this attachment secured to the violin, the musician could play

the air of a song and a pizzicato accompaniment at one and the same time. Three clamps grip the stick of the bow. These are secured to a brace pivoted on a rod, ascending from the violin chin rest, and having a tooth grip fastened at the other end. A cord attached to either end of the bow, passes in back of the violinist's neck. By moving his head from side to side he can draw the bow across the strings, thus leaving his hands free for double-stopping, bowing one of the double-stop notes, while the other is sounded in pizzicato fashion. A trick musician could use one of these devices on the stage, but in our opinion they would never be employed in orchestras.

Master Tuning Fork and Resonator

(No. 1,419,919, issued to John C. Deagan)

Where exceedingly accurate



pitch is desired, a very exact volume adjustment between the master fork and its supporting resonator must be obtained. In order to do this, the inventor has designed a tuning fork which is mounted upon a pedestal. A hammer located alongside permits this fork to be struck without damaging the same. The valves opening into the resonator chamber are movable, and the bottom of the resonating chamber may likewise be adjusted roughly by sliding the bottom back and forth, and a finer adjustment made by a cone-shaped plug, which is threaded into and out of the bottom sliding piece.

Self-Luminous Writing Instrument

(No. 1,420,184, issued to Albert V. T. Day)

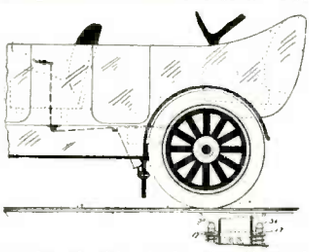
A split tube adapted to engage

a pencil at one end, and hold a self-luminous lamp in the second part of its structure, is the feature of this invention. The lamp is inserted within a casing, and is preferably of radium-luminous material, shielded from view by a reflector. The lamp with its casing may be shifted around, so that its illumination can be directed in any direction.

Sand Delivery Device for Vehicles

(No. 1,421,745, issued to Jason C. Taylor)

In order to prevent the skidding of automobiles on wet pavements, the inventor has provided for a tank containing sand, communicating with an enlarged funnel-like device and a delivery tube. A valve is released by means of a lever alongside of the driver's seat. The



nozzle of this device is directed toward the wheel, preferably the left hind wheel.

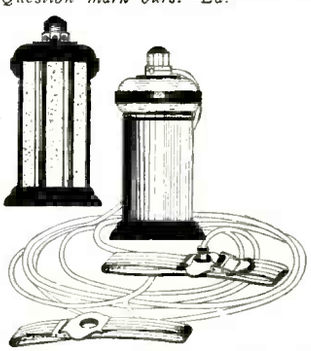
Magnetic Healing Apparatus

(No. 1,421,516, issued to Shintaro Maeshima)

This patent is too rich to let it pass without comment.

The apparatus, according to the inventor, consists of a metallic casing in which are two or more copper rods, which casing is filled with a mixture of 30 parts of powdered magnetite, 15 parts of powdered antimony sulphide, and 45 parts of powdered charcoal. Insulated copper wires lead from carbon rods to two discs held with elastic tapes.

The inventor states that the more important effects obtained by the use of the apparatus are increased blood pressure, regulated pulse, prolonged respiration, and that it produces diuretic, analgesic end peristaltic actions, increases appetite and vital compensation(?). *Question mark ours.—Ed.*



The greatest fraudulent statement made by this inventor is the claim that magnetism travels through a copper wire. Magnetite is slightly magnetic, yet the most powerful magnetic influences can never pass along a copper wire. Current passing through a wire produces magnetic effects, but no current is set up in this device, as there are no dissimilar metals within the container, nor is there an active electrolyte.

THE ORACLE

The "Oracle" is for the sole benefit of all scientific experimenters. 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:

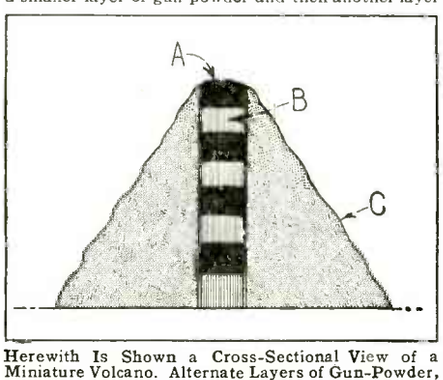
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by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

A MINIATURE VOLCANO

(1303) Clarence Clapp, Jr., Newton, N. C., wants to know:

Q. 1. How to cause a miniature volcano to use in a pyrotechnic display.

A. 1. Obtain a cardboard tube about 1 inch in diameter and as long as the height required for the volcano. Into this introduce a small quantity of a mixture of sulphur and potassium chlorate to which some sugar has been added. This is packed to a depth of about 1 inch. On top of this mixture place a smaller layer of gun-powder and then another layer



Herewith Is Shown a Cross-Sectional View of a Miniature Volcano. Alternate Layers of Gun-Powder, A, and a Mixture of Sulphur, Potassium Chlorate and Sugar, B, Are Packed in a Cardboard Tube. The Sand, C, Is Used to Hold the Tube Upright and Also to Represent the Sides of the Volcano.

of the mixture. Continue this to the top of the tube, having the last layer consist of gun-powder.

Stand this tube upright and around it pack sand to form the sides of the volcano.

Touch a match to the top layer of gun-powder and a miniature explosion will result, after which clouds of smoke will hover over the volcano, and the melted sugar will flow down the sides in much the same manner as lava. When the mixture is burned down to the next layer of gun-powder another explosion will result, blowing off some of the volcano, and the same procedure will be gone through again. This will continue until all of the mixture in the tube is consumed.

SECRET CODE

(1304) A. S. Brubaker, Santa Fe, Kansas, asks:

Q. 1. If we can supply him with a good, simple secret code.

A. 1. The best code for messages is that employed by the U. S. Army. It consumes a little time to be sure, but is very effective. The alphabet is arranged as follows:

abcdefghijklmnopqrstuvwxyz
bcdefghijklmnopqrstuvwxyza
cdefghijklmnopqrstuvwxyzab
defghijklmnopqrstuvwxyzabc
efghijklmnopqrstuvwxyzabcd
fghijklmnopqrstuvwxyzabcde
ghijklmnopqrstuvwxyzabcdef
etc.

The code word is agreed upon or sent in writing to the party, as, for instance, the word "hero." Suppose now that you are transmitting the message, "Buy up 200 shares of B and O stock." You write the code word above the message, thus:

h e r o h e r o h e r o h e r o h e r o h e r o h e r
B u y u p 2 0 0 s h a r e s o f B a n d O s t o c k.

Now look for h, the first letter of the code word, in the horizontal column and B, the first letter of the message, in the vertical column at the extreme left, and the point of intersection of the letters will be the letter transmitted in this case i.

Example:—Suppose "hero" is the code word and we are transmitting "cage ace"; we will place the letters of the code word above the letters of the message, thus:

h e r o h e r
c a g e a c e

Then, looking for h in the horizontal column and c in the vertical column at the extreme left, we get the letter j at the point of intersection; then look for e in the horizontal, and a in the vertical, and we get e; look for r in the horizontal and g in the vertical and we get x, etc. The message then transmitted is j e x s h g v. In transcribing the process is simply reversed inasmuch as the code word is known by both parties. This is the most difficult code to decipher to anyone not "in the know."

ETHYL CHLORIDE

(1305) Thos. S. Denike, Nauvoc, Ill., wants to know:

Q. 1. At what temperature ethyl chloride boils.

A. 1. Ethyl chloride at atmospheric pressure, boils at 12.5° C. Some authorities give the figure as 19.5° C. At ordinary temperatures it is a gas, but when compressed it becomes a colorless highly inflammable volatile liquid.

Q. 2. Of what use is it in medicinal work?

A. 2. It is used as a local anesthetic in operations and dentistry. Due to its rapid evaporation, it freezes the tissues surrounding the point of application and allows cutting without pain.

Q. 3. Is it poisonous?

A. 3. It is not poisonous; unless swallowed in very large quantities it can do no harm, as it evaporates almost immediately on being exposed to the air, or on being applied to the skin. If application is prolonged, permanent injury to the tissues may result.

Q. 4. How will it affect rubber, leather and copper?

A. 4. With regard to this question we would state that we will first have to carry out experiments upon its action on metals, rubber and copper. Practically speaking, we do not see that it would have any action upon any of these objects, for, although an elastic rubber band would lose its elasticity when practically frozen, on thawing out again it would resume this physical property. Leather and copper would not be affected by it.

WHAT IS SNOW?

(1306) Walter F. Dantzscher, Brooklyn, N. Y., inquires:

Q. 1. Can snow be properly called crystallized water?

A. 1. Snow cannot correctly be called crystallized water. As a matter of fact, science does not know what snow really is, but believes that it is a crystallized vapor.

Q. 2. When blood clots, does it absorb oxygen?

A. 2. When blood clots, it does not necessarily absorb oxygen. The clotting is due to fibrine found in the blood which fibrine has been activated by an enzyme known as fibrinogin. This enzyme activates the blood fibrine when the same passes through the skin or through the seat of the injury. When a waxed glass tube is inserted into an artery, the blood that flows out can be successfully transfused into another body without the clotting effect. Blood is also prevented from clotting by whipping or by the addition of salts in certain proportions.

LIGHTNING PROTECTION

(1307) T. B. Enders, Mystic, Conn., asks:

Q. 1. Why a wooden lattice cage on top of a 20-foot iron pipe, which stood in 6 feet of water, was struck by lightning, if the theory of the lightning rod is true? Should not the pipe dissipate the electricity in the air before it has time to collect in a charge sufficient to cause lightning?

A. 1. You are quite right in assuming that a pipe standing in water should dissipate the electrical potential sufficiently to prevent a disruptive cloud discharge; but at the same time there is absolutely no reason why a sudden rise in potential would prevent the wooden cage from being struck.

There are even cases where houses protected by lightning rods have been struck, but the cases are so very few in comparison to those not protected that it is worth while to employ lightning rods wherever it is thought necessary.

Lightning laws are not as yet well known and many freak tricks are performed by it.

INSULATING COMPOUND

(1308) F. G. Mitchell, Ridgefield Park, N. J., asks:

Q. 1. What is the composition of the insulating compound which is used to seal up small fixed condensers?

A. 1. The compound used for sealing up fixed condensers and other electrical apparatus is usually asphaltum, or some compound of tar, sulphur and the like.

We give herewith a formula for making such a compound. One part of Stockholm tar, one part resin, and three parts of gutta percha.

Q. 2. How to obtain and use large Rochelle salt crystals for a detector or amplifier.

A. 2. Rochelle salts cannot be used as detectors or amplifiers, but have been used as telephonic transmitters and receivers, using two or more audion bulbs for amplification. A very complete treatise on this subject appeared in the December, 1919, issue of the *Electrical Experimenter*. This article also explained clearly just how the crystals were "grown."

OXYGENATING WATER

(1309) Chas. E. Hanson, Sioux City, Iowa, asks:

Q. 1. Can I increase the amount of oxygen in water by forcing air through it?

A. 1. Forcing air through water will undoubtedly aerate the water slightly; aeration is used in the great reservoirs which supply the larger cities, for purifying and making the water more palatable.

Q. 2. If not, can you give me the name of some chemical which will do this?

A. 2. One way in which the oxygen content of the water may be increased is to change the water to the unstable compound H_2O_2, or peroxide of Hydrogen. This contains two atoms of oxygen to two atoms of hydrogen and can be simply made by adding a quantity of barium binoxide and a small amount of an acid to the water. Water so acted upon is not suited for drinking purposes.

VELOCITY OF PHONOGRAPH RECORDS

(1310) N. Ivanoff, Lawrence, L. I., N. Y., asks:

Q. 1. What is the velocity of the point on a phonograph record on which the needle is placed?

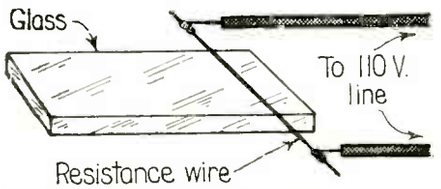
A. 1. The average speed of a record is eighty revolutions per minute. Multiply this by the circumference in inches at the point of application of the needle, and you have the velocity of this point in inches per minute.

CUTTING THICK PLATE GLASS

(1311) H. W. Brown, Baltimore, Md., wants to know:

Q. 1. How to cut plate glass which is one inch thick.

A. 1. Probably the best way to cut plate glass one inch thick would be to obtain a piece of resistance wire slightly longer than the glass is wide, and lay it across the glass at the place in which the glass is to be cut. This wire should be of such size as will become red hot when a current is passed through it. The current is now turned on, and the wire allowed to become red hot. Remove the wire and throw water over the plate glass. You will find that the glass will break smoothly and evenly at the desired place.



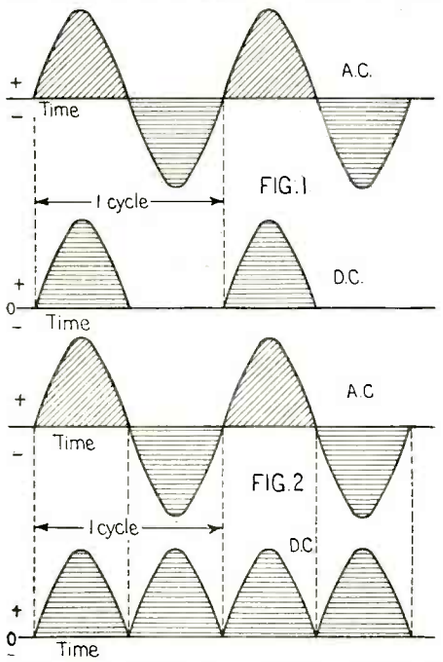
A Method of Cutting Thick Plate Glass with the Aid of an Electrically Heated Wire Is Shown Herewith

ONE AND FOUR JAR RECTIFIERS

(1312) R. D. Bernard, Akron, Ohio, asks:

Q. 1. What is meant by saying that a one jar rectifier only rectifies one-half the cycle of the alternating current, while a four jar rectifier rectifies both halves of the cycle?

A. 1. We are giving herewith two sets of curves which show the difference between the current rectified by a single jar rectifier and a four jar rectifier. In Fig. 1, at the top, we see the regular curve for an



In Fig. 1 Is Shown Graphically the Difference Between Alternating Current and the Direct Current Delivered by a One-Jar Rectifier. In Fig. 2 the Alternating Current Curve Is Again Shown, But the Direct Current Curve Shows the Wave Form Characteristic of a Four-Jar Rectifier.

alternating current; that is, a current which changes its polarity a certain number of times per second. The number of reversals per second determines the number of cycles. An electrolytic rectifier allows current to pass through it in only one direction, and with a single jar rectifier the resulting direct current is graphically expressed in the lower curve of Fig. 1. Here you will see that direct current is delivered through only one-half of the cycle. In other words, we have a pulsating direct current, with a space between the pulsations equal in time to the length of the pulsations themselves. This means that we obtain lower rectification.

In Fig. 2 the upper curve is the same as the upper curve in Fig. 1. However, the lower curve shows the direct current as delivered by a four jar rectifier. Here we see that, while we still have a pulsating direct current, the entire cycle is rectified. That is, there is practically no space or dead interval between the pulsations of the current, and consequently this latter mentioned type is more efficient than the single jar rectifier.

LUMINOUS PAINT AND LIGHTNING QUERIES

(1313) Edgar Plumsteel, Buffalo, N. Y., inquires:

Q. 1. Is luminous paint harmful to the face or hands?

A. 1. We do not advise applying any luminous paint to either the face or the hands. If you want to perform a stunt requiring the use of luminous paint in this way, wear a mask or protect the face thoroughly with a layer of wax. The luminous paints made out of calcium or barium sulphite, will not cause any great injury, except that they dissolve the hair upon the face and hands.

Q. 2. Can a phosphorus composition be used in place of luminous paint?

A. 2. Phosphorus should never be used, as it may produce a peculiar skin eruption.

Q. 3. Is there any solid matter in lightning?

A. 3. No.

Q. 4. What causes lightning to give a loud report when it strikes anywhere?

A. 4. The cause of the loud report is not due to the lightning striking anything, but by the sudden rushing in of the air into the space previously occupied by the lightning flash. In many cases lightning never reaches the ground.

WATERSCOPE

(1314) C. E. Morse, Detroit, Mich., says:

I recently lost a portable motor overboard from my row-boat. I have tried dragging without success, and also made a waterscope, but could see only about ten feet under the surface with it. The motor was lost in about twenty feet of water. He asks:

Q. 1. Can you give me any help toward locating the motor?

A. 1. The very best thing for you to do will be to increase the length of your waterscope, and at the bottom of the same attach a powerful electric light, encased in a waterproof covering. Needless to say, this covering must have sides and bottom made of glass. With a 100 to 200 candle-power bulb, we believe you should have no trouble in locating your motor. Why not drag for it with a well insulated electro-magnet? Even a strong steel magnet may help to locate it.

FROSTING GLASS

(1315) Chas. Ordine, New York City, requests:

Q. 1. One or more formulæ for frosting glass.

A. 1. Either of the following solutions will give the desired frosted appearance to glass.

Magnesia sulphate	6 ozs.
Dextrin	2 ozs.
Water	20 ozs.

Apply the solution evenly and when dry the magnesia sulphate crystallizes in fine needles, and is held to the glass by the dextrin.

Sandrac	2½ ozs.
Mastic	½ ozs.
Ether	24 ozs.
Benzine	18 ozs.

This solution is applied and allowed to dry.

Q. 2. Please give a way for producing a very heavy frosted appearance on an electric light bulb.

A. 2. Use the above mixtures as a dip.

SEPARATING OIL

(1316) George Durgin, Luber, Maine, asks:

Q. 1. Would an ordinary milk and cream separator separate lubricating oil from cotton-seed oil, since lubricating oil is lighter than cotton-seed oil?

A. 1. It will not do it.

NICKEL PLATING

(1317) W. H. Kykins, Cherokee, Iowa, asks:

Q. 1. Do you know of any method of nickel plating by the dip or direct application method such as was described for silver in the July issue of SCIENCE AND INVENTION?

A. 1. Nickel plating is one of the hardest of all the plating processes, and there is no method of dip plating which may be used successfully with nickel. The best and cheapest way to do nickel plating is by the use of electricity. The reason we say that this plating is hardest is because if the article to be plated is not absolutely clean and pure ingredients are not used in the electro-plating solution, the plating will be a failure, because the nickel will crack and peel.

We give herewith a good solution for nickel plating:

Water	1 gal.
Nickel ammonium sulphate (double salt)	12 oz.
Nickel sulphate (single salt)	2 oz.
Boric acid	2 oz.
Ammonium chloride	1 oz.

The double nickel salt is dissolved in hot water. To this solution is added the single nickel salt and ammonium chloride. The boric acid is dissolved separately in hot water before it is mixed with the solution previously prepared.

A more generally known, and certainly more simple, nickel-plating bath may be formed from:

Water	1 gal.
Nickel ammonium sulphate (double salt)	14 oz.
Boric acid	2 oz.

The nickel ammonium sulphate is dissolved in hot water, then a quantity of the latter is added to the solution until a hydrometer reading shows a density of about 7 degrees Baumé.

The anodes must be of 99 per cent. nickel, otherwise any traces of impurities of other metals will tend to discolor the deposit.

Nickel plating requires a voltage of 2½ to 5 in still-tank work. A rough crystalline deposit is the result of too heavy a current.

Do not forget that the article to be plated must be absolutely clean, and after once being cleaned must not be touched by the fingers, or any other object which is likely to place impurities or oil of any kind on the surface.

PERPETUAL MOTION AGAIN

(1318) Stephen Maloney, Scranton, Pa., inquires:

Q. 1. Has Perpetual Motion ever been discovered?

A. 1. Since the accepted definition of Perpetual Motion is, "A machine which will run either by its own power or assisted by gravity, but not any other form of natural energy, such as temperature changes, and air currents," there has not been discovered any real Perpetual Motion device. There was, however, at one time, a clock put out on the American market, the motive power for which was supplied by the daily temperature changes. This, however, was not real Perpetual Motion, in that, if it were placed in a perfect vacuum the clock would stop, because temperature changes could not reach it.

Q. 2. What would a man gain by inventing a Perpetual Motion device which would run small toys and machinery? That is, would the financial returns be worth the time and trouble put into the machine?

A. 2. If a man were able to invent Perpetual Motion in any form whatsoever, whether it would only run toys and light machinery, or large dynamos and large machines, the wealth of the world would be at his command. We say "if" advisedly, because, while many noted scientists and men of ingenuity have worked on this problem for years, there has as yet been no solution found.

We would not advise anyone, whether rich or poor, and whether endowed with mechanical genius or not, to waste his time, money and patience on any such fallacy as Perpetual Motion.

ETCHING GLASS

(1319) J. Alden Higgs, Jamaica Plain, Mass., inquires:

Q. 1. Is there any powder which will etch glass in much the same manner as hydrofluoric acid?

A. 1. Probably the powder which you mean to be used for etching glass is the sand-blast method. We do not know of any powder which in itself will act on glass in the same way as hydrofluoric acid.

In the sand-blast method the part of the glass which is to stand out clear is covered with a substance which will prevent it from being injured by the blast, and a stream of fine sand is directed against the glass by means of a powerful jet of air. This blast roughens the surface of the glass, and when the protective covering is removed from the other parts, the design stands out sharp and clear against the rough dull surface.

THERMOSTATS

(1320) A. J. Gibson, Philadelphia, Pa., says:

That he has made a thermostat of a strip of steel and a strip of zinc soldered together. When it is heated it bends, but when it cools, it does not return to its original shape. He asks:

Q. 1. Why does it not do this and how can I make it do so?

A. 1. The reason your thermostat does not work maybe is because you apply too much heat. When steel becomes heated above a certain point, the molecular structure of it is changed, and its form will also be changed permanently. Possibly the zinc is permanently stretched. We would suggest that you try using a copper and iron combination in place of the zinc and steel combination, and, above all, do not heat the combination to anywhere near a red heat. You should try the G-E thermostatic metal.

A FOG DETECTOR

(1321) S. J. Kinchi, Napavine, Wash., asks:

Q. 1. For the details for constructing an instrument for detecting the presence of fog or moisture in the air.

A. 1. You can make a very simple instrument for your purpose in the following manner: Some calcium chloride is placed in a U tube and the air to be tested is drawn in through a respirator for a certain definite length of time. The weight of the calcium chloride has first been recorded and the chloride is again weighed after, say, twenty minutes to one-half hour of its operation (the duration of time dependent upon the extent of the fog). From this last weight you will find that the chloride is considerably heavier than it was before the beginning of the experiment, due to the amount of moisture absorbed by it. By proportioning these amounts, you can make your own chart for determining the amount of moisture in the atmosphere every day.

GLASS

(1322) Jos. W. Podengal wants to know:

Q. 1. How glass is made.

A. 1. A typical glass is made from a mixture of 64 parts of sand, 6 parts lime, 23 parts of carbonate of soda, and 5 parts of nitrate of soda, heated in a furnace to 2,300° F. It then may be rolled, shaped, blown or molded while in its molten state. Of course, glass for different purposes is made by a variation of the above combination, and sometimes additions thereto. The exact formula depends entirely upon the use to which the glass is to be put.

SUBWAY LOUD TALKERS

(1323) E. Peckham, New York City, wants to know:

Q. 1. How to make an amplifier such as used in New York subways.

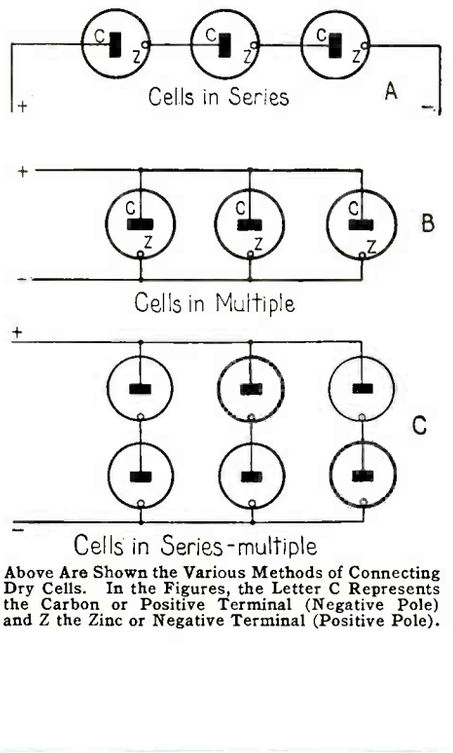
A. 1. In subways no amplifier is used; a sensitive microphone, a loud-talking receiver, and a horn are the only things necessary. The microphone is capable of passing nearly five amperes and is connected in series with the loud-speaking receiver and some source of direct current.

DRY CELL CONNECTIONS

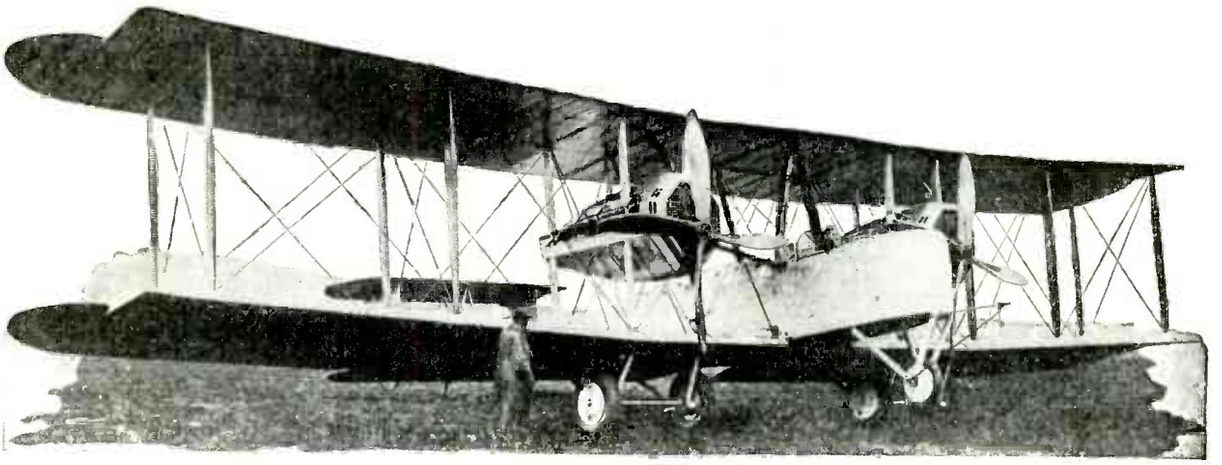
(1324) S. H. Gray, Phœnix, N. Y., requests:

Q. 1, What is meant by the following terms when applied to the connection of dry cells? Series, multiple, and series-multiple.

A. 1. We are giving herewith diagrams showing how to connect dry cells as you request. The multiple and series-multiple connections are sometimes called respectively, parallel and series-parallel.



Above Are Shown the Various Methods of Connecting Dry Cells. In the Figures, the Letter C Represents the Carbon or Positive Terminal (Negative Pole) and Z the Zinc or Negative Terminal (Positive Pole).



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No Electricity of Friction

By ELIHU THOMSON

EXTRACTS FROM A PAPER READ BEFORE THE A. I. E. E.

BEFORE the days of the discovery of the voltaic battery or the generation of electricity by contact of two different metals, the only source of electricity and the only knowledge which we had or which the world possessed depended on the development of electrical charges on the surfaces of non-conductors by friction.

The glass plate, so called "frictional electric machine," was early found to be superior to the cylinder machine. I have not, however, noticed any reason having been given for this in the literature with which I am acquainted, other than that the plate gave the possibility of a greater velocity of travel, and with it gave greater length of rubbing surfaces in moderate space, since both sides were rubbed. It had been noticed that if the revolving plate was too thick it was not as effective as when it was of moderate thickness. We can now readily ascribe the true cause for the superiority of the plate machine in that when both sides were subjected to the action of the rubber, and if the sides were not too far apart, as would be the case in too thick a plate, the electrification would inductively act through the plate, or more properly, the capacity of the plate after it left the rubber would be less than in the case of the cylinder where only one side of the glass was charged by the friction, which charge would tend to bind to itself through the glass an opposite charge on the other side. It was early found, that the pressure of a dry cork on a glass surface, or other smooth surface, gave rise to the separation of electricities, such that the cork acquired a charge on the surface which had been in contact with the glass, while the glass surface had acquired an opposite charge. It was then discovered that a piece of glass plate dipped into clean, dry mercury, and removed, came away with its surface highly charged. It was this observation of the effect of dipping glass into the clean, dry mercury which led to the use of mercury amalgams of tin or zinc as a facing for the rubbers on the cylinder, or plate type of so-called "frictional machines," and in my early experience I used the tin mercury amalgam scraped from the back of the old-fashioned looking glass, which was made into a paste with a little grease, and spread upon the rubber, with the result of greatly enhancing the output and the voltage of the frictional charge, so called.

The so-called static machines of the early days, therefore, were simply means of obtaining electricity of comparatively high tension representing an exceedingly small output of energy, and it was not until about two-thirds of the nineteenth century had passed by when such machines as the Holtz influence machine were produced that there was any possibility in view of obtaining a measurable current. With an influence machine, however, of say a dozen plates, all actively at work and revolving at a fair rate, the output becomes measurable by a milliammeter.

When a collodion film is dried against a glass surface and stripped off the pyroxyline comes away in a high state of charge. The shavings from a wood plane, when the air is dry and the wood very dry, are exceedingly highly electrified, and even paring wood with a knife under similar conditions gives chips which are charged. Combing the hair, brushing surfaces, scuffling over a carpet, result in a separation of electrical charges. Even the movement of a belt over a smooth pulley, if the belt be dry and the surrounding air be dry, will often give rise to the very decided manifestation of an electrical charge, as the belt moves away from the pulley surfaces, and, in fact, in the presence of gasoline or alcohol vapors, a moving belt is often a source of great danger of fire. The electricity developed in belts has often been attributed to the friction on the pulley, but it is a notable fact that even when the belt is not slipping, a charge is developed and is not notably increased if the belt does slip. The true state of the case is that such electrification is developed as in the case of the varnish or collodion film by the mere contact of the belt with the pulley surface rolling off it. and as it rolls away, there is a great reduction of the capacity of the system, so that the charge which is bound to its opposite when the belt is upon the pulley is separated with great reduction of capacity, and consequent enormous increase of its tension or potential. In this view of the case, manifestly the belt action is no different from that of the early frictional machines. The friction in these early frictional machines becomes evident as a means of merely getting a continued contact and separation. A reduction of capacity and rise of potential is the consequence thereof.

It may be said in conclusion, that it is probable that there is no such thing as frictional electricity, as distinguished from that produced at the contact of dissimilar surfaces. On this basis, we can dispense with the term "tribo-electricity."

To Broadcast Chorus of a Million Marmots

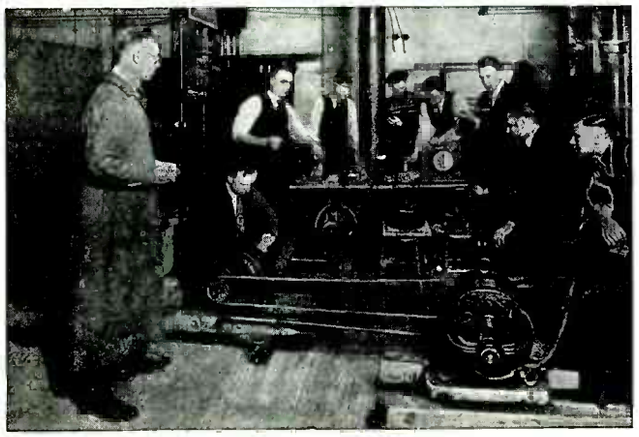
"The next number on tonight's program will be a piccolo imitation entitled, 'The Whistling Chorus,' by the Rocky Mountain Marmot Singing Society of one million voices."

Such may be the announcement to astonish the ears of any number of listening radio fans in the near future, if a proposal before the National Park Service of the Interior Department is carried through. It will be possibly the most novel treat that the numberless radio amateurs could ask, whose apparatus would tune in with a broadcasting station in Glacier National Park, in the heart of the Rockies, which would catch and transmit the shrill whistling of these small dog-like animals.

Within fifty miles of the park, in the northern part of Montana, near the Canadian border, resides the largest colony of the animals on the North American continent. It is estimated there are close to a million of them, living in dense population. On still nights the wonderful shrilling chorus of the piccolo-like voices is carried miles on the rare mountain air, and tourists in the camps enjoy the evening programs immensely.

It has been proposed that a receiving set and broadcasting station of 200-watt capacity, sending at a 360-meter wave length, be installed close enough to catch the voices clearly.

Quick Thorough Training Fits You For Brilliant Career *in the Great Field of Electricity*



How America's Greatest Institution of Electrical Education Makes You an Expert Quickly—Ready to Step Right Into a Big Pay Job

THE other day a young man, smartly dressed, with the firm step and keen eye that is always a part of the highly successful man, stepped up to the desk of the Registrar of this great school. After warm greetings, for this young fellow was a graduate of the school, a story of his quick rise after graduation followed with the request that a place be reserved in the Fall Term for his younger brother.

This young man had a few years back come to the United States from South America. He wanted to learn electricity in all its phases—to become an electrical expert. Before selecting a school, he thoroughly investigated them all. He attended classes, examined their laboratory equipment and looked up the records of their graduates.

He finally chose the School of Engineering of Milwaukee, because as he said: "There is really no other school like this. Your immense laboratories with every conceivable piece of electrical equipment, the large and wonderful staff of expert instructors, the general air of thoroughness about doing everything here is incomparable. The minute detail with which you treat every phase of electrical work, makes your graduates **real experts** ready to cope with any situation out in everyday work, thereby fitting them to hold important jobs right after they leave school. In my work back home, I have never met a problem that had not already been mastered at the school and some mighty hard ones have arisen many times. I owe my success entirely to my splendid training here. That's why I am bringing my brother to you."

For over **17 years** the School of Engineering of Milwaukee has been training men for brilliant careers in all branches of electricity. This great institution is devoted exclusively to practical electrical education and offers advantages to be found nowhere else. There are large laboratories filled with thousands of dollars worth of motors, generators, switchboards, meters, testing instruments, apparatus and electrical equipment, etc., etc., all working size—not just models—with which the students daily learn in actual practice every angle of this fascinating work. Both theory and practice are taught so that every graduate is ready instantly to fill a high salaried position.

Never Greater Opportunity Than Now

The electrical industry has developed so rapidly within the last few years, that today there is a great shortage of trained specialists qualified to fill with credit the many splendid positions open every day. The requirements constantly become more stringent, so that in order to make good today, a man **must have special training.** And the wise young man is he who comes to this great electrical school, learns electricity thoroughly and then steps into a fine paying job.

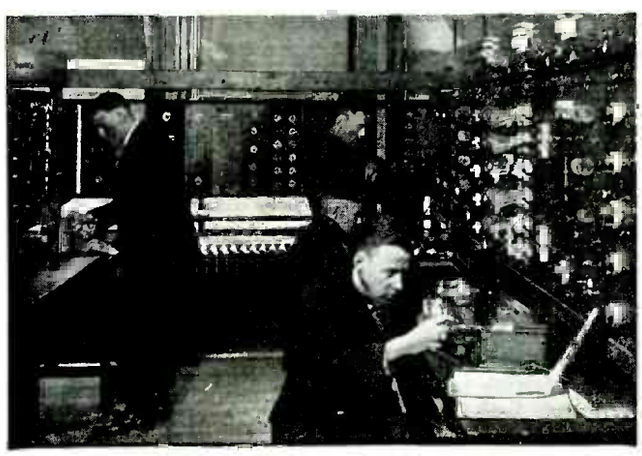
No matter what your age or what your previous education has been, the School of Engineering of Milwaukee can and will make you an expert in electricity. That is perhaps the most popular feature of the system of training employed only by this famous institution. It strives to take care of every ambitious man in the way best calculated to fit his ability and means. You may take a short, intensive, specialized course or you may take a long general course, as may seem best for you.

Choose the Branch That Interests You Most

The man who makes good money today is the one who **specializes!** That is why this school first gives a student a quick, intensive training in the general theory and practice of the principles of electricity and then trains him for whatever branch of the work in which he desires to specialize. He quickly becomes not only a good electrician but also a specialist—ready to earn big money out in the industry. You may become here an Electrical Engineer, an Electrotechnician, a Practical Electrician, Motor Generator Maintenance and Repairman, Electrical Draftsman, Automotive Electrical Expert, etc., etc.

Spend Just the Length of Time Here You Desire

Our long experience has taught us that many young men want to come in for a short time to learn an electrical trade so that they can get into electrical work immediately. To care for these knowledge seekers, we have provided a series of intensive short Shop Courses which are thoroughly practical and quickly mastered. COURSE I makes an Expert in Electric Light Wiring and Testing; learn in 3 months. COURSE II covers Armature Winding for A. C. and D. C. Motors; learn in 3 months. COURSE III combines Electric Light Wiring, Testing and A. C. and D. C. Armature Winding and takes 6 months time. These courses are very popular. They cover 8 hours class work each day, five days a week.



Automotive Electrician—Master this work in 3 months. A complete and thoroughly practical course that fits a man to repair and reconstruct any electric starting and lighting system, ignition, storage-battery, for an automobile, auto truck, tractor, motorcycle, motorboat, airplane, etc. This is one of the most profitable fields of work, many men in it making splendid incomes in their own shops, service stations, or garages.

Expert Repairman on D. C. and A. C. Armatures—Learn in 3 months. A most pleasant, highly paid calling that is claiming more men every year. A field that is full of opportunity the world over.

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Electrotechnic—A course of 1 to 2 years. Makes you an expert Electrotechnician—the man who fits electricity to modern industry. This fascinating course gives you a practical training that leads to such positions as Superintendent of Maintenance, Director of Construction, Radio Engineer, Superintendent of Testing and Installation, Electrical Equipment Salesman, etc. Every one of these positions pay handsome salaries.

Electrical Engineering—Learn in 3 years, with B. S. Degree. With this training, you may quickly take your place with the leaders in the industry. Many of the graduates of this school now occupy places of great honor and high incomes. Yet the field is less crowded than in any other profession.

The Helping Hand We Lend You

Young men coming here find always a sympathetic, conscientious atmosphere, a desire on the part of the principals of this school to help every one to accomplish his ambition. Milwaukee is a busy, thriving industrial city, filled with opportunity for the aggressive young man who must work in spare time to defray his expenses. The leaders of industry here are ever ready to help the conscientious, deserving young man who develops himself through education in this great school to make a mark for himself in the world. Write at once for complete details of how this plan works.

Your Passport to Success

is the coupon below. Send it at once to get our illustrated catalog and complete information about this wonderful school. Mention the branch of electricity in which you are most interested. In fact, we suggest that you write us all about yourself, so that we can advise you in detail of the steps you should take to accomplish your ambition. Don't put off! Every hour cheats you of the power to earn more money, keeps success just that much longer away from you!

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Experimental Electro-Chemistry

By RAYMOND B. WAILES

(*Continued from page 559*)

pass through one-hole stoppers. The boundaries between the two solutions must be sharp. The current produced by this type of chemical-electric cell flows from the lower solution to the upper.

SHORT-CIRCUITED CONCENTRATION CELLS

This type of cell is similar to the above, only it is short-circuited on itself, the phenomena produced by the shorting being visual.

Figure 4 shows this cell. The tin rod is immersed in two layers of electrolytes, A and B. Electrolyte B is made by dissolving 8 grams of tin in 40cc of hydrochloric acid. Electrolyte A is made of a very dilute solution of the above prepared solution, just a little acid being added if a precipitate forms when diluting, to clear the solution from the cloudiness. A 25cc metric graduate serves as a container. A tin tree will form as shown if the whole short-circuited concentration battery is left undisturbed for several days.

OXIDATION CELLS

The oxidation of metals can also produce an electric current. Figure 5 shows a small experimental cell by which this process can be carried out and the current produced measured.

A battery jar contains strong nitric acid. In it a beaker is placed, containing a shallow pool of mercury in which a 1-inch cube of pyrite or fools' gold rests. The pyrite is electrically connected to the voltmeter by means of bare copper wire W, wrapped around it and led up through the glass tube G. A ¾-inch layer of chloroform is poured over the mercury, and this chloroform layer is then followed by a caustic soda (or potash) solution as shown. The glass tube protects the copper wire from the action of this latter solution. Asbestos cord dips into the nitric acid in the jar and into the smaller jar, or beaker containing the pyrite, caustic soda, etc., as shown. A carbon rod, or, better, a platinum wire, makes contact with the nitric acid.

In action the pyrite, which is iron sulphide, is oxidized to a higher state of valency and then dissolved by the caustic soda solution, forming a precipitate of iron hydroxide. If potassium tartrate is added to the caustic solution, this precipitate will dissolve as fast as it forms, thereby keeping the resistance down. It can be seen that both the caustic and the pyrite are both consumed. As fast as the caustic solution is used up, slaked lime can be added to further the reaction. The cell will give about 1.15 volts and 0.3 ampere.

This source of electricity produced from metallic sulphides, which are cheap and plentiful, has been proposed to be carried out commercially. The prominent fact developed is that certain mineral sulphides readily oxidize in a caustic solution with a consequent production of an electro-motive force.

CORRECTION

In the August number of this journal there appeared an article entitled, "Seaplaning From Florida in Record Time," wherein the railroad running time between Palm Beach and New York City was given approximately as sixty hours. We have been advised by the Atlantic Coast Line Railroad Company that they operate two high speed trains between these cities, one of which makes the run in 39 hours and 45 minutes, or about 40 hours, and a special winter tourist season train, which makes the run in 38 hours and 20 minutes.

Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 543)

of Antares about 45 times the mass of the sun. Of course these values are uncertain, for they depend on the values assumed for the densities which are not definitely known, but they are probably approximately correct.

The star-system investigated by Dr. Plaskett, then, consists of two stars that are, individually, much more massive and dense than either of the red giants Betelgeuse and Antares, but far less bulky. It is well to bear in mind the distinction between the size and mass of a star. One star may be much larger than another and yet be less massive. The mass of a star depends on the quantity of matter that enters into its composition, the size of a star depends on its volume which is proportional to the cube of its diameter. The density of a star is the mass per unit volume; that is, mass divided by volume gives density. We emphasize this point because it has been said by some that the individual stars in this newly-discovered binary system are larger than Betelgeuse. This is not true. These stars are probably more massive than Betelgeuse, though nothing is definitely known regarding the mass of the red giant aside from what we have given above, but they are far smaller than Betelgeuse. The diameter of Betelgeuse is three hundred and eighteen (318) times the diameter of the sun. The diameters of these two suns are respectively twenty and eighteen times the diameter of the sun *at the most*, and their diameters may be only about *half* of these values. The importance of Dr. Plaskett's discovery lies in the fact that the masses found for these stars are about four times greater than the upper limits formerly set for the masses of the stars. These two stars are the most massive of all stars, so far as is known, but they are by no means the largest or bulkiest.

Another most interesting and important feature of Dr. Plaskett's investigation of this remarkable system is the discovery that it is surrounded by a cloud of calcium gas which does not have the same motion as the star-system. The binary system is receding from the earth with a speed of fifteen miles per second, while the calcium envelope is receding with a velocity of ten miles per second. Dr. Plaskett points out that this may be due to the Einstein effect that has so far been vainly sought for in the case of the sun. One of the three Einstein predictions was that the lines of the solar spectrum should be shifted toward the red by the measurable amount of one-half mile per second as a result of the effect of the sun's gravitational field on rays of light from the sun. This shift is proportional to the mass of the source of light and inversely proportional to the diameter. It should be observed, therefore, in the case of this star. The difference between the common shift of spectral lines of this pair toward the red, and the shift of the surrounding calcium gas, is five miles per second, and this may be due to the Einstein effect that has up to the present time been vainly sought for in the case of the sun. Dr. Plaskett considers, however, that the measured shift for this pair should be approximately two miles per second instead of the five miles per second observed. Assumption of higher densities would give smaller diameters for these stars and would result in a closer agreement between the predicted Einstein shift and the observed shift, but the lower densities are considered to be the most probable.

The discovery of clouds of calcium vapor surrounding these stars is in itself an important and interesting discovery irrespective of its bearing on the Einstein theory of relativity. A few years ago Director Evershed of the Kodaikanal Observatory in

Southern India call attention to the presence of the stationary calcium line in the spectra of a number of binary systems and temporary stars and suggested the possibility of the presence of clouds of calcium vapor lying between us and these stars. It is uncertain whether these vapors closely surround these stars or lie at considerable distances from them. Dr. Eversheds investigations seemed to indicate that the clouds of gas were nearly stationary in space and entirely free from the stars. Dr. Plaskett's observations of the calcium clouds surrounding this system would suggest that they were more or less closely associated with the star, and were receding with it through space.

The discovery of this unusual double star system at the Dominion Astrophysical Observatory raises, as we have seen, a number of questions of great interest to the astronomer, and may be of very great value in the solution of some perplexing astronomical problems. Needless to say, it will be observed with great interest at other observatories equipped with suitable instruments for its observations, and additional information regarding its remarkable properties will doubtless be forthcoming from such observations. The Dominion Astrophysical Observatory is to be congratulated upon the admirable work that is being done there with its giant reflector, and for the valuable contributions that it is making to astronomical research.

A Sub-Conscious Murderer

By NELLIE E. GARDENER

(*Continued from page* 539)

She cried it aloud, in her sleep, during the dreadful weeks in jail, the sheriff's wife told me. But no answer came.

Today's rapidly moving events had brought some light. But not the motive. Why had the old professor wished to wreck their lives? He always seemed so fond of his pupil, and watched the growing attachment of the young sweethearts with almost fatherly affection.

For the first time, I wondered as to the nature of his affection for Elaine. Was it something more than paternal? I had been so wrapped up in her mental and spiritual development, and so proud of her remarkable advancement! Besides, her father had trusted him.

Yes, one part of the mystery had been solved. The professor had influenced her to kill the man she adored, the man whose wife she wanted to be.

Jealousy was the only explanation. He wanted her. My precious girl,—and that old man! It was too hideous! He had coveted her womanhood, and when the wedding was only a few weeks remote his passion overcame him. He would have permitted her to suffer anything—imprisonment or death—so long as she did not become the wife of another man. If it had not been for the tenth-hour aid of Science, he would have gone free, while Elaine,—Oh!

I scarcely heard the Judge, as on motion of the prosecution he dismissed the case. I couldn't speak to the attorneys and jury who crowded around us with their congratulations. All I could see was Elaine's face,—gray, motionless, blank. Dazed by her grief, the arrest and trial had meant little to her: and now acquittal and freedom could not mean much more. John was dead. What else mattered?

Futility, tragedy, despair were written into her face.

As we were preparing to leave the courtroom, she stepped quickly to the table where the scientist had been standing, and picked up the thin, black reel lying there. She smashed it to the floor, and screamed incoherently, in a voice that hurled defiance at God and man. The effect was terrifying! Then she dropped into a chair and sobbed.

They were her first tears since that other day. Old Doctor Stevenson, who had sat near us through the ordeal of the three days' trial, motioned us away. He placed one hand on her head, and patted her shoulder with the other.

"There, 'Lainy," he said, calling her by her pet name of childhood, "have a good cry. It will do you good. You need it, little girl. You'll be all right now."

We were all crying—Judge Manley (our neighbor), Doctor, and I. And some of the lawyers hurried out into the counsel room.

One of the reporters, apologizing, asked about the instrument that had been brought into the courtroom that morning—which, as he said, had been responsible both for Elaine's deed, and for her freedom of the accusation of guilt. He wanted an accurate story for his paper, he said, and also for a scientific journal, to which he occasionally contributed.

He was the son of a dear friend, and his paper had been fair to us, this month. Besides, I was anxious to help attest my daughter's innocence. I knew that Elaine was in better hands than mine, for the doctor was comforting her and helping to direct her returning faculties. She would be all right, he assured me. Her violence had expressed itself in that one rebellious shriek. Instead of passing from the semi-trance into the madness we all feared, she had been shocked back into reason.

So, while the doctor soothed Elaine, I sat at one side and told the newspaper man the whole story.

My husband and I had met Professor Zeidmann on one of our summer trips to Germany. He was then fairly young, without family, and devoted to his science. He was shy and erratic, in those days, but in later years developed unusual poise. At our first meeting he told us that school-room teaching made him nervous and he wished for private tutoring. Accepting our invitation, he came across to visit us next year, and our friendship deepened. Later, when Elaine was three years of age, we took her with us to Europe, and once more renewed our acquaintance with Professor Zeidmann. Two years later, on the professor's second visit to America, we asked him to stay and become Elaine's tutor. He was well versed in languages, science, music, and art, and seemed just exactly the tutor we desired. That was sixteen years ago.

Next year her father died—I can never get used to being without him. Of course I asked Professor Zeidmann to remain with us, for I needed his advice and assistance in bringing up Elaine. And my husband trusted him so much!

Well, the years passed. Elaine made remarkable progress in her studies, in memory work especially. She could commit long passages from the Æneid, Iliad, Odyssey, and Idyls of the King, and could recite most of Shakespeare, too. Besides, she could play and sing many of the opera scores, without looking at the music.

These memory feats I always attributed to Professor Zeidmann's "Hyp"—Elaine's name for his "Hypnobioscope." This was a scientific instrument of European make, whose inventor was known to the world only by the mysterious cipher 87 K 6 G. No one knew who he was, Professor Zeidmann told me, and only a few scientists made any use of his invention.

Professor Zeidmann asked me not to mention its existence to my friends, so I never did. He took such pride in Elaine's advancement that I was willing to help him keep his method of instruction secret.

This thought-registering instrument consisted of a large thin reel, upon which was wound a long narrow film. At night, this reel was placed in a rack beside Elaine's bed. After she was asleep I clamped a double leather head-band about her head, with metal plates touching her temples. Then I attached the little narrow film—entirely black except for the white transparent wave-line that ran through its center—to the Hypnobioscope and turned on the current. This magical mechanism transmitted the impulses of the wave-line

direct to the brain of my sleeping daughter, and she was made to "dream" the Odyssey, Romeo and Juliet, Mignon, Tristan and Isolde, algebraic formulæ, or French conjugations. All her lessons were learned this way, at night, leaving the daytime free for the piano, swimming, tennis, and riding.

If you have never thought about the subconscious mind, you do not realize how much we are governed by it, and, likewise, how completely we may place it under our control. That is the first principle of the "Hyp." It has been known for centuries that the human brain can be affected during sleep by certain processes. If you place a heavy object on a sleeper's chest, he will dream that it is there. If you apply anything hot or cold to his hand, he will dream that his hand is being scalded or frozen. If you remove the sheet from over his body, he may dream that he is walking naked in a snowstorm! These are only physical sensations that are impressed upon the sleeper's subconscious brain. Mental perceptions and moral suggestions may equally well be written there! And it remained for 87 K 6 G to invent the machine which transmits words direct to the sleeping brain, in such a manner that everything can be remembered in detail the next morning.

This is made possible by having the impulses act directly and steadily on the brain, while the mind is in a passive state. It seemed an easy, natural, and mechanical process, with Elaine, and whatever she "read" during the night she never forgot. She often said that as time passed, instead of fading from her mind, the impression grew stronger. Anything conveyed to her, in that manner, during sleep, made five times as strong an impression upon her mind, as if taught during her waking day. Finally, it became absolutely indelible!

The more pleasant the idea, the more quickly she learned it. Something disagreeable to her was not easy for her to recall until after several nights' repeated instruction. For example, biology, which was always more or less repulsive to her, was the most difficult subject in her entire course with the "Hyp," and the lessons had to be repeated for weeks.

One condition the professor imposed, that Elaine should never listen to these lesson "records" during her waking hours. It would ruin the psychological effect, he said, and she could never get any benefit thereafter. This seemed strange, yet he never gave a satisfactory explanation. He was so imperious in his conditions, however, and I trusted his scientific judgment so implicitly, that I dared not disobey.

So every night for ten years, except brief intervals when Elaine was visiting friends or attending camp, I slept in the same room, and by force of will kept awake until she was asleep. She was such a deep sleeper, from tiny girlhood, that she never wakened until morning. After she retired I listened patiently until her breathing told me she was asleep, and then tiptoed to her bedside and clamped on the headpiece and turned on the reel that Professor Zeidmann had ordered for that night. It was usually the same for the entire week, making a strong, permanent impression, he said, and never being repeated again. He made these films himself, in his laboratory on the third floor, where he worked alone, often for hours into the night. I tried to "listen" to one of the records, once, many years ago, but it failed to register an impulse upon my conscious brain. That seemed proof enough, to me, that it was a mystical piece of mechanism, capable of acting only upon the subconscious mind.

What I did not know until today in the courtroom was that this thought record could be attached to a vacuum tube amplifier and its wave-line translated into the spoken word, audible to any one in the room.

Sydney Harrison—who, as you know, never concealed his fondness for Elaine, even after she announced her engagement to John—had been working every hour over Elaine's defense. He insisted that there was some

sinister motive and some unexplained influence.

When Sydney first offered his service for the defense, it all looked so hopeless! What could be accomplished by a long trial? We had found them together. John was dead. Elaine admitted she did it. What else remained?

But Sydney—bless him—refused to give up. There must be some way to set her free! He worked without many words or questions. The latter seemed useless, anyway, for to them all Elaine replied, "I can't tell what made me do it!"

One day Sydney asked me to tell him everything in regard to Elaine's education since the professor first came. So I tried not to omit one detail. We talked for hours, apparently without arousing his interest. Finally I mentioned the "Hyp," in the most casual way, and he sprang from his chair, exclaiming, "My God! Mrs. Huntington, why didn't you tell me that before?"

It hadn't occurred to me that there might be some connection between Elaine's peculiar educational system and our present tragedy.

Sydney asked to see the Hypnobioscope and some of the recent records. He examined the headpiece carefully, attached it to his own temples, but heard nothing. He had it clamped upon his head, by his older brother, after he went to bed, but in the morning said he could remember nothing!

Still he did not give up!

These investigations were carried on, of course, without the knowledge of Professor Zeidmann. During these weeks preceding the trial the professor was so comforting. He always accompanied me when I went to visit Elaine, and when we left he usually kissed her good-by. I hadn't seen him do this, since she had outgrown her childhood.

I knew he looked upon her almost as his daughter. But I remember thinking it queer that Elaine returned his kiss rather passionately sometimes. That seemed entirely unlike her nature—at least any expression of it that I had witnessed—for she was apparently quite cold and controlled. But I attributed this sudden display of emotion to overwrought nerves, and loneliness for the lover she had lost. Perhaps, too, she longed for her father's strengthening presence. Of course, here was Sydney. But he had too often made love to her for Elaine to consider him in a paternal light.

To all of Sydney's consultations she remained indifferent. I really believe she hoped the punishment would be extreme and its execution swift. That would bring release.

Sydney warned me against any allusion to the Hypnobioscope. He wanted her mind free from ponderings so that, at the final moment—he could make the suggestion and watch the effect.

Meanwhile he was working night and day for a clue to the motivating influence for the murder. He took several of the late reels into the city, where an old college friend had a well-equipped laboratory, and left them there. If these mysterious films would yield their secret, this young delver into the unknown would find the answer, he said. But days passed, and the man of science had found no clue, and the man of law no further evidence, or explanation.

As the trial approached, Sydney became more nervous, the professor more excitable, and Elaine more immobile. To me everything seemed lost, but for Sydney hope could not be killed. If the worst came, he said, the jury could be depended upon to listen not unfavorably to his plea for young feminine beauty, now loverless and brokenhearted!

Well, you know the outcome. How the trial progressed, and Elaine was made to repeat her story, time after time, because the prosecution hoped to break down her lethargy, and arouse her to words of anger or jealousy, or any emotion that might have made plausible the killing of her fiance.

You were there, too, this morning, when the man unknown to all of us entered the courtroom with a large package, and motioned to Sydney to come outside. How every one

waited to learn the outcome of that hurried conference!

Will you ever forget Sydney's triumph as the two men re-entered the court chamber? And Professor Zeidmann's horror when he saw them walk to the front of the room, and the attorney for the defense ask the Judge for permission to introduce some important, relevant, and extremely urgent evidence and testimony?

Did you see the professor rise, white-lipped, from the chair beside me? And at Sydney's quick request, how the Sheriff came and stood beside us, with his hand ready for the coward's shoulder?

Then, the hush, as Sydney demanded the arrest of the man who was the object of the eyes of all, and ordered the strange scientist sworn as an expert witness.

There the manipulator of sciences, physical and metaphysical, produced an instrument which had the appearance of a combined radio vacuum tube set and a stock ticker, and which could translate the thought waves on the recorded "Hyp" film into sound waves that could be expressed in words and reproduced through the horn, so that all the room might hear and comprehend. At last, the secret of the white-streaked ribbon and the metal plates was made clear!

Speechless, we heard the "lessons" that Elaine had been taught during the nights of the month preceding her intended marriage. Passionate love poems, most of them. The kind to fire a young girl's brain with inflaming imagery. How unlike the French verbs and mathematical formulæ that I supposed she was reviewing!

And all ending the same way!

Will you ever forget the poignancy of Browning's love lyric, on the record this morning:

"Be a god and hold me
With a charm!
Be a man and fold me
With thine arm!

"Teach me, only teach, Love!
As I ought
I will speak thy speech, Love,
Think thy thought——

"Meet, if thou require it,
Both demands,
Laying flesh and spirit
In thy hands.

"That shall be to-morrow
Not to-night:
I must bury sorrow
Out of sight:

"Must a little weep, Love,
(Foolish me!)
And so fall asleep, Love,
Loved by thee."

Then, Elaine's cry as the record ended with the slow, distinctly spoken words: "GUN: KILL JOHN: LOVE ME: GUN: KILL JOHN: LOVE ME."

Sydney Harrison was speaking: "In the name of the Law, I demand the arrest of Professor Zeidmann, in the murder of John Cavendish."

But the little German was too quick. With an appealing look at Elaine, he drew his hand from his pocket and fired. The brain that had controlled the destinies in the drama wherein he had moved was resourceful and daring enough to save himself the ignominy of arrest. The calculating scientist died discovered, but undefeated.

To think that I, through all those nights, had been the unknowing accomplice! And that the inanimate, blameless Hypnobioscope, invented for the advancement of science and the benefit of man, had been used as an agent for murder! Can I ever forget the horror or forgive myself for my part in it?

Doctor Hackensaw's Secrets

By CLEMENT FEZANDIÉ

(*Continued from page 541*)

temptuously, "but all those that you have seen depend upon the action of selenium cells, and selenium will never give the real solution of the problem. Light and sound are both vibrations, and as soon as the telephone was invented for transmitting sound vibrations, it was patent to every thinker that an instrument for transmitting images in the same way was also a possibility. Many men have worked on the problem, but they have chosen the wrong road. By the use of selenium cells they have succeeded in transmitting the photograph of an object point by point, and in black and white, but this is not what is wanted. Selenium cells will never send the continuous image of a moving object in its natural colors—or at least will never do so satisfactorily. The real solution is to be sought in another direction."

"Indeed?"

"Yes, and it seemed to me that the solution was simple. Light and sound being both vibrations, and differing also in the number of vibrations per second, I saw at once that all I required was a perfected telephone—a telephone of extreme delicacy which would transmit the light waves without too much distortion. Our telephones now transmit sounds very clearly, but something far more delicate would be required for transmitting the light waves. I saw at once that I must discard the clumsy microphone at both the receiving and sending end of the line and use something less mechanical."

"And you found a satisfactory substitute?"

"Yes, I suppose you have heard of the 'Telegraphone'?"

"Vaguely—"

"Well, the telegraphone is a phonograph in which sounds are recorded by magnetizing an iron wire. This is a far more delicate method for making records than a wax sheet and a cutting stylus. Now it struck me that I could use the same method in my television apparatus. Instead of a microphone transmitter and receiver I use a traveling wire at each end. Speak into one end and the sound waves magnetize the wire as it passes and the wire in the receiver is magnetized in like manner and the sound heard there far more clearly than with the usual telephone. The message is also recorded and can be reproduced at will.

"Having accomplished this for sounds I was ready to turn my attention to the transmission of images. Many experiments were necessary before I accomplished anything, and I was obliged to invent a new form of audion for amplifying the light waves before I achieved any real results. You can judge of my success by the dance you yourself have just seen. And please remember that I not only receive the pictures transmitted from a distance, but that my traveling wires carry a permanent record of the picture in the varying magnetization of the different parts of the wire. I can hence throw a picture over and over again on the screen just as a phonograph record can be played a number of times. Better yet, I can combine the phonographic and the 'chromographic' records on the same wire, thus solving the problem of having motion pictures in the natural colors, either of past events or of occurrences taking place at the present moment in some distant place. And remember, please, that these pictures are *continuous*. In the movies you have only about sixteen distinct pictures of an object in a second—the pictures *are not* and *cannot be* continuous. But in my apparatus you see a continuous picture of an object just as you would see it in a mirror. Every phase of the motion is there, and we can slow up the reproduction to any degree desired and still obtain an absolutely correct picture. This feature alone is invaluable and will enable us to solve many scientific prob-

lems, especially in physiology and pathology."

"True," said Silas, "but how about the freak movies? These will be impossible if the pictures are continuous. They depend on the intermission between the pictures, which enable the photographer to show people run over by automobiles, carriages with their occupants hurled down precipices, etc."

Doctor Hackensaw smiled. "The freak motion pictures are the least of my worries," he said. "Besides, means will always be found for making them."

"Is your instrument now ready to be put on the market?"

"Well, yes, in a way, and yet, would you believe it, I am not yet altogether satisfied with it."

"What!" cried Silas. "Isn't it enough for you to be able to send images in color from place to place, and make permanent records of them that can be used over and over again?"

"No," replied the doctor, "it is not enough, and I did not stop there. If I could send these pictures by wire, there was no reason why I should not transmit them by wireless, and experiment showed that I was right. I began by using *wired—wireless* so as to be better able to study the new problems involved and then I discarded the wire altogether, using wireless waves—either *directed* waves if I wished the picture to go in one direction only; or *undirected* waves if I wished to broadcast the picture to different receiving stations."

Here Doctor Hackensaw paused a minute, then continued: "You would imagine Silas that this last triumph would satisfy me, but not a bit of it. It only whetted my appetite for fresh conquests. I resolved to carry the thing one step further, and do away with the sending station altogether. When we look at an object with one eye, or when we take a photograph of it, we do not need a sending station to send the image to us, even though the object is a star millions of miles away. Now if the image of a star comes millions of miles to the retina of my eye without the need of an operator to send it, why could not my television apparatus do as much?

"Here was a new problem, far more difficult than those which had preceded it, and many times I was tempted to give up work in despair. But, step by step, I overcame the obstacles, and you can imagine my joy when one day I found I could see objects in the next room right through the walls, even though that room contained no apparatus or operator. The natural ever-present electrical waves that accompany light were there, and they did their own transmitting. Now I can receive images of objects many miles away without any sending station at the other end of the wire. My receiver is provided with adjustable diaphragms and micrometer screws, and by turning it in the desired direction and tuning it to receive the waves at the desired distance, I can receive on my mirror here the image of any object I desire to see, even though it may be miles away and even though houses and other obstacles intervene. In order to help me in focusing the instrument for the desired point, I use special *finders* similar to those used on large telescopes. They aid in finding the object desired because they cover a larger area of vision."

"But," objected Silas, perplexed, "it seems to me you took a lot of trouble just for the sake of saving the cost of an operator at the other end of the line."

Doctor Hackensaw looked at the reporter with scorn. "Why, man alive!" said he, "don't you realize what a marvelous achievement my invention really is—what almost supernatural power it gives me! It is not the saving of an operator's salary that is important; it is the power I have obtained of seeing anything I wish within a radius of one hundred miles or more, even if the object is inside of a house or even under the ground, for my 'Telopticon,' as I call my television apparatus, will show me things several thou-

sand feet below the surface of the earth."

"How can it do that, when there is no light under the earth?" asked Silas, more and more perplexed.

"True," said the doctor, "there are no light waves but there are electrical waves, and these suffice. You know that photographs can be taken with X-rays, without light. It is less commonly known that photographs may also be taken by heat-rays in the dark. Even ordinary photographs depend more upon the invisible actinic rays than on the light rays. Every substance existing is traversed by electric waves, and it is these waves that I amplify and catch with my apparatus, even though the object itself be in absolute darkness."

"Then," said Silas, "you mean to say that not only you can from your laboratory here look into the rooms of all the people in the city, see who is present, what they are doing, and . . ."

"Pshaw!" interrupted the doctor, "I could do that if it were worth while. But I did not spend years in perfecting this apparatus merely to satisfy an idle curiosity by prying into my neighbors' affairs. I have confined my researches to practical purposes."

"And of what practical use is your invention?"

"To begin with—there is the location of mines."

"Gold-mines?"

"Humph! When you speak to the average man of a profitable mine, he always thinks of a gold-mine, when, as a rule, the gold-mine is not the real gold-producer. However, I have located all kinds of mines with my apparatus—gold, silver, copper, tin, lead, etc., to say nothing of coal-mines, but I have given special attention to locating petroleum deposits, for oil-wells are in great demand nowadays with the increasing consumption of gasoline in automobiles, aeroplanes, etc. But I see I weary you. Sit down in front of the screen here—I mean the mirror, and I will take you for a stroll through New York City. It will be the old fairy tale of 'The Beauty and the Beast' come true. You remember the Beauty could look into the magic mirror and see all that was taking place at home."

"Yes," assented Silas, "and the Hindoo fakirs can spread ink in a boy's hand and see reflected there not only what is taking place elsewhere, but also what took place in the past and what will take place in the future."

Doctor Hackensaw laughed. "I haven't got so far as that, yet," said he, "but I think I can show you a few views of New York that will interest you. First of all I shall show you Broadway near Fulton Street. See, I adjust my instrument and there you are. Forty years ago, in the crowds that pass this point you would have seen only men. You might have stood on this busy corner all day without seeing a single woman pass. But the invention of the typewriter has changed all that. Now, as you see, there are nearly as many girls—and pretty girls, too, let me add—as there are men. Next I switch my apparatus to the Brooklyn Bridge. You can see the cars and the automobiles passing. Next, here is the Statue of Liberty in the bay. Now we shall take a peep into Bronx Park and look at the wild animals. Then into the Metropolitan Museum of Art and see some of the pictures. That is Rosa Bonheur's 'Horse Fair,' and here is the little 'Psyche'—then I switch down to the Battery and show you the fish in the Aquarium. Now we switch to Park Place, nearer to the Hudson River, and there—why yes, there is Mr. H. Gernsback, himself, in his private office, busy editing SCIENCE AND INVENTION. And here are his able assistants—you can see them one after the other as I turn the machine.

"Now we shall try the theatres. There is the matinée crowd at the Metropolitan Opera House. And here is the stage. You see they are playing 'Faust.' But I could go on all day. Let me instead show you one of my

Optographic records. Here is one that I am sure will interest you."

Taking a spool of wire from a cabinet, the doctor placed the spool in his instrument, and as the wire unwound from the spool, the variations in magnetism imprisoned in the steel thread reproduced the original light vibrations that had caused them, and there appeared in the mirror a moving picture in natural colors.

"Good gracious!" cried Silas Rockett, gazing at the mirror in wonder. "Why, that's my own dining-room. And there I am, myself, coming in at the door. Now I sit down at the table and take up the newspaper while awaiting breakfast. When did you take this picture, doctor?"

"I took it this morning, my boy, for your special benefit."

"Now I've finished breakfast," continued Silas. "Here I am in the street. I'm stopping at a flower-stand and buying a bunch of roses." Silas stopped and blushed furiously—"That's not fair, doctor!" said he. "You have no business following me around in my private life with an instrument that will look through walls into a man's room and see all his most secret actions. If people knew that you possessed this power, you would be mobbed."

"Don't get angry, Silas," said Doctor Hackensaw with a laugh. "When I saw you buy the roses, I switched off the instrument. I knew you were going to give them to your invisible mermaid, Gloria Mundy, and I thought you would rather not have me see the meeting between you and the young lady."

"Could I have a look at Gloria, now?" asked Silas Rockett, eagerly.

Doctor Hackensaw laughed. "Perhaps," said he, "but I must take a peep first and make sure that the young lady wouldn't object to your looking in on her. Oh, it's all right, she is only washing her hair, so I don't think she would much mind your having a look. But I must be careful not to allow my instruments to fall into improper hands. A criminal could use them not only for blackmailing purposes, but to ascertain the disposition of the rooms of a house, the whereabouts of the owners and the exact location of valuables in bureau-drawers, safes, etc. The best hiding places would be of no avail against him. But look, Silas, there goes my alarm bell. Watch now, and you will see how my instrument can be used to prevent crimes. I have had my eye on a jealous young fellow for some time, as I fear he is meditating mischief. A selenium cell attached to the apparatus serves as an alarm to warn me when the door of his room opens. See, there he is, coming out! And look at that loaded revolver he has put into his pocket! Quick, I must find a telephone!"

Doctor Hackensaw switched around the finder of his apparatus until he located a drug-store in the street the young man had entered, and a few words to the druggist explained the situation. The porter of the drug-store, with a volunteer to assist him, followed the jealous man to his lady-love's door, just in time to see him enter and to hear a woman's shrieks. The men arrived barely in time to prevent a tragedy, but one of them tripped up the fellow and the bullet from the weapon crashed through the window-pane.

To disarm the young man was the work of an instant, and he was securely tied up until the police could be summoned.

"You see, Silas," said the doctor, "it is just the old story of two men and a girl. But what do you think of my instrument? Do you begin to realize its immense practical value as a crime-preventer?"

Silas Rockett shook his head. "It's a wonderful instrument, doctor," said he, "I'll grant you that. And it may prove very useful. But remember, when I am married to Gloria Mundy, I'll never forgive you if you allow her to look into that instrument to see what I'm doing!"

Unusual Methods of Obtaining Motion

By E. R. CALEY

(*Continued from page* 545)

is produced. A device operating on the same principle is shown in Fig. 9. An exhausted glass vessel containing a small amount of water is shaded on its upper portion and has an indented top which may contain ice or some other cooling medium. When the apparatus is placed in the sun the water evaporating from the lower portion condenses upon the slanting upper surface, where it runs down and operates a small and delicately balanced water wheel.

II. *Devices Operated by Electrical Energy.*

Static electricity may be employed as a source or means of motion. The simplest means of illustrating this is by means of the electric whirl or flyer (Fig. 10). This is simply a set of five or six wires with ends bent in the same direction and fixed to revolve upon a fine point. When the device is connected with the conductor of a static machine it rapidly revolves, due to the repulsion of the fine ends of the wires and the air particles which receive the same charge as the wires from the wires themselves. A reciprocating machine operating upon the same principle as the so-called electric chimes has been constructed. The principle upon which the chimes (Fig. 11) operate is as follows: The two outside bells, A and B, are connected electrically to the conductor bar, while the middle one, C, is insulated from it and grounded. Two copper balls hung by silk cords are shown between the bells. When in operation A and B attract the balls which are immediately repelled upon contact due to the change of charge. They then are both attracted by the middle bell, C, which has become negatively charged by induction. They touch this middle bell and are again repelled and the process continues.

The problem of obtaining electricity from heat by direct means is commercially still an unsolved problem, although many attempts have been made in this direction. Thermo-electric batteries have been made in a great variety of shapes and forms, but so far all have been woefully inefficient in operation. One simple form of thermo-electric battery is the antimony-bismuth couple consisting of alternately joined pieces of antimony and bismuth. When the alternate ends are joined a small current is produced. A thermo-electric battery that has actually been constructed and marketed for operating small laboratory apparatus is that of Becquerel. This consists of alternate elements of artificial copper sulphide and German silver. About eight or nine of these couples are equivalent to an ordinary gravity cell. The obtaining of motion from primary batteries is also an interesting problem. Primary batteries in all their various forms make an interesting study in themselves and too well known, perhaps, to warrant any treatment of them here. Carbon-consuming batteries have been constructed and used to produce motion, although this matter is still in the experimental stage and does not seem liable to come into commercial importance for a long time.

III. *Devices based upon potential or stored energy.*

The common and well-known water wheel and turbine converts potential energy into a usable form. The familiar spring or weight motor which has so many interesting and useful applications, particularly to clocks and watches, is also a converter of potential energy. An unusual form of the weight motor is the common child's toy, the sand turbine, in which sand falling from a hopper rotates a small turbine wheel. The compressed-air motor is another means of using

energy, coming under this classification. Compressed-air locomotives find extensive employment about mines where inflammable gases do not permit the use of steam locomotives. In the early days of automobiling many experimental cars and trucks were constructed and operated by compressed air. These, however, all suffered from the same defect, namely, that only a limited mileage was obtainable from one charge of compressed air. Liquid-air motors have also been tried with practically no success in automobile operation.

IV. *Devices Based upon Chemical Energy.* The ordinary gas or oil engine is the common example of motion obtained from chemical energy. Other types of explosion motors are easily conceived. Those could be made to utilize the force of some solid compound like gunpowder by exploding the powder in a strong vessel and using the enormous pressure of the confined gases to operate a turbine or reciprocating engine.

Another type of an unusual motor employing chemical energy is one using gases freed from solids or liquids by chemical means. If hydrochloric acid is allowed to act upon calcium carbonate or ordinary washing soda, a large amount of carbon dioxide gas is liberated which may be employed to operate a turbine. The writer has made several of these carbon dioxide motors in the form of small models and all have been very successful in operation. Primary batteries mentioned previously are, fundamentally, based upon chemical energy in many diverse and interesting forms.

V. *Miscellaneous Unusual Sources of Motion.*

(a) The so-called radioscope invented by Sir William Crookes and seen in opticians' windows depends for its operation upon the action of heat waves. Briefly, this apparatus consists of a small turbine revolving in a nearly exhausted glass globe. The vanes, usually four in number, are finished brightly on one side and have a dead black surface on the other. The revolution of the device is caused by heat waves being absorbed on one side and reflected upon the other.

(b) A machine depending upon the impact of sound waves was invented a number of years ago by Thomas A. Edison. This device receives air vibrations upon a thin brass plate causing it to vibrate. The vibrations of the plate are then applied in operating a ratchet arrangement of great delicacy which turns a small wheel. Such a machine, of course, must be very delicately constructed in order to operate at all.

(c) The fact that the barometric pressure varies from day to day has been applied in operating clocks. In the early part of the last century several ingenious clocks were constructed which depended for their operation upon the variations in height of a column of mercury. This motion was then transmitted to the usual clockwork by a complex system of levers.

(d) Everyone has seen the familiar hygrometers or weather predictors in which colored figures come out or go in, according to whether or not the air is moist or dry. This motion is usually caused by the twisting of a piece of catgut. Although I have never heard of it being done, it is very evident that a very delicate machine could be made that would operate upon this principle.

(e) Sir William Strutt's radium clock is an interesting instrument whose action depends primarily upon the action of radium. It consists of a glass vessel containing a tube of radium salts in the center from which are hung two gold leaves. The inner surface of the containing vessel is coated with tinfoil. This foil is grounded. The radium salts cause the leaves to become charged electrically. They then diverge and coming in contact with the grounded tinfoil coating, they are discharged only to fall back again and repeat the process. This clock will operate as long as the supply of radioactive material will act. In the case of pure radium this period would be nearly 2,000 years.

Laboratory to Determine Atomic Weights

Translated by DR. T. O'CONOR SLOANE

(*Continued from page* 549)

tion with the periodic system, has led to the prediction of K. Fajans of Munich, that for the perfect explanation of all chemical characteristics, there must be differences in atomic weights; that for example, there must be several kinds of lead. When the accuracy of this conception had been experimentally proved, reformation of the famous hypothesis of Prout was in order. The elements, whose atomic weights were not integral as Prout's hypothesis required, were simply mixtures of atoms of integral atomic weight. This theory was so confirmed by the investigations of the English physicist, Aston, that today it is considered definitely established, that in Prout's theory there is a germ of truth, so that all matter is made up of the same original matter—hydrogen, which as we know, consists of positive and negative electric charges. This will suffice to disclose to the laity the importance of the modern investigators of atomic weight. They seek and sometimes lose the foundation stones of the chemistry of today.

Among those who have made the investigation of atomic weights their life's work, Richards in Cambridge and Hoenigschmidd in Munich occupy the first place. Especially is the latter engaged in the most exact determination of atomic weights, so as to bring an interpretative decision of the newest theoretical investigations into unity with them. Thus Hoenigschmidd has confirmed by experimental analysis the astonishing prediction of Fasans that there must be more than one atomic weight of lead. He found that lead, which came from primeval minerals, in spite of perfect chemical identity with ordinary lead, differed in atomic weight. Hoenigschmidd's work in the determination of the atomic weights of the wonderful element radium with uranium and uranium lead, established accurate boundaries between which the greater number of the radio-active elements are confined. Those elements which are decaying, on investigation have opened to us the most wonderful knowledge of the formation of the atom and of the inter-relation of the elements, and already the German laboratory for the determination of atomic weights sees prepared for itself new and endlessly important work. If it wishes to go into competition with the allied and associated scientific world, its spirit and fame, it must take up the wonderful problems with all its power, which today stand in the focus of scientific interest: How far do the integral numbers of atomic weights stand in relation to the exacting proof applied in all the modern methods of the highest art of experimenting, and in what degree from this very simplicity can the formation of elements of the same nature, and of the same weight, be determined.

Poisonous Snakes, Snake Poisons and Their Antidotes

By DR. ERNEST BADE

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results that have been attained upon experimented animals have been highly satisfactory. In action the serum neutralizes the snake poison, but nearly each poisonous snake species requires a different type of serum, since the activity of the poison is usually highly specific in character.

The destruction of the poison with chemicals is only possible under certain conditions. It must not have spread to the heart, and it must still be in the immediate vicinity of

the wound. Otherwise it is only possible to employ serums with success.

But it is absolutely essential that one knows the different types of snakes, those that are harmless and those that are poisonous, as well as to be able to differentiate the poisonous species. This becomes self-evident when it is considered that it is useless to employ a serum when a harmless snake has drawn blood. But in order to take the responsibility of not employing a serum, a definite knowledge of the kind of a snake producing the wound is absolutely imperative. On the other hand, certain snake poisons require very definite serums, which can only be used successfully when the snake producing the wound can be definitely identified. Therefore it is a necessity to become acquainted with the various species of snakes inhabiting the vicinity of one's home. This not only applies to the doctor or physician, but to each individual who may be placed in such a position where it becomes a necessity for him to give first aid.

The serum is obtained indirectly from the poisonous snake. Captive species are taken, their poison extracted from the glands, and collected in flat glass vessels. The snake, carefully held by one operator, is permitted to bite the dish. At this point the poison exudes through the two fangs which may either be deeply grooved or hollowed to conduct the fluid. The forked tongue never stings, it is too soft. After striking the glass a few times the toxic fluid of the glands is exhausted and some time must elapse before it is renewed.

The freshly exuded poison, which may be colorless, milky or yellowish, according to the species, is slowly dried until tiny crystals are formed. The dried poison is then dissolved in a solution of ordinary table salt and the fluid injected, in minute quantities, under the skin of mule or horse. Every third or fifth day the dose is slightly increased until, in the course of a year, the animal can withstand many hundred times the, otherwise fatal, poison. During this period the body of the horse produces a neutralizing poison in the blood, and, under rigorous antiseptic conditions, 5 to 6 liters of it are finally taken, and coagulated to obtain the serum.

America's Fast Mine Layers

By GRASER SCHORNSTHEIMER

(*Continued from page* 534)

If the enemy advances farther it will be headed off by the mine field. If he attempts to rush straight through, at least two of his ships will be lost. Should he turn to the side, it is more than likely that some of his ships will foul the end mines. Either the enemy will have to stop and become prey to the torpedoes from submarines or fall back and cut a wide circle around the mine field.

But in all probability the enemy would foul the mines before their presence is realized. The mine layers will have worked under cover of a destroyer smoke screen which has hidden their presence as well as their work from the enemy's light forces.

This new arm of the service is a most valuable and dangerous one. With the capital ship forces of the country limited by an international agreement we cannot afford to overlook any efficient means of defense.

LIGNITE COAL FOUND TO MAKE GOOD BRIQUETTES

The experiments in briquetting the lignite coal of Saskatchewan have proved thoroughly successful up to the point of carbonizing the fuel, according to a statement made in the House of Commons by Hon. Charles Stewart, Minister of the Interior. F. R. Goold, M.P., stated that there was sufficient coal in that area to supply all the industries of southern Saskatchewan.

Answers to Puzzles on Page 555

PROBLEM OF THE HOIST

Since the boy pulls upward against his own weight, it is evident that the total weight that his effort must balance is his weight (W) increased by the force (F) with which he pulls. And since there are two ropes that support the weight it is evident that this total weight (F + W) is twice the applied force (F); from which it appears that the force with which he must pull is just equal to his own weight.

PERPETUAL MOTION VS. CAPILLARY ACTION

Water rises in glass tubes of small bore because of two conjoining circumstances: surface tension and the adhesion of water to glass. The cohesion of the water particles, or the tendency of the particles to cling together, tends to form a thin, but highly elastic, surface film which adheres at its edge to the interior surface of the tube. Because of this adherence of the water particles to the glass, the edge of the membrane tends to creep up the tube bearing with it a tiny column of particles that cling to it and to each other from below. As the surface film creeps higher and higher it is stretched more and more by the weight of the column until at last an equilibrium is reached when the weight of the water column just equals the tension of the film supporting it.

No arrangement such as Nate proposes will let the water return continuously back to the dish because the very same forces that cause the rise of the water in the main tube will prevent its return by any other. In other words, a second surface film will be formed in or at the end of the return tube. The tension of this film will prevent any escape of water back of the dish.

Water will not drip indefinitely from a wick hanging into a dish of water as previously described, for the same reason as that given above in No. 8. Water rises in wicks by capillary action; that is, by the rising of fine surface films adhering to and surrounding the interlacing threads. Behind them, these advancing films conduct tiny columns of water the particles of which stick or adhere with great tenacity to each other and to the threads of the wick. When the end of the wick is reached, and when the wick is saturated with water, the action ceases. Surface films which surround the exposed portions of the wick prevent any escape of the water except through evaporation.

THE PROBLEM OF THE FIVE DRAWSCALES

The drawscales will read "ten pounds." The second ten-pound weight adds no extra force to the scales. It may be thought of as holding the scales and the other weight in place. All scales should, of course, read the same, for they all bear the same stress, and each one must bear the total stress just as each link in a chain must sustain the same force.

MAGNETIC ATTRACTION

The boat supporting the magnet will have no tendency to move either north or south, for the simple reason that, if one pole of the magnet is attracted by an adjacent pole of the earth, the opposite pole of the magnet will be repelled by an equal force. But of course if the boat is not already turned in the direction of the lines of force, the earth's magnetism will soon turn it in that direction just as it does with a magnetic compass.

BALL DROPPING IN A LIQUID

If the ball were dropping through a vacuum instead of through water, it is apparent that while en route to the bottom of the jar the ball would cease to bear upon the scale in any way. The reading, consequently, would decrease by an amount equal to the weight of the ball. But if, on the contrary, it dropped through some restraining medium such as air or water, the frictional resistance of the medium would be transmitted to the scale and the reduction in reading would be

less than the weight of the ball by an amount proportional to the weight of the ball and to the acceleration with which it descended.

Newton's second law of motion states that the acceleration of a given body is proportional to the force causing it. We know, too, that the weight of the ball, if unhampered, would give it an acceleration of 32.2 feet per sec. (the acceleration due to gravitation). But since in our case a retarding force acted so as to reduce this acceleration one-fourth, it is evident that the effective weight of the ball would be reduced by one-fourth of its normal value. Consequently the scale would register a loss of a quarter of a pound while the ball fell.

A Cuprous Oxide Photo-Electric Cell

By RAYMOND B. WAILES

(*Continued from page* 560)

cated in the housing so that each copper strip is facing a hole in the side of the housing, as shown. The housing should be given a coat of dead (flat) black paint.

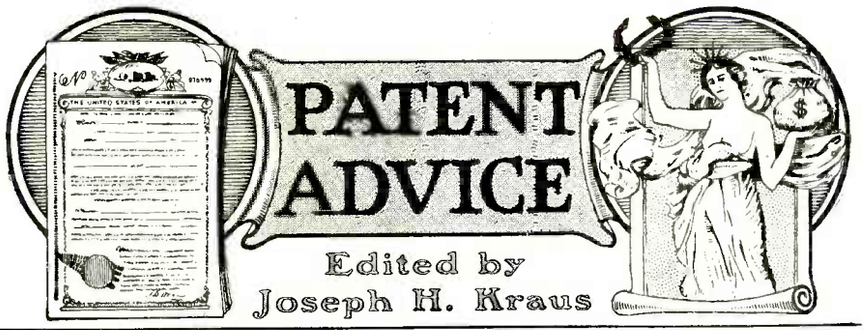
If the housing be illuminated by two high wattage lamps situated about a metre from the cell, and the rotors be driven, a loud note can be heard in a pair of telephone receivers which are connected to the terminals of the photo-electric cell. No battery is required.

In operation, one side or plate or electrode of the cell is exposed to the light and the other kept in shadow or dark. On exposure, or insulation, the exposed plate is then placed in the dark (by turning the cell) and the plate previously placed in the dark is now exposed. A black cover, cut half away on one side throughout its length, will permit one plate to be darkened while the other is exposed, without the use of a housing as shown.

The larger the plate surface, the greater will be the output.

Using the rotating sectors in the alternating current photo-electric cell, a 120 cycle note can be easily reached. A steady current has been obtained which persisted, with continuous operation, for six weeks.

If the cell will not work, make up a new solution, and either decrease or increase the amount of formic acid added.



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.

ADVERTISING DEVICE

(640) C. E. Payne, Redding, Calif., requests our opinion on an advertising device having movable letters which are changed magnetically; and on a cane telescope in which a lens is slidably mounted in the handle of said cane.

A. The suggestion for an advertising device which you have forwarded has considerable merit, but we doubt whether a patent can be secured upon the same. We would, nevertheless, advise that you have a search made upon this idea. A long focus lens held at arm's length will not magnify distant objects. It produces a reduced size focal image of these objects.

AUTOMATIC DIMMER, VACUUM TUBE, MICROPHONE

(641) Kenneth Gold, Holyoke, Mass., submits several ideas, the nature of which are made clear in the answer.

A. We do not think very much of any of the ideas which you have forwarded. The device for automatically dimming automobile headlights is decidedly undesirable. Supposing that the operator's headlights are burning brightly and an automobile with dimmed headlights approaches, it is evident that the selenium cell will not act until the headlights of the other automobile are well upon it. If, on the other hand, the rider is passing through very rocky country, where it would be necessary that the headlights be fully illuminated, and another machine approaches with brilliant headlights, immediately the headlights on the machine equipped with the automatic dimmer, will be turned low. Throughout various parts of the country different flashes of light will cause a dimming of the device. Lightning will likewise do this. The relay of such a device would have to be extremely sensitive and the vibration of the auto would probably close the contacts when least desired.

Placing a magnetic plate around the anode of the vacuum tube does not affect the working of the vacuum tube to any great extent; your design does not depart from the original three-element valve; consequently it is not patentable.

Making a microphonic attachment to be inserted in place of a needle in the reproducer of a phonograph means that you automatically lengthen the needle and create a different angle of the same with reference to the phonograph disc and the reproducer and, therefore, do not get the proper vibrations of the needle. The attachment is practically worthless because the entire microphone is free to vibrate in its holder, a very undesirable feature. Its length does not permit clear reproduction of maximum intensity. We do not suggest a patent upon any one of these ideas.

PERPETUAL MOTION

(642) Joseph Akelaitis, Baltimore, Md., writes that he has produced two perpetual motion machines which work, saying that the majority of machines are not practical.

A. You will pardon us if we say that we doubt the claims which you have made in your recent communication. Our doubt is based on the experience and theories of past and present generations, and we would say that not only such machines are impossible, but all which have as yet been called to our attention, are absolutely impossible, both theoretically and practically.

Ever since the law demanding that a working model be submitted when a patent for a perpetual motion device is applied for, went into effect, no patent on a perpetual motion machine has been obtained. This proves our contention without even permitting the shadow of a doubt.

RAILROAD CROSSING GATES

(643) Ivan Shiller, Del Rio, Tex., enters several photographs of drawings and a description of a railroad crossing gate which gate should drop when a vehicle closes the circuit on a side road, said circuit being in series with another closed by an approaching train. Papers submitted to us are sworn to and witnessed to establish priority.

A. There are many points about this crossing signal which would make it entirely impracticable. In the first place, if an automobile had already passed the contact-making feature in the road and the train were approaching but had not yet reached the circuit-closer itself, it is evident that the automobile would be able to proceed across the railroad track without any interference. This is as it should be, but if, instead of an automobile, an ordinary horse and wagon were approaching the gates and had already passed the road signal, this horse and wagon would meet the train right on the track, due to the differences in speed.

If the road signal is placed too far away from the track it becomes inapplicable because automobiles may happen to be stalled along the road. If, on the other hand, an automobile were approaching from one side, just in time to close the circuit, and another machine had already proceeded halfway across the tracks in the opposite direction, the descending gate would cause the second machine to stop upon the track.

Your feature is very expensive, indeed. It is elaborate. It necessitates differences in road design as well as signal equipment. Such changes in road construction are not advisable because they make it necessary for train crews to operate on roads far beyond the railroad right-of-way. Your gate, therefore, presents the same difficulties which other gates meet with—namely, there is no provision made for permitting pedestrians and road traffic to escape from between the tracks and yet not to permit future traffic to cross.

It is advisable in gates of this nature to make an apparatus which will be simple, which will not contain as many parts as yours does, and which will operate with every degree of safety for stalled traffic or slowly moving pedestrians, which will effectively block further traffic and which is not located anywhere but on the railroad right-of-way, acting regardless of whether the ground is covered with sleet, snow or rain or whether the temperature is 10 degrees below zero or 100 degrees above. We do not suggest applying for a patent upon your system and doubt that it would find even slight favor.

Your method of establishing priority is very good indeed, and this letter to you will further establish your claim. However, in view of the inefficiency of this device, we doubt that such priority is at all necessary.

CRYSTAL DETECTOR

(644) William Borinski, Brooklyn, N. Y., submits a sketch of a crystal detector for radio receiving sets, having a plurality of adjustable contacts touching the crystal.

A. There is nothing new in your crystal detector. A multiple contact point is not as good as a single contact. We do not believe a patent for it would be granted.

CAN OPENER

(645) R. Henkel, Fort Wayne, Ind., submits a sketch of a can opener having a cutter and a pair of guide rollers to grip the rim of a can. He requests our opinion on the device.

A. Your idea of a can opener seems novel and quite clever. Many cans, however, are not supplied with a rim large enough to hold the friction wheel, and these cans differ with regard to their sizes. You have made absolutely no provision for these size variations and styles in your device. Consequently, although the system is suited for a certain type of can, it could not be successfully operated on other forms or styles of such cans. No doubt twisting the tool will enable it to fit smaller cans, but in doing so the cutter is not presented at its most efficient angle. We, therefore, would not suggest a patent upon this system.

MINERAL LOCATER

(646) Arch S. Dixon, Natchez, Miss., asks if any patents on a mineral locater have been taken out by a Mr. Chayko, a Ukrainian engineer.

A. There have been no patents taken out in the Patent Office at Washington, D. C., for a mineral locater by anyone known as Chayko. We are giving herewith a list of patents on mineral locating devices for your benefit. A recent patent application for such a machine has been made which, if it works, will excel any other device heretofore placed upon the market. Unfortunately, the inventor is a poor man and cannot obtain enough money to build the experimental model.

367,422 Mellet, August 2, 1887; 961,298 Jewell, June 14, 1910; 817,749 Brown, April 17, 1906; 841,188 Schmid, Jan. 15, 1907; 737,866 Pike, Sept. 1, 1903; 1,163,468 Schlumberger, Dec. 7, 1915; 736,411 Leonard, Aug. 18, 1903; 672,309 Brown, April 16, 1902; 274,882 Brown, Mar. 29, 1883; 645,910 Brown, Mar. 20, 1900; 589,849 Brown, Dec. 31, 1901; 686,632 McClatchey, Nov. 12, 1901; 714,775 Brown, Dec. 2, 1902; 681,654 McClathey, Aug. 27, 1901; 412,924 Kester, Oct. 15, 1889; 380,842 Williamson-Hickins, April 10, 1888; 367,541 Mellet-Prince, Aug. 2, 1887; 293,518 Prince, Feb. 12, 1884; 817,736 Draft-Williams, April 10, 1906; 727,077 Brown, May 5, 1903; 308,908 Lighthill, Dec. 9, 1884; 1,163,469 Schlumberger, Dec. 7, 1915; 1,092,065 Lowy, Mar. 31, 1914; 1,240,328 Fessenden, Sept. 18, 1917; 1,325,554 Carlson-Hanson, Dec. 23, 1919; 1,045,575 Lowy, Nov. 26, 1912; 1,248,380 Nelson, Nov. 27, 1917; 1,241,197 Conklin, Sept. 25, 1917.

AIR PRESSURE DEVICE

(647) John G. Raynes, St. John, N. B., Canada, enters a very elaborate design of an aspirator, using water under pressure to develop air pressure. He wants our advice.

A. Suppose that we admit that everything you say is true, then as the old adage goes, "Now that you have it, what are you going to do with it?" No doubt you are delivering a small quantity of air at the delivery point, the pressure of which air is about twenty pounds per square inch, if that high. This air can be used for no practical purpose except, perhaps, supplying a slight air force for a torch or other form of blow pipe for small brazing and soldering. The device is no more efficient than existing devices.

STEEL RAILROAD TIE

(648) Karl E. Mann, Mt. Bethel, Pa., asks whether a steel railroad tie is patentable.

A. We do not know whether or not your steel tie is patentable, inasmuch as you have not submitted any drawings or description of the same. We would suggest that you have a reliable patent attorney make a search for you.

We doubt if the idea is of any value for the simple reason that many steel ties have been designed and up to the present time few, if any, are employed in this country. The railroad companies find it far easier to use wooden ties which are acknowledged to be nearly as safe as the steel ties. These latter may be replaced readily, they last for a great many years and do not rust or corrode. The concrete tie, also patented, is seemingly superior even to the steel tie.

STATIC ELIMINATION

(649) Harold V. Miller, Paonia, Colo., suggests that a cage be placed around the antennae and grounded to eliminate static, the idea being obtained when he read an article in SCIENCE AND INVENTION which stated that radio messages could be received in a tunnel.

A. Your theory regarding radio reception and method to eliminate static is not practical for the simple reason that a complete wire or metallic cage not only effectively screens the static but also the receiver of the radio waves. Consequently, although the waves penetrate the tunnel, this tunnel presents no real grounding effect (see Rogers Underground System, March, 1919, and June, 1919, issues of this journal). If the tunnel is of metal and closed at both ends, or a train carrying an outfit is passing through a railroad truss completely enclosed, radio waves have no effect on the antenna. The cage, therefore, would eliminate nearly all of the static and the signals as well.

VARIO-COUPLER

(650) C. E. Cardwell, Jackson, Tenn., desires our opinion of a vario-coupler with a tapped secondary.

A. A tapped secondary for a vario-coupler is nothing new and it has been tried experimentally numberless times. There is very little gained, inasmuch as shunting a variable condenser across the secondary serves the same purpose and produces a much better effect. The wave length is changed by varying either the capacity or the inductance, or both.

New Talking "Movie" Process

By EDWIN HAYNES

(*Continued from page 550*)

long series of experiments with mechanical devices such as shutters and mirrors, he found that they were not available on account of their inertia. In every instance this resistance caused a time-lag. Light is too rapid in its motion to be varied in its intensity by any device actuated mechanically. The difficulty was finally overcome by the application of a basic principle unlike any heretofore employed for this purpose, and by which light is varied without involving any moving part and is not affected by extraneous vibrations from any source.

The first attempt to solve the difficult problem of recording sounds photographically was made by Ernest Ruhmer about twenty years ago. He used an arc light and a fixed lens. His device was called a photographone.

Other experimenters endeavored to improve on this method by employing V-shaped mirrors, incandescent lamps and other vibratory agencies for varying the intensity of light.

They all had to contend with the sluggish action of moving parts. It is in the essential particular that it has not a single moving part that the photomagnetograph differs from all previous devices. In consequence of this there is no time-lag, it cannot get out of order, is fool-proof, as the saying is, and cannot wear out.

The photomagnetograph is in the shape of a tubular cylinder containing a chemical solution, and another element around which is wound a magnetic coil of many turns. When the sound waves, in terms of electric pulsations, are conveyed to this instrument they are transformed into light vibrations of varying intensities, which in their turn correspond to the original sound values. These variations are photographed in varying shaded parallel lines, or striations, at right angles to the direction of the moving film. The photomagnetograph is so compact that it can be readily attached to any standard motion-picture camera.

THE PHOTOTRON

In the reproduction of the vocal or instrumental sounds of a photo-drama, as recorded on the film margin, the phototron is employed. It is attached to a standard projector and requires no additional attention on the part of the operator. This instrument involves the principle of the photo-electric cell, a device well known to physicists and electrical engineers. A properly constructed photo-electric cell will convert light values into electric values and was suggested by the fact, long ago observed, that surfaces when charged with negative electricity lose that charge when exposed to light. The photophone has several electrodes, and is served by an electric battery. It is so sensitive that it will respond to light emitted by a candle seven miles removed and even to light emanating from distant stars.

At the instant the film begins to unwind in the projector light from a strong source passing through the photographed sound-record is given variations in intensity corresponding to those produced by the recording instrument (photomagnetograph) when the record was made. These varying light vibrations upon their emergence from the film register impinge upon the phototron, which reconverts them into electric impulses of equivalent intensities, and at the same time amplifying their relative values. This conversion is accomplished by the electric discharges setting up electric pulsations,

which are transmitted for further amplification to the multiphone.

Inventors have endeavored to accomplish this transformation by the use of an element known as selenium. Although this element has the peculiar property of being a conductor of electricity in proportion to its exposure to light, and of being a non-conductor of electricity in the dark, it is inefficient.

Variations in its action in accordance with changes in the intensity of light given access to it cause an electric current to vary, but it is not dependable. It is sluggish, gets tired, slows up.

THE MULTIPHONE

In the intoning feature of the system, an important advance has been made over existing methods in the reproduction of sounds and of their amplification.

Numerous attempts have been made to devise an electrically controlled instrument to magnify the tones of the human voice and of musical instruments, but with one exception very little improvement has been made upon the principle of the well known Bell telephone receiver. The departure made in this phase of the photophone system consists in the application of the sympathetic note effect, as is done in the octaphone. Seven conical diaphragms are used ranging in diameter from three to eight times that of the usual phonograph diaphragm, from which the sounds are directly intoned. The usual horn with its objectionable throaty effect is dispensed with, for although some reduction in amplification results from its elimination, the vastly improved quality of the reproduction more than compensates for its omission. The diameters of the seven reproducing diaphragms are so graded that the series respond to the seven octaves of the piano, each diaphragm to an octave. By a process of selection, the series of diaphragms so respond that all of the music being intoned is rendered in all of its richness of tone and detail of color. Such is the flexibility of the device that the multiplicity of the sound combinations emanating from a large orchestra, or the subtle phrasing of a single singer or musician, are accurately reproduced.

In the production of screen drama, the prattle of a child, the whispered nothings of lovers, the striking of a match, subdued laughter are all rendered with strict fidelity to nature.

Scientists and expert electrical engineers have expressed approval of the Photophone, including Samuel O. Hoffman, a scientist and electrical expert, who was in the Science and Research Division of the United States Army during the great war, and who invented a wonderful instrument for detecting the approach of the enemy in the dark, called "night seeing"; Frederick F. Brush, an electrical engineer, well known in this country and abroad, and others.

A fact in evidence that important basic principles are collectively employed in the photophone is that two of the features of the system can be applied to other uses. The photomagnetograph can be embodied in an instrument for recording cable and wireless messages or other signals, with marked advantages over present methods sluggish in their action. It can also be made to serve as an electrometer for measuring the magnetic lines of force of any magnetized body, such as magnetos, at present an inaccurate process. The phototron can be employed in an instrument to which the inventor has given the name Photopyrometer, to determine the highest temperatures known to science. Such determinations cannot now be made, in consequence of which frequent losses are sustained in important industries.

Apart from its use in the motion picture art, the new instrument can be made to serve as a super-phonograph in hotels, restaurants and cafes of the better class, club rooms and auditoriums, for the production of selections from operas, oratorios, symphonies, and all forms of concert music.

Preventing Dust Explosions

(*Continued from page 551*)

the second combustion not only tears the walls of the grain elevator away from their reinforcements, but generally wrecks the entire plant, killing all within the danger area. More than a mile from this plant buildings were shaken. The explosion was felt in Benton Harbor, fifty miles away, where windows were rattled by the blast, and individuals more than one hundred miles away reported hearing the detonation.

How then are we going to prevent future explosions of this nature? How are we going to save the money losses, to say nothing of the loss of lives resulting from such calamities? It is evident that we cannot prevent dust in such grain elevators or plants. Therefore, our next recourse is to remove it as quickly as it is formed. There are places where it is formed, and where it cannot be eliminated, even though we use exhaust fans in and around buffing wheels, grinding wheels, etc. It is deposited on rafters and walls where one cannot remove it without sweeping it away. If, however, an attempt were made to sweep during the daytime, while all the machinery was in operation, it would subject those employed there to still greater hazard than the one under which they were working. Naturally our own common sense would tell us that our best recourse is to remove whatever dust is deposited as quickly as it comes to rest, and one engineering concern tackled the problem in that way.

This dust-collecting system which we illustrate is for removing dust from walls, ceilings and floors. There are more than four hundred inlet valves in the elevator shown, and there are about 11,000 feet (over two miles) of piping 2 inches to 6 inches in diameter, run throughout the building. Suction producers in the form of a series of reverse blowers, acting in this manner as exhaust fans, are connected to these pipes. There are four of these pneumatic units and each will have three collectors placed in its individual circuit. The first of these collectors separates the grain from the dust. A second will remove 90 per cent to 95 per cent of the dust; a third will remove the remainder, leaving the air clean to pass through the reverse blowers. An undertaking of such immense proportions has never been attempted heretofore, and the amount of dust (three carloads per day) picked up from a plant of this nature would be sufficient to clog any type of machinery. Consequently the dust collectors have to be interposed in the piping system. Flexible non-resisting metallic hoses enable the operators to pick up dust and grain from the walls and floors at any point 50 feet from the inlet of the piping system. As shown in the illustration, the operator merely walks through the building with his large sweeping nozzle and picks up every particle of material from the floors, making the floor resemble a newly washed section. Nevertheless, the operation must be continued throughout the day, as in half an hour the floor is again so thickly coated that one could never see where the floor commenced. It is obvious that if such speedy removal of combustible material is maintained should the dust in the room be ignited a slight puff might occur, yet a disastrous explosion could not take place, as the air would at no time be laden with a sufficient quantity of material to permit the propagation of the flame through it. The human life hazard is therefore materially decreased.

Photos and data courtesy B. F. Sturtevant Company.

Radio for the Beginner

By ARMSTRONG PERRY

(*Continued from page 572*)

same though very different in appearance from single-layer or bank-wound coils, one usually is hung like a gate, swinging open and shut while the other is stationary.

Often a beginner sees a zigzag line of about the same dimensions as some of the inductance symbols and assumes that it too means inductance. This is a mistake. Zigzag means *resistance*. All material resists the passage of electricity to some extent but in radio circuits it is often necessary to put in wire or other material that will furnish so much resistance as to cut down considerably the amount of current passing through it. Excess current will ruin the filament of an electron tube just as surely as excess water pressure will burst a pipe. So a resistance coil, which with its tongue and base is called a rheostat, is put in to regulate the flow of juice.

When a pair of short parallel lines interrupt the continuity of an otherwise continuous line it means there is a condenser at that point. The symbol is a clear one, for the condenser, in effect, is usually two metal plates with air, glass, oil, mica or some other non-conductor between. A diagonal arrow across the parallel lines means that the condenser is variable. By turning a knob or making some other adjustment its effective capacity is increased or decreased.

An arrow point resting on a short, heavy line means a crystal detector. The point is the cat whisker or movable crystal and the heavy line the stationary crystal. This is the valve which, with the help of the coils in the phone, cuts down the very rapid oscillations of the radio current and delivers to the diaphragm of the phone a series of magnetic impulses which make it deliver sound waves at a rate accommodated to the human ear. The symbol for phones could hardly be mistaken for anything else unless it might be a pair of spectacles.

Another type of valve, the electron tube already mentioned, looks more complicated on the diagram and is more complicated than it looks, though that does not prevent persons from using it who are entirely ignorant of what part it plays in their pleasure. First there is a circle to indicate that the elements are enclosed in a glass bulb or tube. Then there is an angle or a finger-shaped line for the filament, that part that gives forth light when the juice is turned on. The zigzag line is the grid, which in most hook-ups receives the impulses brought in through the antenna and uses them to affect the flow of electricity from local batteries through the tube. The third element in the tube is a straight line or a rectangle indicating the plate.

Wherever such a tube is shown there are as a rule two rows of parallel short lines connected with it. They are at right angles to the lines that connect with them. Each row is composed of alternate short and longer lines. The shorter lines are sometimes thicker than the others. At one end of a row frequently appears the plus sign (+) and at the other end the minus sign (—). These are batteries. Although the diagrams are alike, except for the length of the rows, the batteries are very different. The shorter one, connected to the filament by the shortest route, is called the "A" battery. It is a heavy contraption, usually filled with lead plates and sulphuric acid. Contrary to expectation it delivers a lower voltage than the "B" battery, which is a clean and compact little box. The latter,

if connected directly to the filament, burns it off in an instant and spoils a tube worth $5.00 or more. The plus side of it is always in the direction of the plate, for the current is assumed to pass out of it in that direction. The filament is safe if the thing is hooked up that way.

These are the principal symbols found in radio diagrams. Switches are often left to the imagination or the discretion of the man who follows the diagram since many of them are matters of convenience rather than of necessity. The lightning switch and lightning arrester ought to appear in diagrams oftener than they do. A house fired by lightning burns just as quickly, and an insurance adjuster who learns that protective devices were missing is just as obdurate, as though the tearful loser did not point to diagrams in government and other reliable publications to show that he did the best he knew how. A switch is shown in a diagram by a break in the line which obviously can be closed at will. If a particular type of switch is required, it is shown.

For convenience in mentioning elements of a diagram in an accompanying description, inductances, condensers and other devices which occur several times are numbered and lettered. "L1" means first inductance coil, "C2" the second condenser and so on. Except in the case of inductances, the letters used are generally the initials of the name of the apparatus. "D" stands for Detector; "T" for Telephone or "P" for Phone; "C" for Condenser. The letters "P" and "S" when placed near coils that are close together usually signify "Primary" and "Secondary" respectively. The primary coil is the one that first receives the current and the secondary the one in which it is induced. If the current is put in at the other end of such a piece of apparatus the secondary coil becomes the primary and the primary coil the secondary.

When two coils cross each other at right angles that signifies a variometer or a vario-coupler. If a line passes from the end of one coil to the end of the other it is a variometer, but if lines from the ends of the respective coils pass to separate circuits it is a vario-coupler, which serves to connect the antenna circuit with a secondary circuit as a loose coupler does.

Dotted lines mean wires or apparatus that may be inserted but that are not operative as the diagram stands.

Loud speakers and some other bulky and distinctive devices may be indicated by symbols that closely resemble their general outlines.

A radio chart seems as complicated to the novice as the reading chart does to the primary pupil on the first day of school, but in a few days, if he keeps after it, he can draw diagrams himself as blithely as though there were not many things yet to learn. A radio catalogue, or preferably a bunch of them, will do even more to associate the symbols with the apparatus itself than a text-book, for the book in the nature of the case can hardly use as illustrations pictures of all the devices we find upon the shelves of the radio shops. Text-books must be impartial but when we purchase we must select the product of a particular manufacturer. Learning to know the apparatus by sight and name will save many an embarrassing moment.

Learning to read a diagram will pave the way for diagramming our own hook-ups, which is a very desirable but neglected practice. Many a man who has sweated, slammed and sworn because his receiver would not work could have detected and corrected his errors immediately if he had sat down with a piece of clean, white paper, a good black lead pencil and a spirit of calm deliberation and reduced his complex mess of wire to lines which he could clearly trace to their various connections.

Radio and the Telharmonium

By ROBERT STEWART SUTLIFFE

(*Continued from page* 565)

on each musical instrument whose tone was to be produced. For instance, the C on the trombone, and C on the flute, have the same fundamental vibration, the difference in their effects upon the ear being due to different admixtures of overtones. Dr. Cahill found that vibrations produced by passing an alternating current with a frequency equivalent to that of a note made by a musical instrument, through the windings of a telephone receiver, would produce from the diafram of the receiver, a sound identical to that note.

The second problem was to construct the machines to produce all the necessary combinations of vibrations to equal those of the different instruments in producing various musical sounds. After a very large amount of laboratory work, and the expenditure of much money, a music manufacturing machine was perfected in his laboratory. It consisted of a large number of alternators with stationary armature and field coils producing various frequencies, which fed their currents into transformers called *mixers*, which combined magnetically the fundamental and overtones in their proper proportions and sent them along to the telephone receivers. By this same means it was possible to produce musical sounds in combination giving several sounds in unison, also to shade the sound so as to produce the most agreeable harmonies.

There were 144 alternators used in this system of manufacturing music, each one of which was controlled through a relay by a key situated in a keyboard similar to that found in the ordinary church organ. These alternators were capable of producing frequencies of from 40 to 4000 cycles. Rheostats were used to govern the amount of sound, and were controlled by *stops*, conveniently placed on the keyboard.

The depressing of a key produced a fundamental, and by closing several keys simultaneously harmonics were obtained. In one of the demonstrations of the apparatus it was shown that the ground tone produced a pure flute note, a ground tone with the third and fourth harmonics that of a clarinet, and to produce the tone of a violin all the harmonics up to the eighth were used.

In 1907, mechanically manufactured music was heard in public exhibitions, and was applauded by hundreds of thousands.

Every musical sound heard was a virgin sound. It had never been heard before but had left its place of creation wholly in the form of electrical frequencies. One enthusiastic listener described the music as that of a "glorified church organ." It was different from any instrumental music hitherto heard by the ear of man, and multitudes said that it was the most satisfactory music they had ever heard.

In the spring of 1907 it was believed that the apparatus invented by Dr. Cahill had reached a stage of perfection where it would be commercially profitable, and a plant was installed in a large store at Broadway and 35th Street, New York City, the basement being used for the machinery, which weighed ten tons. An invitation concert was given to the New York Electrical Society. When the distinguished audience had assembled, the only machinery visible was an upright cabinet with two banks of organ keys. The operator manipulated the keys, and the room was flooded with an indescribably beautiful harmony. Its source was a mystery, until it was announced that the sound came from ordinary telephone receivers concealed about the room. The concert was a comprehensive one, including solos and ensemble instrumental pieces, and everyone present expressed great delight.

(*Continued on page* 608)

Radio and the Telharmonium

(*Continued from page* 606)

But the Telharmonium proved a financial disaster. For demonstration purpose trunk lines were run to nearby hotels, and nightly concerts were successfully given, but although it was found that a great demand existed for the service, telephone circuits could not be used, and a private underground system to connect up the thousands of subscribers would have been prohibitive in cost. Aside from this last-mentioned obstruction to the success of the Telharmonium, it would have also been practically impossible for the company to have obtained the right of way to run lines under the streets of New York. This right is almost entirely usurped by the various water, gas, electric light, telephone and subway corporations. Even if the company were allowed to run lines under the streets, great difficulty would be encountered in finding room enough for them. Also, it was found impracticable to use the telephone cables themselves, due to induced currents, which produced musical "cross-talk" in other lines in the same cable. No matter how delightful the music, people would not have it on their telephones while engaged in conversations, so after a few months, the expensive plant was junked, the promoters retired from the scene, and the Telharmonium became a memory.

The question now presents itself of the possibilities of the Telharmonium in conjunction with radio. We show herewith an illustration of the elementary workings of the Telharmonium, and also how it could be used in connection with a radiophone broadcasting station.

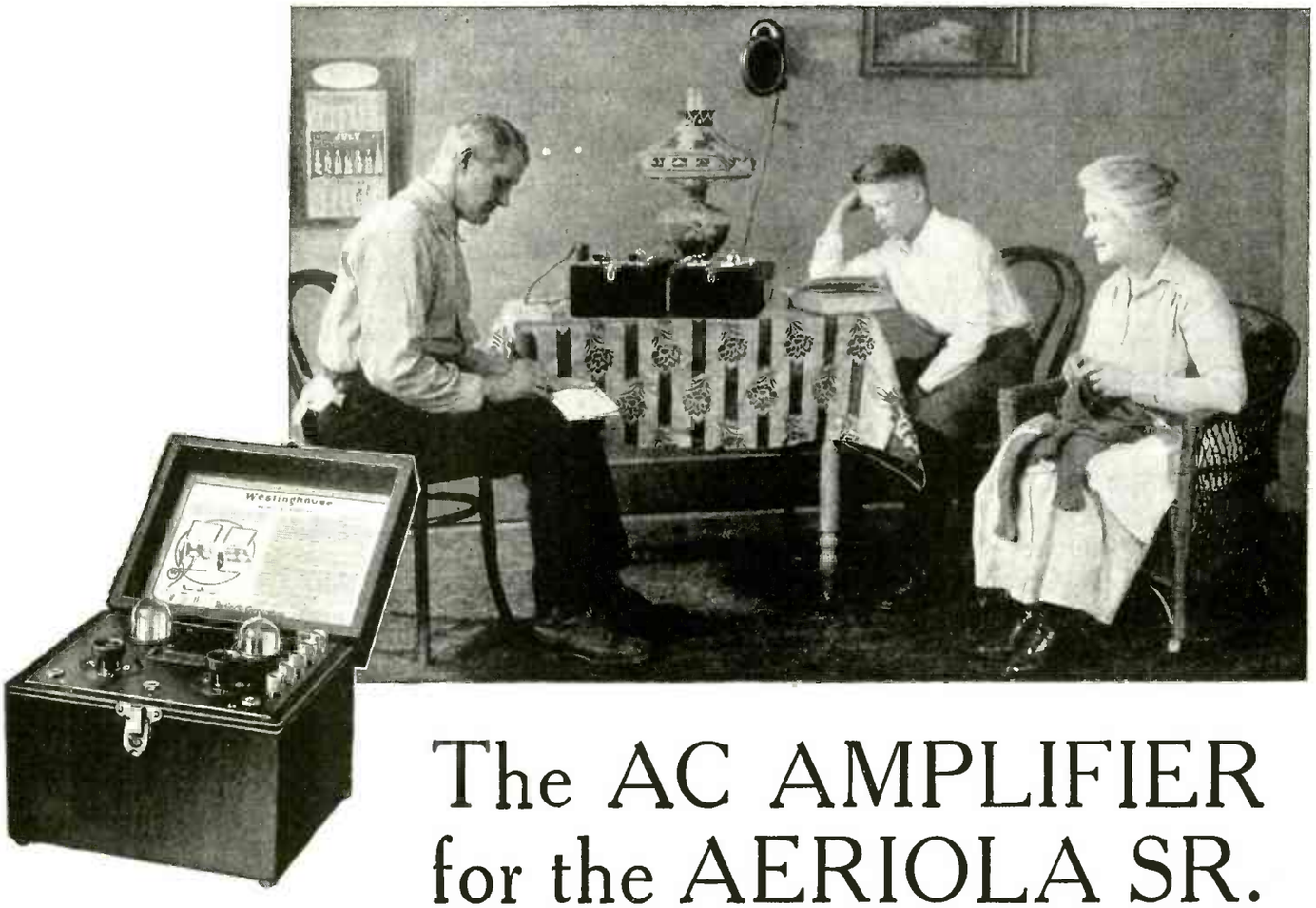
Will the time not come comparatively soon when broadcasting will be so diversified through the perfecting of sending and receiving apparatus that the number of waves, or rather wave lengths, available for broadcasting will be practically unlimited? When this is a fact, radio will furnish the missing link between the wonderful Telharmonium and the homes of the people. Radio receiving sets in many homes throughout the country will then furnish rich and poor alike with music that will satisfy the soul, and make life more worth while.

Flickerless Movies

(*Continued from page* 552)

all standard films. The sole purpose of this sprocket driving wheel is to propel the film accurately past the lens, there being no intermittent motion or hesitation of the film whatever.

In the theater size projectors now being designed, the lens wheel will be about 28 inches in diameter, while in the portable machine for home and office use the lens wheel will measure about 12 inches in diameter. The builders intend to make these lenses in four quadrants or units, which will be securely clamped into the lens wheel. The machines are designed with magnetic brakes for quick stopping, and they can be brought up to full speed within two to four seconds. By means of a magnetic *framing* mechanism, the picture is synchronized so as to be properly placed on the screen, and at this point it is interesting to note that the picture may be *framed* from any point in the theater, simply by pushing an electric button, this button operating the electro-magnets connected with the framing mechanism of the machine. In view of the fact, as pointed out by Mr. Bardy, that nearly 100 per cent of the light is projected on the screen, it not only will mean a great saving in electric light bills for motion-picture theater owners when this machine comes into use, but also the greatly reduced degree of heat evolved by the smaller incandescent lamp, instead of an arc, means comparative freedom from film fires and from cracked lenses.



The AC AMPLIFIER for the AERIOLA SR.

AERIOLA AMPLIFIER
Model AC
Complete with 2WD-11 A vacuum tubes (without batteries)
$68.00

VOCAROLA LOUD-SPEAKER
Model LV
$30.00

RCA

This symbol of quality is your protection.

Before buying radio apparatus, always consult the book "Radio Enters the Home." Price 35 cents by mail.

The Aeriola Sr., simplest and most efficient of all single-tube receiving sets, becomes still more efficient with the new model AC amplifier.

No storage battery is required. With only two dry cells, two tubes, and a 45-volt plate battery the model AC amplifier greatly increases the Aeriola Sr.'s range of reception. Used with the Vocarola loud-speaker, the amplifier connected with an Aeriola Sr. fills a whole room with concerts received over distances of 10 to 30 miles.

Anybody can make the simple connections required, including mother and the girls.

Because there are no storage batteries to charge, because both the Aeriola Sr. and this new model AC amplifier are so light and handy, the combination is ideal for Boy Scouts and for campers.

Radio Corporation of America
WORLD WIDE WIRELESS

Sales Dept. Suite 2070
233 Broadway
New York City

District Office
10 South La Salle St.
Chicago, Ill.

New Filament Compression Rheostat

(*Continued from page* 571)

energy dissipation within the resistance element or continuous operation may raise the temperature to a point dangerous to the maintenance of the original form of the container. Porcelain is desired, therefore, or some similar material.

Regulation of a smooth characteristic is desirable in order that automatic and manual application of power may be readily regulated of *felt* by the operator. It also is suitable to regulating where a certain movement one way or another brings about an approximate definite change, as, for instance, in radio work where we turn a dial ten points to the right and get the beats in the high frequency current which are audible and then repeating the movement to the left a corresponding ten points to obtain a similar set of beats and then judging the medium of *in tune* position.

The temperature of the filament of the vacuum tube is a sensitive matter and, therefore, the regulation of the current is sensitive. Consequently a vernier adjustment, as it is called, is desirable. If the regulation of the rheostat is not uniform, it is not possible to obtain sensitiveness or—better—ease of close regulation. Therefore, the rheostat should be both of long range and smooth regulation somewhat similar to the ideal curve 3 in Fig. 2.

One long experienced worker in radio work pronounced it the only 100% perfect rheostat on the market.

It has been adopted as the standard equipment for a new radio outfit equaling the Armstrong regenerative system, it is claimed.

In order to increase the speed of adjustment an external snap switch is added.

"Movie" Explains Radio

By H. WINFIELD SECOR

(*Continued from page* 567)

the *radio bug* and the next scene shows him at home in bed. The doctor prescribes a wireless set as his prescription, and from then on the patient recovers rapidly. A little later the boy is seen receiving radio broadcast concerts, and finally the whole family are bitten with the same fever. From there on the picture story takes us to the interior of the broadcasting station "WJZ," thence on through the series of pictures we have just described. At the wind-up of the film, interplanetary radio is represented by a picture of the earth and a distant planet, radio waves in the form of ever expanding circles emanating first from the heavenly body and then from the earth, etc. This is accompanied by a fitting poem extolling the power of radio in the hands of man.

One of the most interesting and cleverly worked out scenes in the picture is that whereby the velocity of radio wave transmission is shown. Following the caption, "A radio wave can pass around the earth seven and one-half times in a second," a picture of the earth appears and in an instant a white line encircles the earth at the equator seven and one-half times in the period of one second, or as quick as you can say the word "zip." There is one fine bit of technique we forgot to mention; this is the one following the caption, "imagine that you are riding on a radio wave leaving the earth." The earth fades away from you so rapidly that it takes your breath away, and in about a second and a half, the earth is about as big as a peanut, and you see a heavenly body at the left—the caption following it explains it, "That was the moon—240,000 miles from the earth! It took just a second and a half to pass it."—*Pictures courtesy Bray Productions.*

"WBAY"—Latest New York Broadcasting Station

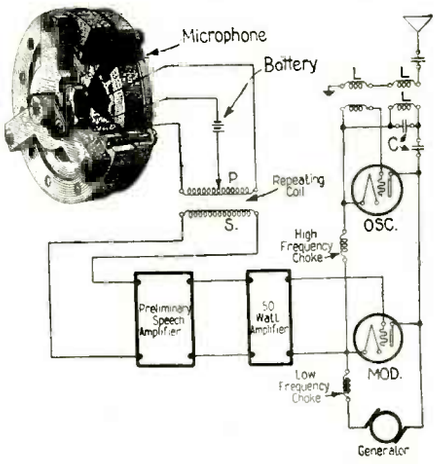
By A. P. PECK

(*Continued from page* 571)

mum because of the equalizing effect gained by the use of the two cups. It would seem from the illustration of the microphone that it could be talked into from either side. However, according to the engineers this is not so and all sides are open merely in order to allow complete air circulation.

When using this type of microphone it is not necessary for the artist or speaker to stand close to the instrument, a condition which adds materially to the ease of performance on the part of the artist.

Another interesting feature of this microphone is the method of damping the vibration of the diaphragm by means of the air holes in the framework of the microphone proper. These air holes give access to a certain amount of air which forms a cushion about 1/1000 inch thick between the diaphragm and the body of the transmitter. As the diaphragm vibrates the air is rapidly forced in and out of this space and at high vibration periods this *pumping* effect renders the instrument almost equally responsive to all vibration periods for the whole range of speech and music.



"WBAY" Hook-Up. Circuit Diagram From Push-Pull Transmitter Thru the Speech Amplifiers to the Radio Set. The Heising System of Modulation Is Used. By the Use of a Microphone With Two Buttons Working in Opposite Phases and Joined to the Repeating Coil as Shown, Practically All of the Distortion of the Ordinary Microphone Can Be Eliminated.

The equipment of the studio is so arranged that another type of transmitter may be used if desired. This type is not known as a microphone but is generally called a condenser transmitter. It contains no carbon grains or carbon balls but has a vibrating steel diaphragm which moves closer to or further away from another plate placed in close relation thereto when vibrated by sound waves. This of course forms a condenser whose capacity is changed every time the diaphragm vibrates. This type of transmitter, however, requires considerably more preliminary amplification than the microphone and is therefore not as extensively used as the former type.

A glance at the circuit diagram will show how the electric waves formed in the microphone by the sound waves go first to the voice amplifier, which consists of three small amplifying tubes and one 50-watt tube, and thence to the transmitter proper, which consists of two 250-watt tubes as modulators, and two as oscillators. In these two sets the tubes are connected in parallel and therefore only one of each is shown in the diagram. All these tubes employ the oxide-coated filament, which tends towards efficiency and economy

in operation. The modulating system used is of the Heising type. In one of the photographs we see a front view of the power control and the transmitting set panels. At the top of the transmitting set, in the back of the panel may be seen the 250-watt tubes, a larger view of one of these tubes being given also.

The current for the operation of this set is provided by a motor-generator and storage battery outfit located in the room next to that occupied by the transmitting equipment; 1600 volts are supplied to the plates and 14 volts to the filaments. The motor-generator is controlled from the operating room, and by means of a switch in the studio the current may be cut off from the antenna between different parts of the program. This set, as above described, puts 13 amperes into the antenna.

The antenna is 481 feet high, and is supported by two steel towers, each 100 feet high, located on the top of a building 381 feet high. These steel towers are built to withstand a wind pressure of 5,000 pounds. The ends of the antenna wires are fastened to "S" hooks, which will part and relieve the towers of the strain by dropping the antenna to the roof when the load reaches 3,400 pounds. This is the estimated strain to which the wires would be subjected with a wind velocity of 100 miles per hour and 1 inch of sleet on the wires. The antenna is 150 feet long, and is of the "T" type.

The lead-in consists of eighty-four strands of No. 22 copper wire wound on a hemp cord. This cable is designed to secure a surface with low resistance to high frequency currents.

The lightning switch located in the operating room is of gigantic size, having a switch arm approximately 3½ feet long by 3 inches wide by ¼ inch thick. This switch is placed near the top of the room, and has to be operated by means of a long pole with a hook in the end.

In place of either an ordinary counterpoise or ground, this station uses the steel frame of the building, which of course, acts in the same manner as a counterpoise.

In the operating room there are located two receiving sets, one permanently tuned to the same wave length as that of the station, and another which may be used on higher wave lengths. The first set is used to monitor or "listen in" on their own transmission; the receiver being operated in connection with a loud-talker located in one corner of the operating room. In this way the operator in charge of the transmission may know instantly that the set is radiating and in working condition. This is quite necessary, inasmuch as this station is used for toll broadcasting, and naturally the company or person paying for the privilege of sending out their advertisements and entertainments from this station will want to be absolutely sure that the station is really radiating. In addition to this monitor set, there is a special private telephone line running to Princeton, N. J., sixty miles away. By inserting a plug in a jack, the operator automatically lights the filaments in the tubes of a receiving set located in Princeton, which is tuned continuously to WBAY's wave length. The receivers at the station in Princeton are placed in proximity to a telephone transmitter, which is connected through the telephone line to WBAY. Now when the transmitter is set in operation, the operator may "listen in" on the telephone line and hear how his signals are coming in sixty miles away.

The receiving set mentioned above which tunes to the higher wave lengths, is used to "listen in" for distress signals, as is required by the government.

In accordance with the time schedule at present assigned by the Department of Commerce, WBAY will operate daily from 11.00 to 12.00 in the morning, and from 4.30 to 5.30 in the afternoon. The station also broadcasts every Thursday evening, starting at 7.30 o'clock, daylight saving time.

Animal Monsters in Miniature

By Dr. E. BADE

(*Continued from page* 554)

adults. With the aid of their segmented beak the sap conducting tissues are pierced and the rising sap is pumped into the creatures' organism, thus retarding the development of the plant.

Some of these leaf hoppers produce frothy masses thru the pumping of the sap. This is known as frog spittle. But neither man nor frog has expectorated this foamy mass upon the plant. It is the work of the larva from the frog hopper or spittle insect which lives under this mass of bubbles.

When the froth is carefully moved aside, a tiny mite, green in color and very soft of body, can be seen. In the fall the female of this species lays its eggs in the stems of some grasses. Next spring, when the eggs have hatched and the larvae have made their appearance, they migrate to some soft shoot, bore with their beak into the tissues, and begin to suck the sap. They absorb all necessary food material required for their bodily growth. The clear unused sap is discharged, but no bubbles are, as yet, to be seen. They are later formed thru the continual expansion and contraction of the abdomen which brings air into the fluid mass. It seems very probable that the abdomen, during this process, is also used for breathing. Within this foamy mass the larva lives until the last moult.

This froth does not protect the creature from its enemies since wasps and other insect robbers know full well how to find the larva in its foamy coating. It only aids in the conservation of its bodily moisture, for otherwise the soft body would soon dry up in the intense rays of the summers' sun.

Other hoppers, for the same purpose, surround themselves with a secretion of wax. In some species thick brushlike structures are formed consisting of long waxy hairs. This undoubtedly also prevents the drying process of the sun, only incidentally offering protection against insect-eating beings.

Experiments with a Spark Coil

(*Continued from page* 561)

whole sheet will be illuminated with great numbers of sparks. (See Fig. 2 C.)

About the prettiest effect of all can be secured by threading metal and glass beads alternately on a silk thread, hanging this in festoons against a black background and connecting the ends to the coil. If your coil is a large one the string can be long and arranged to spell a word.

A "COHESION" EXPERIMENT

For this, or rather these experiments, for a great number can be performed, we require a disc of glass or mica and a square metal plate. The latter is connected to one side of the secondary; and a wire from the other terminal is connected to the center of the piece of glass (or mica). Around this wire place a drop of liquid from which (when the coil is started) a number of small irregularities will form and from these others branch out till the plate is covered. The resultant figure differs according to the liquid used, because their molecular cohesion is different. Figure 3 shows the result obtained with potassium cyanide, a deadly poison.

CLIMBING VINES

Coat a beaker on the outside to within one inch of its upper edge with tinfoil. Place one-half inch of water in it and connect the

tinfoil and the water to the spark coil secondary. When the coil is started long sparks dart from the water's edge up the sides of the beaker. At the bottom they are fairly thick, but as they come to the top they branch out, becoming thinner and thinner till at last when they reach the mouth of the beaker they have disappeared. These sparks very much resemble climbing vines, hence the name. (See Fig. 4.)

THE DISCHARGE ON THE OUTSIDE OF A BOTTLE

Lengthen one electrode wire so that it can be wound around a bottle half way up. (For this experiment thin bottles or beakers work best.) The other secondary wire dips into a quantity of water contained in the bottle. On working the coil the entire outside of the jar will be covered with sparks.

Contributed by ARTHUR C. ALLEN.

Print with Linoleum

(*Continued from page* 562)

This Design of a Bird with a Border Around the Picture Can Be Readily Cut Out on a Piece of Linoleum, and It Makes a Very Novel Design for Stamping Linen Doilies, Towels, etc.

Not only are these linoleum stamps well adapted for printing linen and other articles with, but initial and monogram stamps, such as used in office work, can be very nicely made from this material. The linoleum plate with the letters suitably engraved thereon should be glued or nailed to a wooden block, and this block in turn provided with a suitable handle. Ink pads can be purchased at any stationery shop.

This Owl Design, the Original Oilcloth Stamp of Which Was Used in Making This Impression from Which the Electrotype Was Finally Made, Gives Another Good Idea of What Can Be Accomplished Even by the Inexperienced.

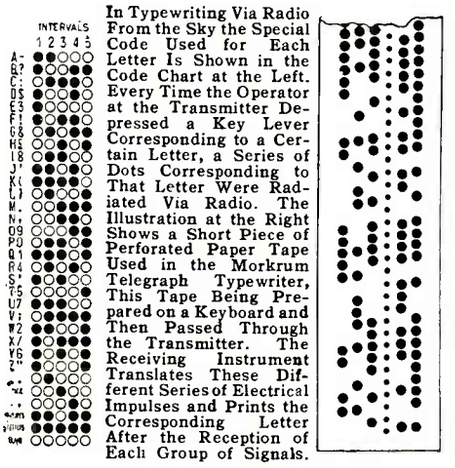
Radio Typewriter Here

By H. WINFIELD SECOR

(Continued from page 546)

trivial, and so it will no doubt be arranged that when a letter is transmitted, the local machine will simultaneously make a copy of the outgoing message or letter, and drop it into the basket. A separate roll of paper and printing mechanism could be arranged on the opposite side of the machine for making these copies, so as not to confuse them with the incoming letters.

Various business concerns will of course have to use different wave lengths for operating their machines with, but with the rapid advance in fine tuning now being accomplished, and by arranging schedules for transmitting periods during the day, the radio typewriter, we have no doubt, may easily become quite a commonplace before a great while. For transmitting important messages, such as stock reports, etc., the radio teletype fulfills the requirements beautifully, this machine corresponding to that here shown in the naval photos.



In Typewriting Via Radio From the Sky the Special Code Used for Each Letter Is Shown in the Code Chart at the Left. Every Time the Operator at the Transmitter Depressed a Key Lever Corresponding to a Certain Letter, a Series of Dots Corresponding to That Letter Were Radiated Via Radio. The Illustration at the Right Shows a Short Piece of Perforated Paper Tape Used in the Morkrum Telegraph Typewriter, This Tape Being Prepared on a Keyboard and Then Passed Through the Transmitter. The Receiving Instrument Translates These Different Series of Electrical Impulses and Prints the Corresponding Letter After the Reception of Each Group of Signals.

The editors have known of this work for nearly a year, but as photos and official reports of the work could not be obtained, we deferred publishing anything about it. Some of the older readers will probably recollect the article which appeared in the May, 1915 issue, about eight years ago, describing the installation of the Morkrum telegraph typewriters in the New York office of the Associated Press. It only remained to connect up suitable relays and vacuum tube amplifiers and transmitters to the keyboard or sender, and also to the interpreting or receiving instrument, which selects the letters when the proper sequence of signals is received at each pressure of the key of the transmitting station, when lo! and behold! we have the radio typewriter. Of course, the same as in all wireless transmission and reception, the greater the distance the more power we will need at the transmitter.

With regard to the military and naval aspects of this brilliant achievement, it was recently pointed out by the naval authorities, that a reversal of operation, so that aircraft can receive typed messages from ground stations, is really only a matter of technical detail. This new communication system also possesses the advantage of eliminating much of the chance of error in transmission and reception, experienced in the usual telephone and telegraph service. This, one naval officer pointed out, will be a marked step in advance, in that it will allow explicit directions to scouting and combat planes in flight, by the commander-in-chief of the fleet, and will enable scouts and other types of planes to convey accurate and detailed information to the high commanding officers. It is nothing short of marvelous, even to those who are quite familiar with radio and electrical

achievements, when they first see the radio teletype go into action. The sender presses a key for the letter A, for example. Practically instantaneously the receiving machine sounds a few rapid clicks, all in a fraction of a second, and behold, the letter A is printed on the paper tape, which starts reeling out of the device.

One of the features of the radio teletype or radio typewriter, will be its adoption on trains and boats, as well as aircraft, so that the latest news broadcasted via radio, particularly stock market reports and other vital messages, will be picked up while a man may be traveling over land or water, or through the air, and thus will present it to him simultaneously with its transmission.

In the radio typewriter apparatus illustrated on our front cover and also in one of the accompanying pictures, the radio receiving and transmitting instruments, including the vacuum tubes or audions, tuning condensers, rheostats, variometers, etc., are all incorporated in the one machine. Such a compact and complete outfit, ready for transmitting and receiving typewritten messages, would have a range of, let us say, 100 miles; i. e., for the size of apparatus shown on the front cover. Where greater distances were to be covered, and more power used than that provided by small vacuum tubes, a special vacuum tube transmitting outfit would be arranged externally to the radio typewriter of the style here shown, and the same keyboard and interpreting mechanism would then simply act as a relay in transmitting with the increased power. The receiving instrument would for ordinary purposes require four to six vacuum tubes of standard size.

MOTORLESS PLANE FLIES 3 HOURS, 10 MINUTES

The world's motorless airplane soaring and gliding record was smashed during August in the "air-sailing" competition at Wasserkuppe, in the Rhöhn ridge of hills near Wiesbaden, Germany.

Flying in the record-breaking glider *Vampire*, in which Martens had remained aloft 1 hour and 6 minutes the day before, Hentzen, a fellow-student of Martens at the Hanover Institute of Technology, remained aloft 2 hours and 10 seconds. At the finish he glided ten kilometers, landing within a few feet of the spot where his colleague had landed the day before.

Herr Hentzen, who astonished the world by his motorless airplane flight of two hours and ten seconds broke his own record when he soared to above 1,000 feet and remained at that height for a considerable time, though the wind increased in strength and approached half a gale.

Finally Hentzen performed a long flight on a straight line and landed in the darkness in the Fulda Valley. He had been in the air for three hours and ten minutes.

The glider *Vampire* was designed and constructed by the Science of Aviation Department of the Hanover Institute of Technology.

This was the manner of Hentzen's superlative achievement:

There was a wind of from seventeen to twenty miles an hour, with occasional thirty-mile gusts. Hentzen was shoved off a precipitous cliff at Mount Wasserkuppe, the highest peak of the Rhöhn watershed. The *Vampire* was immediately wafted upward 100 meters, at which altitude Hentzen hovered and cruised for several minutes before he climbed another hundred meters. This altitude he maintained for an hour and three-quarters, soaring around and over the starting point. When the wind dropped to about ten miles an hour he indulged in a graceful ten-kilometer quarter-hour glide to a goal previously fixed.

Three students of the Darmstadt Institute of Technology were also aloft with sailplanes, so that the evening sky presented the picture of four airmen soaring without motors.

"RASCO HAS IT!"

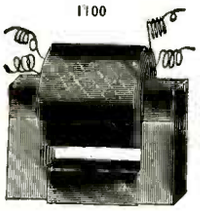
THE Radio Specialty Co.--"*Rasco*" for short—is probably the most unique supply house in the United States, if not in the world to-day. This company makes a specialty of small orders, no order being too small to get immediate and prompt attention for the simple reason that most of our orders are small.

The reputation of this house was built upon service. Ask any of your acquaintances what they think of *Rasco* goods, *Rasco* service, *Rasco* promptness! Thousands of unsolicited testimonials on file to prove that we serve the public best!

Be sure to get our great catalogue, containing several hundred different parts, which is illustrated below.

ORDER DIRECT FROM THIS PAGE. ALL GOODS SENT PREPAID IN 24 HOURS

1100



"RASCO" AUDIO FREQUENCY TRANSFORMER

We have compared many of the present transformers on the market but have finally decided upon a type that is the most efficient one we have seen so far. The best amplifying transformer is that in which the impedance of its primary is equal to or exceeds the impedance of the plate-to-filament circuit of the tube in which it is connected.

We guarantee this transformer to equal any one on the market.

No. 1100 "Rasco" Audio Frequency Transformer **(not assembled) each prepaid**.....$2.65

ANTENNA CONNECTOR

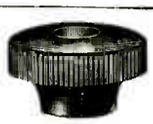
This antenna connector is made entirely of aluminum, is light and will not rust. The only connector of its kind. The 4 antenna wires go to the upper holes; the lower hole takes the lead-in. Don't solder your aerial, don't have loose connections. Dimensions 2" high, 1¾" wide, ⅝" thick.

No. 999, Connector, each..$0.35

999

PANEL KNOBS

6241



838

No. 6241 is well made and has a good corrugation. Its dia. is 1", height is ½", hole 5/32". The shank is ¼" high.

No. 6241, Knob, each.....$0.08

MARCONI KNOB

Has a central hole of 5/32" and seat to hold the screw, dia. is 1¼", height ¾".

No. 838, Marconi Knob, each.....$0.15

RASCO POSTS

202 201

030 029

These are our very own patterns, from our own designs and look mighty handsome on any instrument. The top knobs are of composition, the bottom parts brass nickel plated polish.

No. 202 is nickel plated at bottom part.

"Rasco" Binding Post, 8/32 thread, each, $0.10; doz., $1.00.

No. 202, Post, each, ...$0.08

Nos. 650 and 651 made entirely in composition with a hexagonal brass nut in center.

No. 650 has 8/32 machine screw.

No. 651 has bottom wood screw.

No. 650, Post, each.....$0.08

No. 651, Post, each.....$0.08

Dozen, each style.....$0.90

650 651

BRASS NICKEL POSTS

No. 029, Binding Post, each.....$0.05

No. 030, Binding Post, each.....$0.04

RASCO SWITCH POINTS

75 1 2 3 4 5 6 7 77 76

Nickel plated and polished. The following have been found the most popular.

No. 1 ¼"x¼", 6/32 thread, ea., $0.03; doz., 35c

No. 2, 3/16" high, ¼" dia., 6/32 thread, ea., $0.03; doz., 35c.

No. 3, 3/16" x 3/16", 4-36 thread, ea., $0.03; doz., 35c.

No. 4, ¼" dia.; ⅛" thick; stem 6/32, ea., $0.03½; doz., 40c.

No. 5, ¼" dia. 3/16" thick; stem 4-36, ea., $0.03½; doz., 40c

No. 6, 3/16" dia.; 3/16" thick; stem 4-36, ea., $0.03½; doz., 40c.

No. 7, 3/16" dia.; ⅛" thick; stem 4-36, ea., $0.03½; doz., 40c.

No. 75, Switch Stop, ⅞" long, 4-36 thread, complete with nut, ea., $0.05; doz., 50c.

No. 76, New style Switch Point, to be pressed into bakelite panels with forced fit. Wire is soldered to pin end. Head ¼"; dia., 1/16" thick, ea., $0.03½; doz., 40c.

No. 77, same as above, but head is ¼" dia. x 3/16" thick, ea., $0.03½, doz., 40c.

1898

THE RASCO BABY DETECTOR

In presenting this little Detector, we feel sure that it fills a place never taken before by any small detector. It does a variety of things and does them all well and better than many $5.00 detectors. The base is solid, black composition. Mounted on same is a nickel holder and binding post which holds a flutted hard rubber knob with its sliding rod member.

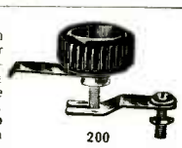
The outstanding part of the Detector, is the patented nickel detector cup and binding post. The knurled cap unscrews and you place the Galena Crystal in the cup, then replace the knurled cap and the galena crystal is held secure. The circular hole in the cap exposes enough of the crystal for ordinary purposes.

No. 1898, Rasco Baby Galena Detector. Price, prepaid.....$0.50

No. 1899, Rasco Baby Detector with Galena and Radiocite Crystals. Price, prepaid.....$0.75

PANEL SWITCH LEVER

New style switch lever with lock fork. It is impossible for this lever not to make positive contact at all times. The blade radius is 1¼". Blade is nickel plated and polished. Fork is phosphor bronze. The lock fork holds the screw (in which it rotates), securely. A loose contact is impossible.



200

No. 200, Switch Lever, complete as illustrated..$0.30

LITZ WIRE

323

This wire is recognized as the only thing for winding coils for Radio instruments. Particularly recommended with our **No. 343** Variocoupler Rotor, for vario-couplers, banked windings, etc.

No. 323, Litz Wire, 20 No. 38 strands, enameled double silk wire, per foot, $0.02; per 100 feet, $1.15

No. 890, Litz Wire, 10 strands No. 38 wire, per foot, $0.01; per 100 feet, $0.75.

No. 891, Litz Wire, 16 cables of three strands No. 38 wire, per foot, $0.03; per 100 feet, $2.25.

NOTE: This page contains only a few of our 300 specialties.

PANEL KNOB

This is a very distinctive knob and can be used on dials, panels, switches, condensers, etc. It is exceptional and well made. Dia. 1 1/16"; height 11/16"; comes with 8/32" bushing.

No. 815, Knob, each.....$0.18

815

VARIOCOUPLER ROTOR

343

This rotor is used by all up-to-date amateurs. Is accurately turned of hard wood and is used as a secondary coil. It takes any finish, either shellac or stain and can be drilled readily for any size hole. Large hole 2" dia. Width of spool is 2". Total dia. 3⅜".

No. 343 Variocoupler Rotor, each $0.75

827

"RASCO" NAME PLATES

839

Our name plates are of brass with a black background. Letters are polished nickel. Order by name and number.

		Each			Each
807	"Phones"	$0.05	810	"Ground	$0.05
809	"Aerial"	$0.05	812	"Primary"	$0.05
811	"Secondary"	$0.05	814	"Detector"	$0.05
813	"Audion"	$0.05	866	"On"	$0.05
865	"Off"	$0.05	840	"Increase Current" (Left)	$0.10
839	"Increase Current (Right)	$0.10	834	"Series"	$0.05
813	"Vacuum Tube"	$0.05	830	"Receive"	$0.05
831	"Transmit	$0.05	820	"2nd Step"	$0.05
821	"3rd Step"	$0.05	827	"Tickler"	$0.05
819	"1st Step"	$0.05	825	"Plate Variometer"	$0.05
826	"Grid Variometer"	0.05	835	"B Battery"	$0.05
823	"Secondary"	$0.05	817	"Output"	$0.05
836	"A Battery"	$0.05	824	"Primary Condenser"	$0.05
818	"Input"	$0.05	828	"Parallel"	$0.05
829	"Telephone"	$0.05	837	"+ —"	$0.05
833	"Detector Tube"	$0.05	841	"(Blank)" (takes pen or pencil writing)	$0.05
822	"Coupling"	$0.05			
808	"Load'g Coil	$0.05			

Price of all of our name plates in dozen lots, 50c, with the exception of the two "Increase Current"

350-55

BAKELITE PANELS

We list below six panels, the sizes of which have been selected after carefully checking up many dimensions of the most popular radio apparatus on the market.

Note particularly that our prices are anywhere from 25 to 50% lower than those quoted by most other concerns. The reason is that we buy these panels in very large quantities, **and we do not cut sheets to order.** Remember always that when sheets are cut to order they cost you at least 50% more than our prices, because you **must pay for the cutting and the necessary waste.**

Note also that we ship these panels prepaid. This alone amounts to a considerable saving.

No. 350	6"	x 12"	x 3/16"	thick,	each	$1.90
No. 351	6"	x 18"	x 3/16"	"	"	2.85
No. 352	9"	x 12"	x 3/16"	"	"	3.00
No. 353	12"	x 18"	x 3/16"	"	"	5.65
No. 354	6½"	x 19½"	x 3/16"	"	"	3.50
No. 355	6"	x 7½"	x 3/16"	"	"	1.20

"RASCO" LUBRICATED PANEL SWITCH

1921

A radio switch that has two nuts at the end is a monstrosity, for the reason that it will never stay put. Our patent spring fork holds the switch handle always under uniform tension, at the same time it insures the best contact possible. **New wiping contact**, which covers every point of the switch point. Another new improvement is the lock fork, which can assume three different positions to accommodate the switch to various thicknesses of panels.

No. 1921 "Rasco" Switch, as illustrated, each **$0.50.**

199

KNOBS

4451

These knobs are favorites with all experimenters The size of both is: dia. 1⅛", height ⅝". No. 4451 comes with 8/32 and 10/32 bushing.

No. 4451, Knob, each...$0.06

No. 199 (screw length ⅝") Knob, each $0.10

NAVY KEY KNOB

748

This navy key knob is now used on all standard wireless keys. It gives the right swinging motion and rests the fingers. It is a favorite with all advanced amateurs. Once used always used. The screw is 8/32 and will fit all keys.

No. 748, Key Knob, each.....$0.28

8032

THREADED BRASS ROD

We carry two styles, 6/32 and 8/32 thread. **Only 6" lengths sold. No others.**

No. 8032, Threaded Brass Rod 8/32 thread, per 6" length $0.08

No. 6032, Threaded Brass Rod, 6/32 thread, per 6" length $0.06

THE "RASCO" CATALOG

CONTAINS 50 VACUUM TUBE HOOK-UPS

Complete hook-ups of all important vacuum tube circuits are given in clear diagrams with complete explanation. Just to name a few—The V.T. as a detector and one-step amplifier; regenerative circuit; De Forest ultraudion; V.T. to receive undamped and spark signals; Armstrong circuits; one step radio frequency amplifier and detector; three stage audio-frequency amplifier; short wave regenerative circuits; V.T. radio telephone; 4-stage radio frequency amplifiers; radio and audio frequency amplifier, inductively coupled amplifier; Armstrong superautodyne; radio frequency amplifier and crystal detector; etc., etc. The catalog contains 200 illustrations. On account of its great cost, it cannot be distributed free of charge. Mailed only upon receipt of

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SWEDEN TO ERECT HUGE RADIO STATION

A contract for a new wireless station in Sweden, which will insure direct communication between that country and the United States has been awarded by the Swedish Government to the Radio Corporation of America, according to an announcement from the headquarters of the Radio Corporation here. The entire plant will cost more than $2,000,000 and will be one of tremendous power.

Sweden now has one station, that at Karlborg, but it has been found unreliable for transoceanic work.

A statement issued by the Radio Corporation says:

"Sweden, about two years ago, sent missions to England, France, Germany and the United States to study the various wireless systems and types of apparatus in use. In 1921 the mission, under the direction of Seth Sjungquist, head of the Royal Telegraph Administration of the Kingdom of Sweden, visited America to inspect the high-power station of the Radio Corporation and particularly to see the Alexanderson alternators manufactured and also in operation.

"When the Reichstag met this year it sent a special legislative committee to England to study the vacuum tube as developed there, and it was only after hearing this report that the Reichstag recommended the use of the Alexanderson alternator and authorized the signing of the contract by the Telegraph Administration.

"The new station will be situated in the vicinity of Gothenburg, which is on the west coast of Sweden, and the contract with the Radio Corporation of America calls for the installation of two 200-kilowatt Alexanderson alternator equipments, which, when associated with the well-known multiple-tuned antenna, will each deliver to the antenna a current of 600 amperes."

REPORT ON FIRST RADIO FIRE

The following are excerpts from the New York Board of Fire Underwriters report on the only fire credited to radio in the records of the Fire Department. This fire occurred on the afternoon of July 13, at No. 410 West 44th Street during one of the heaviest electrical storms that the city has had in many years.

"An examination of the arrester while in position showed that the heat, apparently from flame, had melted sealing wax at various points and upon removing the arrester from the circuit it was found to contain water."

"The arrester was then sent to the underwriters' laboratories and without being taken apart was placed in the electrical testing cabinet and failed to function with 500 volts across its terminals. Failing at this point, the voltage was raised, and at 1,240 volts current jumped across the terminals. Upon opening the arrester it was found to contain more water and its terminal plates showed marks of only one small arc which undoubtedly was made while testing at 1,240 volts."

The conclusion of the examination by the underwriters' engineers is as follows:

"An examination of the lightning arrester indicates that the lightning did not discharge through it to the ground. The spark gap was abnormally large, owing to a defect in the construction and assemblage of the arrester, as indicated by the test, which showed that it required 1,240 volts to establish an arc, whereas the instrument was designed to function at all voltages in excess of 500 volts.

"The probability of failure of lightning arresters either in whole or in part, to the extent of permitting some of the discharge to enter the building, indicates the desirability of a requirement for a ground switch in parallel with the arrester. Had such a switch been provided in this case the lightning would have had a direct path to ground and all the trouble would have been avoided."

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Boys, build three-foot model aeroplane at small cost. Write Aero Shop, 3050 Hurlbut Ave., Detroit, Mich.

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No Dull Times Selling Food—people must eat. Federal distributors make big money; $3,000 yearly and up; no capital or experience needed; guaranteed sales; unsold goods may be returned. Your name on packages builds your own business. Free samples to customers—repeat orders sure; exclusive territory. Ask now! Federal Pure Food Co., Dept. 60, Chicago.

Agents Wanted in every city and town to sell standard radio apparatus. Attractive discounts given. If interested, write us at once stating age and radio experience. Wilmington Electrical Specialty Co., Inc., 912 Orange Street, Wilmington, Delaware.

Money—Money—Money! Make it selling Hanslick, the new and unbeatable hand-cleaner—the original powdered hand soap! Removes grease, grime, ink, paint, etc., without injuring skin. Spreads like wildfire. Cheaper than all others. Sells in cans (or bulk with dispensers) to garages, autoists, auto supply companies, mechanics, factory and office folks, to housewives, hardware stores. Huge quantities used weekly by mercantile houses. Big repeat business assured. Exclusive agencies, crews working for you; fast sales, splendid profits, permanent business for hustlers. Live ones can clean up $500 a month. Send 10c. (coin or stamps) for liberal sample can. Complete sales plan goes with it. Write quick to Solar Products Co., 124 W. Lake St., Chicago, Ill.

Sales Representative wanted in every county to give all or spare time. Position worth $1,200 to $3,000 yearly. No previous experience or capital necessary. Write for full particulars. A. F. Silver-Chamberlin Co., Clayton, N. J.

World's fastest agents' seller. 300 per cent Profit. Needed in every home and store. Established permanent business. Premier Mfg. Co., 819 E. Grand Blvd., Detroit, Mich.

A Business of your own—Make sparkling glass name plates, numbers, checkerboards, medallions, signs; big illustrated book Free. E. Palmer, 513 Wooster, O.

Tailoring Agents. Greatest One-Price Line. All-Wool Suits at $29.75. You get your profit the minute you take the order. Big Swatch Line in fine carrying case. Salesmen make $100.00 a week. Can use a few more good men. Write fully, state experience, give us good references and we will ship outfit at once. Dept. 392, Park Tailoring Company, Chicago, Ill.

Agents—Big returns, fast office seller; particulars and samples free. One Dip Pen Co., 12 Daily Record Bldg., Baltimore, Md.

Agents, $60 to $200 a Week, Free Samples. Gold Sign Letters for Store and Office windows. Anyone can do it. Big demand. Liberal offer to general agents. Metallic Letter Co., 433Z N. Clark St., Chicago.

We want men and women who are desirous of making $25.00 to $200.00 per week, clear profit from the start in a permanent business of their own. Mitchell's Magic Marvel Washing Compound washes clothes spotlessly clean in ten to fifteen minutes. One hundred other uses in every home. Nothing else like it. Nature's mightiest cleanser. Contains no lye, lime, acid or wax. Free samples make sales easy. Enormous repeat orders—300 per cent profit. Exclusive territory. We guarantee sale of every package. Two other "sight sellers" and sure repeaters give our agents the fastest selling line in the country. No capital or experience required. Baker, Ohio, made $600 last month. You can do as well. Send for Free Sample and proof. L. Mitchell & Company, Desk 79, 1302-1314 E. 61st, Chicago, Ill.

Earn big money fast applying gold initials to autos. Every owner buys. $1.35 profit on $1.50 sale—particulars and samples free. Write quick. Lithogram Co., Dept 19, East Orange, N. J.

Free. Formula Catalog. Laboratories, Boylston Building, Chicago.

Only one sale a day means $200 per month! Five sales, $1,000 per month! Marvelous new adding machine. Retails $15. Work equals $350 machine. Adds, subtracts, multiplies, divides automatically. Speedy, accurate, durable, handsome. Five-year guarantee. Offices, stores, factories, garages, buy one to dozen. A fortune for live agents. Write quick for protected territory and free trial offer. Lightning Calculator Co., Dept. W., Grand Rapids, Mich.

Jaco Sanitary Strops sell on sight to everyone using combs. Three dozen, $3.60 delivered; easily sell for $9.00. $5.40 profit sure every day. Get particulars quick. Jay Company, 113 Jay Building, Washington, New Jersey.

Risk a postal and learn how to start profitable business without capital or experience. $60 weekly easy. Silvering mirrors, refinishing tableware, reflectors, plating. Complete outfit furnished. International Laboratories, Dept. 25, 309 Fifth Ave., New York City.

Agents for my patented night-driving lamp. Can be installed on any car. A. Halliwell Co., 10559 Glenville Ave., Cleveland, Ohio.

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Agents—New Invention. Harper's Ten-Use brush set and fibre broom. It sweeps, washes and dries upstairs windows, scrubs and mops floors, and does 5 other things. Big profits; easy seller. Free trial offer. Harper Brush Works, Dept. Z, Fairfield, Iowa.

We wish representatives in every community to secure subscriptions for Science and Invention, Radio News, and Practical Electrics. This is a wonderful opportunity for Amateur Radio Enthusiasts to make big money quickly. Write Experimenter Publishing Co., Inc., 53 Park Place, New York City.

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Ambitious men, write today for attractive proposition, selling subscriptions to America's most popular automobile and sportsman's magazines. Quick Sales. Big profits. Pleasant work. Digest Pub. Co., Butler Bldg., Cincinnati, Ohio.

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