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August

Science and Invention

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FORMERLY
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"THE MAN FROM THE ATOM"

See Page 329

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"Your course has already obtained a substantial increase in pay for me and made it possible for me to make at least $100 a month in spare time work. You can shout this at the weak fellows who haven't made up their minds to do something yet." Earl Stewart, Corona, Calif.

How to Invent—What to Invent

and What to Do About Protecting and Selling An Invention

ALTHOUGH the fact has been universally recognized that Invention is governed by a few simple, easily acquired, fundamental principles, no one ever thought of putting these principles in black and white so that everybody interested in invention could read them. In spite of the fact that Thomas A. Edison made his famous statement that invention should be taught as a science, thousands of people continued to work blindly, doggedly, haphazardly to perfect their ideas.

But now anyone can learn how to invent. Fifteen famous inventors have at last given to the world the laws and principles of Inventive Science. They have shown every ambitious man and woman how to invent. They are teaching Invention exactly as other people are teaching law, medicine, bookkeeping. Instead of spending years groping blindly, instead of wasting your time in useless, heartbreaking drudgery, you learn how to complete your ideas quickly *and what to do about them* when they are completed. You learn how to think so you are sure to succeed.

—How to develop your imagination
—How to develop your ideas
—How to get the facts you need for inventions
—How to keep legal records of ideas
—How to use scientific principles of mechanics
—How to avoid wasting time on impractical inventions
—How to apply for a patent
—How to organize a company
—How to protect your rights
—How to market a patent
and hundreds of other vitally important facts which EVERY successful inventor knows and uses.

Everybody Invents

For a long time it was commonly believed that every invention was a matter of pure luck—the result of some happy inspiration that suddenly flashed though a man's brain, and which made him fabulously rich without the slightest effort or thought. But you can prove for yourself that this is not so. You can prove for yourself that invention is the result of thinking and action along definitely exact, scientific lines.

Suppose when you went home tonight, you found a window rattling. Through your mind would flash, almost instinctively, a regular order of thoughts which characterize the conception and completion of every invention the world has ever known. First, you would recognize a problem to be solved—the rattling of the window. Then you would think of several principles of science or mechanics which would solve your problem. You might think of the scientific fact that if you poured water on the frame the wood would swell and tighten the window. You might think of using a nail. But what you most probably would do would be to use the oldest mechanical principle known to man, the wedge.

What Invention Is

Brought down to its simplest terms, that is exactly the way every invention has been made—combining two ideas; a problem which must be solved and a fact of mechanics or science which solves the problem. So, although you may never have thought of it in just this way every time you solve a problem in your daily life—at home, traveling, or in business—you are an inventor; you use the principles of thought and action which govern the Science of Invention!

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

You can see, therefore, how easy it is for you to develop your natural instinct to "fix things." The same processes of thought that almost instinctively told you to fix a rattling window with a wedge can be so well developed that you can learn to invent other things almost as easily and quickly. You know, too, that every invention is made only by thinking inventively. And every inventor is agreed that the principles of Inventive Science are so simple, so easy to learn that any one, regardless of training or education, can develop himself to become a successful inventor!

With every new advance, with every new discovery that the world experiences, more problems are coming up—and more inventions are needed to solve these problems. Now, as never before, are new inventions wanted, and the world will pay a fortune to the man or woman who gives it just one of the inventions it needs.

Even little ideas can bring you a fortune. Eberhard who invented the rubber on the end of a pencil, has been paid hundreds of thousands of dollars for his simple idea. The man who invented the metal tip for shoelaces, the man who conceived the idea of the "humped" hairpin, the man who developed the metal tape measure; all have achieved success and wealth as great or greater than the inventors of large machinery.

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If you would like to develop your natural inventive ability along *money making* lines, instead of trifling with ideas—if you would like to DO something about your ideas instead of letting someone else patent and market them ahead of you, let this great Course in Inventive Science help you. Get the advice and the help of the fifteen famous inventors who tell you the secrets of invention which you MUST know to be successful.

This is the first course in practical invention that has ever been devised. In simple easy-to-understand language you are told how successful inventors work; you learn how to think along inventive lines, you learn the short-cuts to successful invention; you learn how to use the secrets of invention that convert a simple little idea into money.

No one step in invention has been omitted. Everything you want to know about invention—developing your ideas, securing information you need, how to apply for patents, how to protect your rights, how to sell your invention—are taken up step by step, so that when you have completed the course you have a wealth of information worth thousands upon thousands of dollars.

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Table of Contents for August

POPULAR SCIENTIFIC ARTICLES

PRIZE CONTESTS

AUTOMOBILES

ELECTRICITY

RADIO ARTICLES

CONSTRUCTOR ARTICLES

ASTRONOMY ARTICLES

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Philadelphia, Pa., E. P. Noll & Co.
Philadelphia, Pa., Roberts Bros. Elec. Co.
Philadelphia, Pa., G. W. Snell Co.
Philadelphia, Pa., Eisenberg & Schaeffer
Philadelphia, Pa., W. T. Grant
Philadelphia, Pa., Neisner Brothers
Philadelphia, Pa., New York Radio Co.
Philadelphia, Pa., Post Cigar Store
Philadelphia, Pa., Schimmel Electric Co.
Phoenix, Ariz., Nielson Radio Sup. Co.
Pittsburgh, Pa., Goldsmith & Sons Co.
Pittsburgh, Pa., Ludwig Hommel & Co.
Pittsburgh, Pa., Gain-a-Day Electric Co.
Pittsburgh, Pa., Liberty Incan. Sup. Co.
Pittsburgh, Pa., Pitts. Radio & App. Co.
Pittsburgh, Pa., U.S. Radio Co. of Penna.
Pittsburgh, Pa., Doubleday Hill Co.
Pittsburgh, Pa., F. & W. Grand Stores
Plainfield, N. J., F. & W. Grand Stores
Plattsburg, N. Y., H. E. Atwater
Portland, Me., L. M. Cleveland Co.
Portland, Me., Chisholm Brothers
Portland, Ore., Stubbs Electric Co.
Portland, Ore., Hynson Electric Co.
Pottstown, Pa., Pottstown Radio Sup. Co.
Providence, R. I., Union Electric Sup. Co.
Providence, R. I., R.I. Elec. Equip. Co.
Providence, R. I., F. & W. Grand Stores
Providence, R. I., B. & H. Supply Co.
Reading, Pa., F. & W. Grand Stores
Rochester, N. Y., Hickson Elec. Co.
Rochester, N. Y., Rochester Elec. Sup. Co.
Rochester, N. Y., Wheeler Green El.Sup.Co.
Rochester, N. Y., Eastman Radio Co.
Rochester, N. Y., R. Schmidt & Co.
Rochester, N. Y., E. C. Sykes & Co.
Rochester, N. Y., Neisner Brothers
Rock Island, Ill., H. E. Gelhart & Co.
Rock Island, Ill., Beardsley Specialty Co.
Rock Island, Ill., Valle Co.
St. Joseph, Mo., Empire Electric Co.
St. Joseph, Mo., Mannschrecks Book Store
St. Louis, Mo., The Benwood Co.
St. Louis, Mo., Fuetterer Battery Service
St. Louis, Mo., Linze Electric Supply Co.
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St. Paul, Minn., North-West Elec. Eq. Co.
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St. Paul, Minn., Pioneer Electric Co.
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Seattle, Wash., Archway Book Store
Seattle, Wash., Williamson Electric Co.
Shanghai, China, E. Evans & Son, Ltd.
Shreveport, La., Interstate Electric Co.
Spartanburg, S. C., Brill Electric Co.
Springfield, Mass., Whitall Electric Co.
Stamford, Conn., Fairbanks Electric Co.
Stamford, Conn., Arthora
Stillwater, Okla., Stillwater Electric Shop
Sydney, Australia, N. S. W. Bookstall
Syracuse, N. Y., Hughes Electric Corp.
Syracuse, N. Y., Alexander Grant Sons
Tacoma, Wash., W.A. Mullens Electric Co.
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Utica, N. Y., Utica Electric App. Co.
Waco, Tex., Jackson's Radio Eng. Lab.
Washington, D. C., Harry C. Grove, Inc.
Washington, D. C., National Radio Institute
Washington, D.C., Con'tal Elec. & Sup. Co.
Watertown, Wisc., D. & F. Kusel Co.
Watertown, N. Y., F. A. Empsall & Co.
West Hoboken, N. J., The Heraco Exchange
West New York, N. J., West N. Y. Heraco
Wheeling, W. Va., Gee Electric Co.
Wilkes-Barre, Pa., Foster Radio & Elec. Co.
Wilmington, Del., Wil'ton Elec. Spec. Co.
Wilmington, Del., Neisner Brothers
Winnipeg, Can., T. Eaton Co., Ltd.
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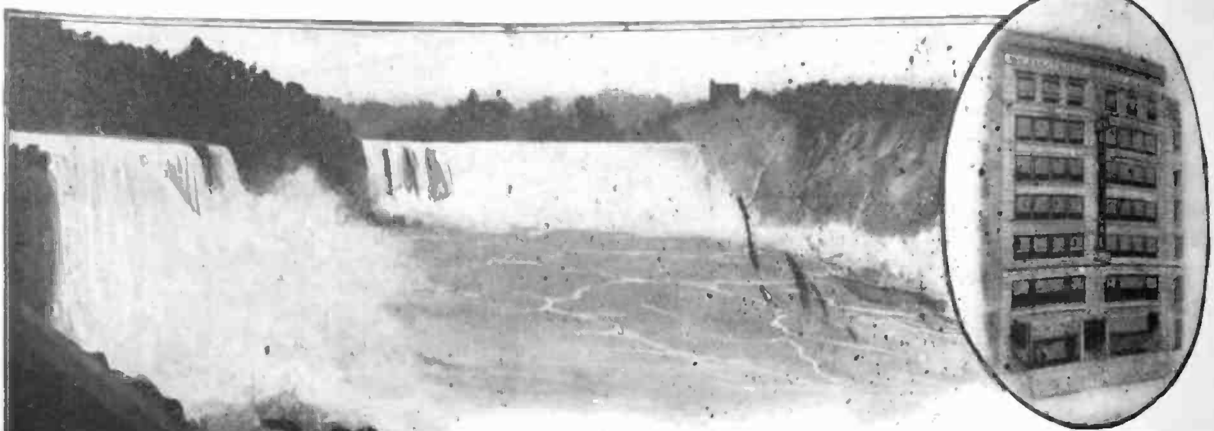

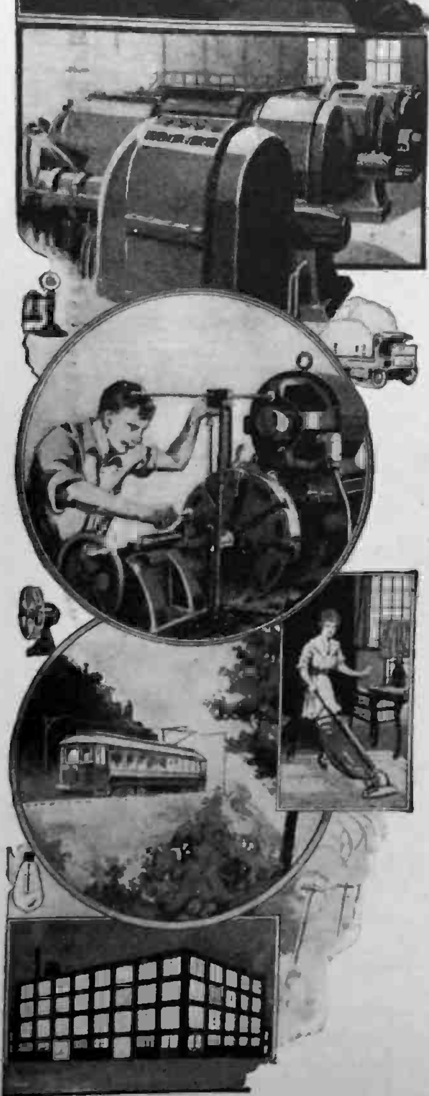

Volume XI
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Science and Invention

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1923
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"Those Who Refuse to Go Beyond Fact Rarely Get As Far As Fact"--HUXLEY

Predicting Future Inventions

EVERY inventor must be a prophet. If he were not, he could not think up inventions that will only exist in the future. For this reason, every inventor must ascend from fact to non-fact. What non-fact will turn out to be, not even the inventor knows beforehand. He prophesies to himself that he can make such and such an invention, all the while thinking about it, and letting his imagination work overtime. He keeps on turning the question or problem over and over in his mind until the subject finally crystallizes itself into a concrete form. All of this takes place in the inventor's mind. He is not working with concrete facts but he imagines and hopes that the particular device upon which he is laboring will turn out to be as he imagines it.

If the inventor's imaginings were wrong, he is a poor inventor. If they are right, he is a good one.

The art of inventing is to produce something that has not existed or has not been known on earth previously. Of necessity, therefore, it lies in the future. Sometimes an inventor may have a perfectly good idea of a certain machine, which he is convinced will work, if certain conditions were fulfilled. He starts working it out until he finds to his dismay that he cannot procure certain materials or certain articles which he knows are needed, but which have not as yet been developed. For instance; inventors over 150 years back, knew the automobile. Steam automobiles operated on the roads of England in the 18th century capable of running at a fair rate of speed and could carry from ten to fifteen people. Such automobiles failed because the automotive power had not as yet been developed perfectly. The missing link was the gasoline engine, which up to that time was not known. The inventor had had all this in his mind's eye and he was prophetic enough to realize that some day such vehicles would become commonplace, as indeed they are now. Jules Verne in his prophetic books, describes dozens of future inventions, nearly all of which have become realities. Indeed, there are not more than three or four of his imaginations left, and these no doubt will come true very shortly. Consider the submarine which was prophesied in its entirety by Jules Verne long before it made its appearance. He had laid the basis for the present day submarine, and lived to see the day when the first one was actually built and had operated as he had prophesied it would.

There are a certain class of people, and we hear continually from them, who condemn the policy of this magazine because we exploit the future. These good people never realize that there can be no progress without prediction. It is impossible to have in mind an invention without planning it beforehand, and no matter how fantastic and impossible the device may appear, there is no telling when it will attain reality in the future. To illustrate: in the August, 1918, issue of the ELECTRICAL EXPERIMENTER, the writer ran a story entitled: "The Magnetic Storm." This was during the war and was a purely fantastic idea; the suggestion was made to stop the war by burning out all electrical instruments throughout Germany. The idea was to have a tremendously large Tesla coil along the border, which would send a current into all electrical circuits through Germany, burning out armatures, automobile wiring, electric installations of airplanes, telegraph and telephone apparatus, etc. While theoretically possible, the idea was very fantastic. Cable dispatches during the middle part of June of the present year brought the news from Germany that the very thing had actually been accomplished by the powerful Nauen radio station. A number of automobiles were stopped at a distance by the energy sent out from this station.

Then again in this magazine we have for the last ten years exploited television, the faculty of seeing at a distance. We have shown all sorts of television schemes, all of which seemed to belong to the distant future. We have on file a great many letters from critics denouncing us for printing such "foolishness," as they call it, because they said it would ever be impossible to invent a machine, by which a man could see at a distance. During the latter part of June, Mr. Jenkins of Washington, publicly demonstrated before Army and Navy officials a machine, whereby it is possible not only to see at a distance but to project a film on a screen in New York and broadcast it all over the country by radio the same as voice and music is broadcasted by radio now.

These are just a few examples among many.

And so it goes. What seems impossible and even ridiculous today becomes an actuality tomorrow. Throughout the ages, the man who looked into the future was usually considered a crank or insane. He is in the same position today. Human nature is such that it opposes changes, particularly if such changes are violent. Anything that tends to pull us out from our daily rut is not welcome, because it means an effort.

When some of our greatest scientific authorities, as late as twenty years ago, proved by mathematics that it was impossible to sustain in the air a machine such as an airplane; when the news of the X-ray was greeted with derision; when the sending of messages by radio was not believed by the populace, when it had already been used for years—it behooves the average man to be extremely cautious in denouncing any idea just because it is new and appears impossible on the face of it.

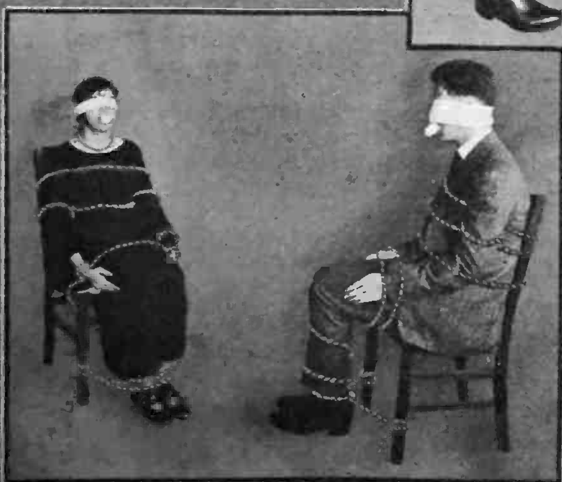
H. GERNSBACK.

In the Center Are Illustrated the Conditions Under Which a Person Must Be Able To Read An Open Book. The Performer Is the Young Lady Against Whose Back Is Held An Open Book. She, Without Seeing the Pages of the Book, Is To Tell What Is Printed Thereon.

At the Left Is Shown How a Mind Reader Must Be Able To Perform In Order To Compete In This Prize Contest. The Young Lady Who Is Blindfolded Must Be Able To Tell What Is Being Written By the Gentleman Whose Back Is Turned To Her.

The Way the Slates Are To Be Held By Mr. Rinn While There Is Being Inscribed Upon Them a Spirit Message.

How a Medium Must Be Bound When She Is To Produce Ectoplasm From Her Mouth Or Any Other Part of Her Body.



Secured As Above, Two Persons Must Be Able To Perform Mental Telepathy From One To the Other In Order To Receive a $1,000 Reward.

A Readable Message, of Which the Young Lady Who Is Blindfolded Knows Nothing, Must Be Produced With the Ouija Board In Order To Meet the Conditions.

ABOVE ARE THE CONDITIONS IN THE $10,000 CHALLENGE BY MR. RINN.

$11,000.00 For Spirit Manifestations

IN the June issue of SCIENCE AND INVENTION MAGAZINE we made an announcement of a $1,000 challenge expiring on May 1st, 1924, in which we offered prizes open for award to any practicing medium imputing supernatural or spiritualistic claims to the manifestations presented. Mr. Joseph Dunninger, chairman of our investigating committee, has announced that up to the present time no medium has had courage enough to come forward and try to win a prize in this contest.

We are repeating herewith the conditions of our contest and adding another; mediums and others may compete for any prize. We have been, and are still of the opinion that we cannot obtain communication from those who have passed out of the world of life. We already know of Mr. Dunninger's work. His name is well known about the country and his articles appearing monthly in this magazine are of vast interest to our readers. Mr. Dunninger and other members of our scientific investigating body, whose pictures will appear in an early issue of this journal, claim to be able to duplicate the stunts of any medium without calling upon spirits to assist them. The communication or whatever it may be must, however, be performed before us.

$10,000 MORE IN CHALLENGE

Mr. Joseph F. Rinn, who was for years a member of both the British and American Societies for Psychical Research, and who participated in such work with the late Prof. James Hyslop, former president of the American Society for Psychical Research, and who further worked with Dr. Isaac Funk, Rev. Minot J. Savage, Prof. William James, Dr. Richard Hodgson, and many others, has added to our challenge an additional $10,000.

It will be seen by Mr. Rinn's prize offer through SCIENCE AND INVENTION MAGAZINE, that he challenges many things which even the educated public believe to be proven. For twenty years he investigated mediums and found his own colleagues to believe in phenomena, which to the endowed magician were absolutely fraudulent. He made statements through the press to the effect that all phenomena classed as psychic by spiritualists were produced through fraud. To prove this both Mr. Rinn and Mr. Dunninger have held open meetings, producing phenomena which outclass spiritualists at their best.

WHAT HAPPENED TO EUSAPIA PALLADINO

When Columbia University experts tested the powers of Eusapia Palladino, the Italian medium, who fooled the scientists of Europe for years, and after sixteen séances were about to certify that her powers were genuine, she was exposed and her methods were thoroughly revealed. Thereafter she discontinued her work. Mr. Rinn also offered to duplicate any of her phenomena by fraud in a test séance, or he would forfeit $1,000. She accepted this offer and the money was duly posted. Photographs were taken at the time when the investigating committee were waiting for her. Both individuals, that is, Eusapia Palladino and Mr. Rinn, were to be tied. Mme. Palladino sent word that she desired eight inches of slack to the rope she was to be tied with; thinking perhaps that Mr. Rinn would object, but instead he agreed. She backed out, however, and didn't show up. Mr. Rinn scoffs at the rewards offered by another publication and their method of investigating would-be mediums, and classes his rewards as follows:

Mr. Joseph Rinn, Who Makes the $10,000.00 Challenge For True Psychic Demonstrations.

> ## $1,000 Challenge
>
> **SCIENCE & INVENTION does not believe that there exists a proven scientific basis to vouch for the communication of the deceased with the living.**
>
> **SCIENCE & INVENTION believes that it can duplicate any avowed spiritistic phenomenon or manifestations effected by any medium, whether they be signals, table-rappings, spirit photographs, or other things.**
>
> **SCIENCE & INVENTION is willing to pay $1,000.00 to any company of sincere investigators, if we cannot duplicate such phenomena or manifestations, to the satisfaction of a disinterested body of scientists.**

$1000—To any person who will read what is on the pages of a book opened at random by me and placed open behind their back during the test.

$1000—To any person who will produce a readable message of any sense on a ouija board, the letters of which have been transposed from their usual positions, and the performer to be blindfolded and his ears stuffed with cotton by me.

$1000—To any person who will cause a message to appear on the inside of slates joined together and provided by me, which during the test are to remain beneath the bosom of my shirt. If removed for examination new slates to be provided by me for further tests.

$1000—To any person who will prove telepathy or the power of two persons to communicate with each other by thought, after being blindfolded, their persons secured, and their ears and mouth filled with cotton by me.

$1000—To any person who will accurately describe something definite going on at a distance in a place selected by me, or who will predict in advance an event or calamity of such a definite nature that it would be impossible for such person to have any controlling power over or previous knowledge of the same; or who will produce a picture on a negative supplied by me while the same is in a locked safe and in a room provided by me.

$5000—To any person who after being searched and secured by me shall produce from their mouth or body what is called *ectoplasm*, and which shall shape itself into definite forms of hands or faces

OR ANY PERSON

who will prove under scientific conditions laid down by me that the spirits of the dead can communicate with the living.

MR. JOSEPH F. RINN, who is making his $10,000.00 challenge this month in SCIENCE AND INVENTION, is well known in psychical circles. The offer that is made by Mr. Rinn is absolutely bona fide and there are no strings attached to it. The conditions that he imposes are extraordinarily simple and not at all technical. Strange to say it requires no apparatus or instruments and the offer is, of course, open to everyone who cares to make a try. The scientific committee selected by SCIENCE AND INVENTION will be impartial enough to suit both Mr. Rinn and the individual trying for the prize.

Mr. Joseph F. Rinn exposed the famous Italian medium Eusapia Palladino who had succeeded in fooling the greatest scientists of Europe for many years.

Furthermore, Mr. Rinn does this work as a hobby; his real profession being a merchant, and he is thoroughly responsible, therefore, for the $10,000.00 which he offers.—EDITOR.

OUR $1,000.00 CHALLENGE

1—The contestant must be a practising medium or spiritist, imputing supernatural or spiritistic claims to the manifestations to be presented. This offer is made as a test to spiritists directly. It does not include conjurers' tricks or optical illusions. Therefore the performances of magicians, or of those not claiming spiritistic powers, cannot be considered, and such tricks will not be accepted as evidence, the contest being intended for practising mediums only.

2—Contestants must be willing to undergo tests on spiritistic phenomena or manifestations at the New York offices of SCIENCE & INVENTION, at 53 Park Place.

3—The same committee of investigators that witnesses the tests of the medium will also witness the tests which SCIENCE & INVENTION will stage to duplicate the phenomena or manifestations in question.

4—Automatic writings will not be considered: such productions as these are considered subconscious phenomena.

5—Mediums must consent to present their offerings before the staff of SCIENCE & INVENTION'S investigation experts, general press representatives, and also Joseph Dunninger.

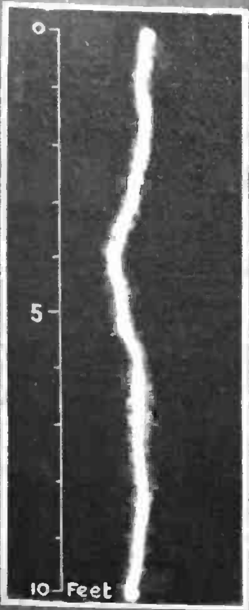
6—It is understood that SCIENCE & INVENTION need not necessarily expose the methods they employ in duplicating the phenomena or manifestations. If the effect produced by the presentation of SCIENCE & INVENTION duplicates the tests submitted by the medium, this is to be accepted as a sufficient reproduction. The details or methods employed by SCIENCE & INVENTION need not be exposed, as it is understood that SCIENCE & INVENTION reproduces all manifestations in a scientific manner, minus the spirits.

7—An impartial committee will pass upon each test, individually.

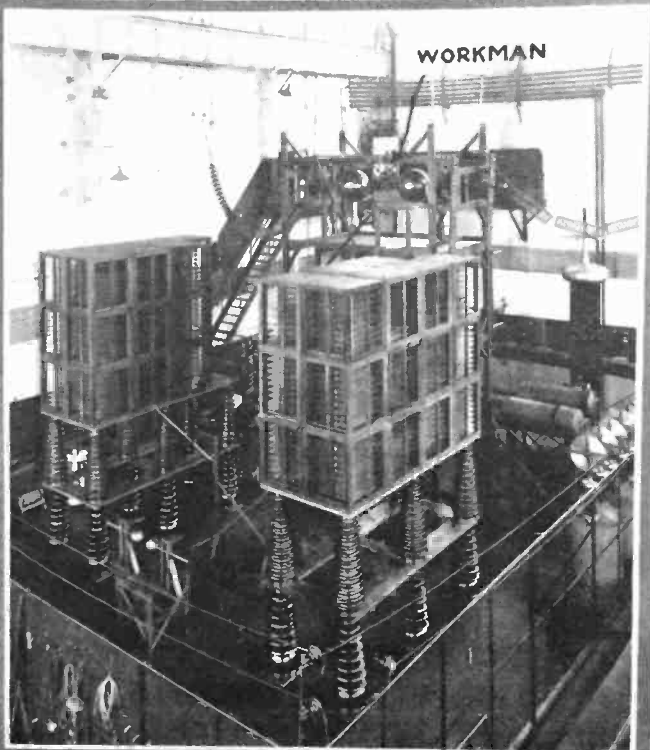
8—No exposés will be published in this magazine as to the methods employed by the practising mediums contesting, as it is SCIENCE & INVENTION'S desire to expose nothing other than fraud spirit medium methods, as well as self-deceptions.

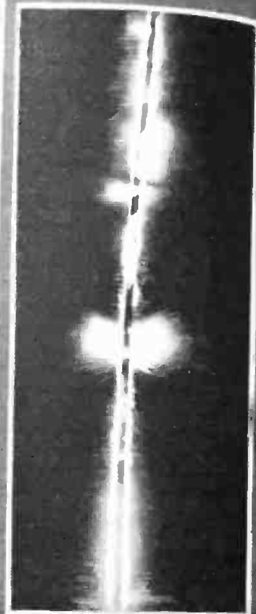
(*Continued on page* 411)

MAN-MADE LIGHTNING



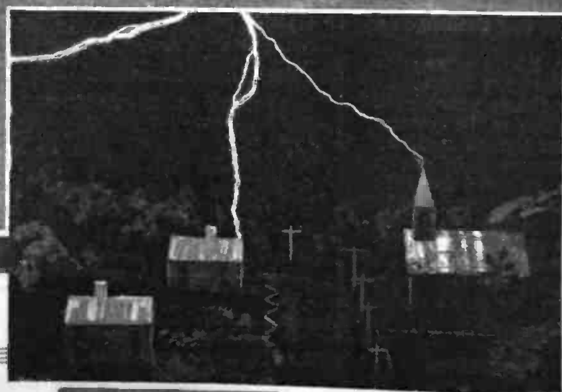
1,500,000 Volts Leaping a Gap Between Needle Points Ten Feet Apart. At 2,000,000 Volts, the Spark Jumped a 15-Foot Gap.

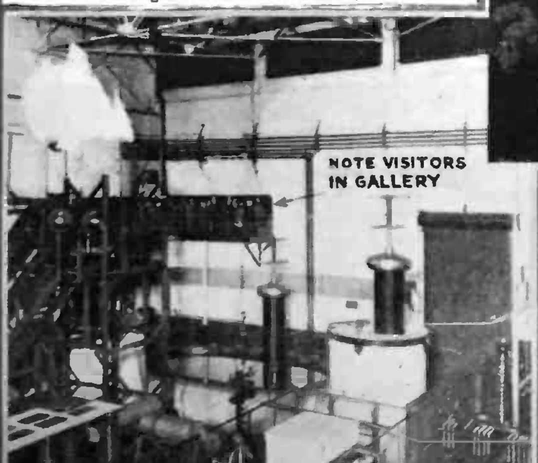




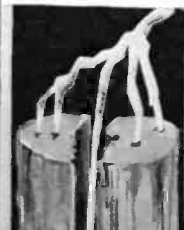
Showing How the Corona Discharge Around a Small Wire Carrying Too High a Voltage Causes Loss of Energy. This Wire is Too Small for the 800,000 Volts Applied to it.

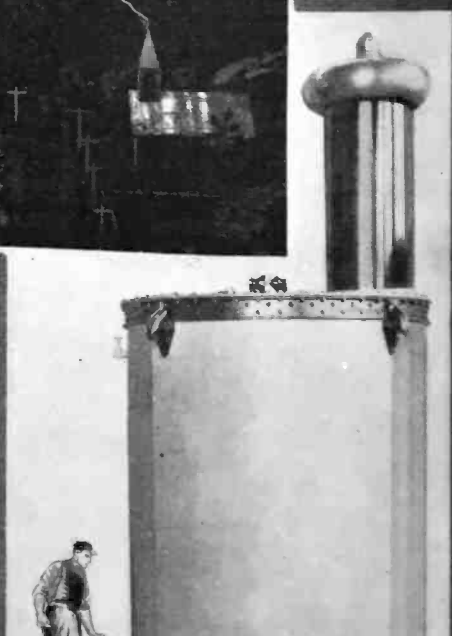
Holes Burned Through Metal by Man-Made Lightning Discharges in Mr. Peek's Researches.





A Miniature Village Demonstrated in Connection with 2,000,000 Volt Lightning Bolts with Rain an' Everything. Several Buildings Were Struck.





Yes, They Were Delighted (Afterwards), As They Stood in the Gallery of the High Voltage Laboratory of the General Electric Company, at Pittsfield, Mass., and Watched the 2,000,000 Lightning Bolts Jump Across the Spark Gap, as Shown in the Picture Above.

Showing Tremendous Size of Specially Insulated Transformers Used in 2,000,000 Volt Experiments.

Man-Made Lightning

Two Million Volt Discharges Produce Artificial Thunder Storms

TWO million volts, the highest electric potential yet generated directly with the aid of transformers or lightning generator, was loosed in the high voltage engineering laboratory of the great General Electric Works, at Pittsfield, Mass., a few weeks ago, before a group of invited guests. Giant sparks and arcs of various kinds leaped, crashed and snapped across huge spark gaps ten to fifteen feet or more in length with a deafening roar that held the spectators spellbound. This apparatus was all contained in a steel building, so that the waves set up by the terrific discharges would not interfere with the electric light and telephone circuits about the city or cause Hertzian waves to be radiated over the earth, which might interfere with radio receiving plants many miles distant.

The voltage was raised from one hundred thousand gradually, the glow discharge about the various wires and spark gaps increasing in the darkened chamber, until suddenly when a maximum potential of some two million volts was reached, the spark gap was bridged with a roaring crashing spark discharge that looked, and in fact was, exactly like the lightning discharges produced by Dame Nature. Dr. Steinmetz's guess is that the average lightning flash is about 15,000,000 volts; other estimates place the potential of Nature's lightning flashes as high as 50,000,000 volts. Mr. Peek's recent investigation indicates that the voltage of the lightning flash is higher than heretofore supposed. The lightning generator developed by Mr. Frank W. Peek, Jr., consulting engineer of the General Electric Co. and in charge of the high voltage research, has been added to from time to time until at present over two million volts are available, and experiments with discharges exactly resembling real lightning so that the effects on transmission lines and many other engineering problems, such as the loss of power due to corona or glow discharge at high voltages, can be carried on. "This impulse generator discharge must not be confused by that produced by an oscillator," says Mr. Peek in his technical discussion of the results of the experiments published in the American Institute of Electrical Engineers Journal. The difference between the Peek lightning generator and others is that it is excited directly by A. C. voltage and does not require rectifiers and static machines. Hence much higher voltages are obtained.

12 FOOT SPARKS

The length of the spark gap, measured between needle points, which a current at a potential of 1,500,000 volts will jump, is, according to the curves and results of test given by Mr. Peek, 115", or nearly ten feet. When the tension is raised to two million volts, or 2,000 kilovolts, a kilovolt being a unit of 1,000 volts, the length of the spark gap between needle points which this gigantic potential will jump is 12½ feet. The current value of the discharges, some of which measured 3" in diameter, between metal spheres frequently rose to 10,000 amperes.

During a thunder storm lightning voltages that reach the transmission line appear across insulators, transformers and other apparatus at the extremely rapid rate of millions of volts per second. With this rapid rate of application the voltage may reach a very high value in a micro-second (one-millionth of a second). Hence, since there is always a delay or lag in the breakdown of insulation, quite peculiar effects result from these voltages. For instance, some remarkable phenomena that take place are: Much higher lightning voltages are usually required to jump a given distance than voltages at normal operating frequency; conductors at normal frequency voltages are often good insulators for lightning voltages; water may be punctured like oil; the wet and dry spark-over voltage of insulators are equal; the lightning discharge has a decidedly explosive effect, etc. In addition to the characteristics just mentioned, a study has also been made of the change in voltage and shape of a lightning wave as it travels over a transmission line at the velocity of light.

MINIATURE VILLAGE STRUCK BY "ARTIFICIAL LIGHTNING"

To show that the man-made lightning was in every respect almost exactly, if not a true replica of Nature's electric discharges during thunder storms, a miniature village several feet long was placed beneath the spark gap and even artificial rain was available. One of the accompanying photographs shows the branchlike discharge of artificial lightning several feet in length, as it struck the lightning rod on the miniature church and other buildings in the town. Incidentally, the value of the lightning rod was proven, as the buildings were not set afire or even scorched.

Another interesting and striking test conducted by Mr. Peek and his associate engineers, to prove that his artificial lightning was indeed just like that produced in Nature, including the accompaniment of explosive effects, due to the liberation of millions of kilowatts in a single discharge in the infinitesimal fraction of a second, consisted of splitting large pieces of hard wood asunder with one single crack of the 2,000,000 volt spark. Down the center of the 12" and 18" pieces of maple ran a large indented mark where the current had run its way through. In most cases the wood was not burned at all. Occasionally there were slightly blackened spots as though they had been a little burned, and the wood was somewhat darker on each side of the indentation. It smelt peculiarly from the gases generated by the electric discharge or spark.

LARGE TUBES FOR HIGH TENSION WIRES

As the result of some of these experiments with 60 cycle power currents it has been found that the problem of keeping down the corona loss has been found to be one of building a tube of sufficient diameter, and one 6½" in diameter has been mentioned as the proper size for carrying a potential of one million volts. The second problem with regard to transmission lines is to space these tubes or cables far enough apart. In this respect, the sparking distance for 60 cycle power currents is over nine feet for one million volts, and almost fifteen feet for a million and a half effective volts.

At present the highest voltage in use for transmitting power is a little less than a quarter of a million volts, or 220,000 volts to be exact, which is in use in California. The principal reason why electrical engineers are endeavoring to find how to efficiently employ higher and higher voltages for transmitting electric power is that as the voltage is raised, the current is reduced and conductors of less weight may be utilized, and power may be transmitted more economically over greater distances, which is the all important thing in the scheme of the super-power plants now being talked about by the leading engineers of the day.

HIGHER VOLTAGE MEANS LONGER DISTANCE POWER TRANSMISSION

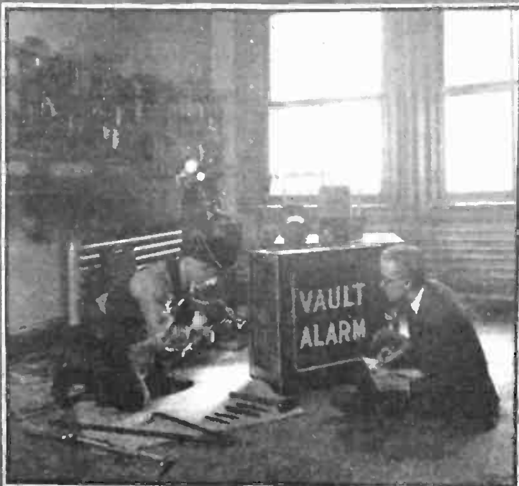
For example, one hundred thousand horsepower may be transmitted over a distance of two to three hundred miles economically at a potential of 220,000 volts which is in actual use in southern California at present. Raise the potential to one million volts and three million horse-power may be transmitted a thousand miles economically with the same amount of copper, but of larger diameter, made in the form of thin tubes. Tomorrow there will be a demand for the transmission of such power over great distances, as our engineers come to examine the giant sources of power which are now going to waste in various parts of the country.

WATER HAS HIGHER DISRUPTIVE STRENGTH THAN AIR

One of the peculiar results of the tests so

(*Continued on page* 375)

SCIENTIFIC SAFETY TESTS

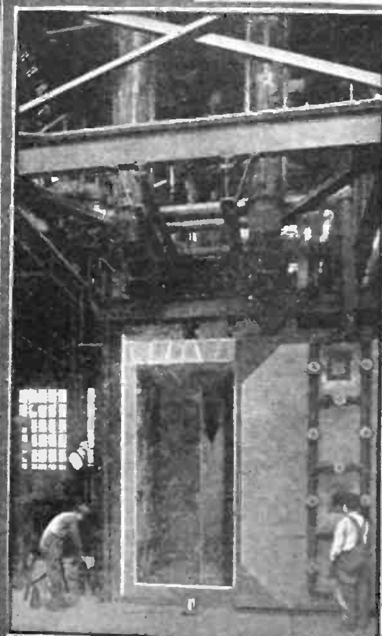


Above: Testing a Vault Alarm With a Breast Drill and Burglar's Tools.

Testing a Hand Fire Extinguisher on a "Standard" Fire.

Testing Electrical Alarms and Other Protective Devices in a Safe.

Dropping a White Hot Safe on a Pile of Bricks to Determine its Ruggedness of Construction.



A Combination of Furnace and Hydraulic Ram for Testing Building Pillars.

Determining the Elasticity of an Automobile Bumper.

Determining Whether or Not the Lenses Used on Automobile Headlights Comply With the Law Requiring Non-glaring Lights.

Underwriters' Safety Tests

By A. P. PECK

DO YOU KNOW WHAT AN IMPORTANT PART THE UNDERWRITER'S LABORATORIES PLAY IN YOUR LIFE? FOR INSTANCE, DO YOU KNOW THAT YOUR FUNDS IN THE SAVINGS BANKS AND VAULTS OF VARIOUS TRUST COMPANIES ARE PROTECTED TO A GREAT EXTENT BY THESE WORKERS? THEY ARE, HOWEVER, AND THE METHODS USED IN TESTING THESE PROTECTIVE DEVICES ARE DESCRIBED IN THE TEXT HEREWITH. EVEN YOUR SAFETY FROM FIRE DEPENDS UPON THESE EVER WATCHFUL WORKERS AS THEIR TESTS INCLUDE ALMOST EVERY CONCEIVABLE TYPE OF FIRE EXTINGUISHER AND FIRE PREVENTION APPARATUS. EVEN YOUR AUTOMOBILE EQUIPMENT IS PROTECTED BY THEM. IT IS WELL WORTH WHILE TO READ THE ACCOMPANYING ARTICLE. TO GET AN INSIGHT AS TO THE WORKINGS OF THIS WONDERFUL DEPARTMENT KNOWN AS THE BOARD OF UNDERWRITERS.

TO the majority of persons the phrase "Passed by the Board of Underwriters" does not carry a very great meaning. It is taken as a matter of course that such things are passed and the public at large is not familiar with the rigorous stages of testing to which various articles are subjected before that little phrase cited above can be applied in the advertising of that particular article. Also the great scope of the Underwriters Department is not usually realized and the significance of the name, to most people, is confined to a very few articles.

SAFES HEATED WHITE HOT AND DROPPED

For instance, it is not usually known that safes are put through a series of exacting tests before they are acceptable to large banks and trust companies. However, several of the illustrations given herewith will show at once that the tests made are of a very exacting character and tend to make safe deposit vaults and safes more reliable.

For instance, the safe to be tested is placed in a furnace, but before the doors of the safe are closed, several magazines, newspapers, and loose papers are placed on the shelves. The safe is then closed and locked and the furnace sealed. Gas is turned into the furnace and ignited and through mica peep holes in the walls of the furnace the engineers make observations. The fire is regulated to keep the temperature even on all sides and the heat is kept up for over four hours. At the end of this time the safe is white hot; the fires are extinguished and the safe is allowed to cool. If the papers within the safe are found to be damaged upon opening the safe, it is not passed. Also if thermo-couples which have been placed within the safe before the test started have registered higher than 300° F., the safe is not considered fit and does not receive the Class A label.

After this actual fire test, if the safe has so far passed the requirements, it is replaced in the furnace and heated again to a white heat. It is then removed from the furnace, chains are slung around it and it is hoisted to a height of over thirty feet, as shown in one of our photographs. From this height it is dropped upon a concrete base, which is covered with broken bricks. When the safe has cooled it is again examined and then subjected to still further heat. It is turned upside down and subjected to flames for one hour. After cooling, the contents are again examined and if intact, an autopsy is performed on the safe itself, which determines what grade label should be awarded to it. This last operation shows the condition of the insulation between the walls.

SECRET CHECK KEPT ON SAFES

The tests outlined above are not always made upon safes furnished by the manufacturer for this particular work, but about once a year, safes of various models are purchased secretly on the open market and then tested, doing away with any possibility of the workers testing a safe especially prepared to undergo such an ordeal.

Another test is also made on safe and vault alarms. The covers of these alarms are subjected to the oxy-acetylene torch as well as to the electric drill- and hand-drill. If an impression can be made upon the casing of the alarm in such a way as to interfere with the working of the mechanism, it is not passed. Our photograph shows one of the testers with a full layout of burglars' tools attempting to get at the working parts of a vault alarm. However, he was not able to make an impression upon it, either with the hand-drill or with his various chisels and therefore, the safe was awarded the Underwriters' sanction.

ELECTRIC SAFE ALARMS TESTED

Another of our illustrations shows how various electrical alarms which are designed to be placed within safes, are thoroughly tested and subjected to a complete examination by experts. The ability of the alarms to work under all conditions is taken into consideration, as is also the fact that they sometimes operate at times when there is no attack being made upon the safe. Such deficiencies are carefully watched for and tested. All these tests and many others are made which render the work of the burglar more difficult day by day, and will, it is to be hoped, eventually eliminate stories of bank burglaries from our newspapers.

FIRE EXTINGUISHERS RECEIVE THIRD DEGREE

One of the greatest home protectors which has been invented is the hand fire extinguisher and practically every office building throughout the country is or should be equipped with one or more. However, these fire extinguishers are not infallible and the Underwriters have done considerable work towards making them more nearly perfect. Our illustration shows one of these hand fire extinguishers being tested on a *standard* fire. If a certain amount of the chemical contained within the extinguisher will not put out the standard fire within a certain length of time, that particular piece of apparatus will be rejected. Tests are also carried out on various types of sprinkler systems and other fire preventatives. All types of fire alarms are also subjected to examination and anyone purchasing one labeled as being passed by the Board of Underwriters may be sure that he is getting the very best of apparatus.

AUTOMOBILE EQUIPMENT THOROUGHLY EXAMINED

Various states in the country are lately conducting vigorous campaigns against the use of automobile head lights which glare into the eyes of the driver of an oncoming vehicle. Various lenses and other apparatus are designed to reduce this dangerous glare and the Underwriters' Laboratories are fully equipped with apparatus for measuring the light intensity of various types of headlights. The beam of light at any given point from the car is carefully studied to determine whether or not the headlight will comply with the various laws. Its non-glare qualities are studied as well as the possibility of it throwing the light too high from the ground.

The above test is especially interesting now, as several states have passed laws, which in a very short time will require every automobile driver to have his headlights examined and tested against a standard photometer. If his headlights pass the test he will be given a card stating that fact, which card must be carried at all times, the same as the driver's license is now required.

Bumpers are as important a part of a car as anything else and if the apparatus is not capable of withstanding humps such as would be encountered in collisions it is valueless. The Underwriters' Laboratories test various types of bumpers by mounting them as shown in the accompanying illustration and causing a pendulum with a weight of about 600 pounds to swing back and forth against the bumper. The weight is swung through a given distance at all times. If the bumper is to pass the test it must give with the shock, but spring back into its normal position. If it does not do this it is not awarded the Underwriters' label.

Aside from those two parts which we illustrate in the action of being tested, there are various other parts of the car which are subjected to the eagle eye of the inspectors. Wind shield visors, stop lights, locks for preventing theft which are to be attached to the steering wheel and various other accessories and necessities on the car are thoroughly examined and subjected to various tests in order to determine whether or not they are worthy of being used.

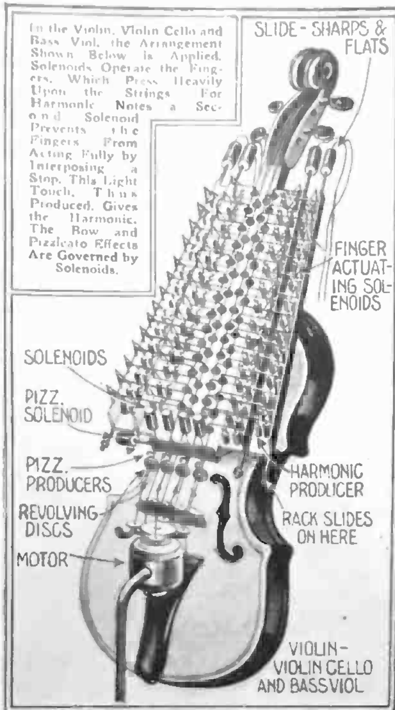
NOVEL BUILDING MATERIAL TESTS

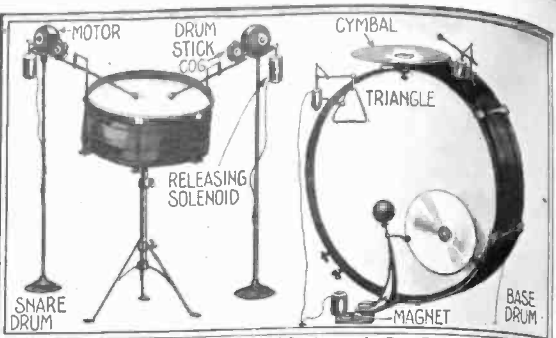
Various materials that go into the construction of buildings are often purchased on the open market by the inspectors, and are made to undergo the tests which have been outlined for them. For instance, in our illustration we show a combination of furnace and ram. In this apparatus is placed a column which has been designed to support various parts of buildings. This apparatus consists of a furnace capable of maintaining a heat of the intensity to be anticipated in building conflagrations, while at the same time a hydraulic ram exerts a downward thrust which is equivalent to the weight of many stories in the building. If the column buckles it is not passed.

These are only some of the many objects which are daily tested by the Underwriters' Laboratory and if anyone desires to go into the matter further they will find a comprehensive study of the various tests given in a new work entitled "A Symbol of Safety," by Harry Chase Brearly. This book deals entirely with the work of the Underwriters' Laboratories and is very complete throughout. It covers considerably more ground than we have been able to do in this short article and anyone interested in the work will do well to procure a copy of the book. The photographs used herewith are given by courtesy of the Brearly Service Organization.

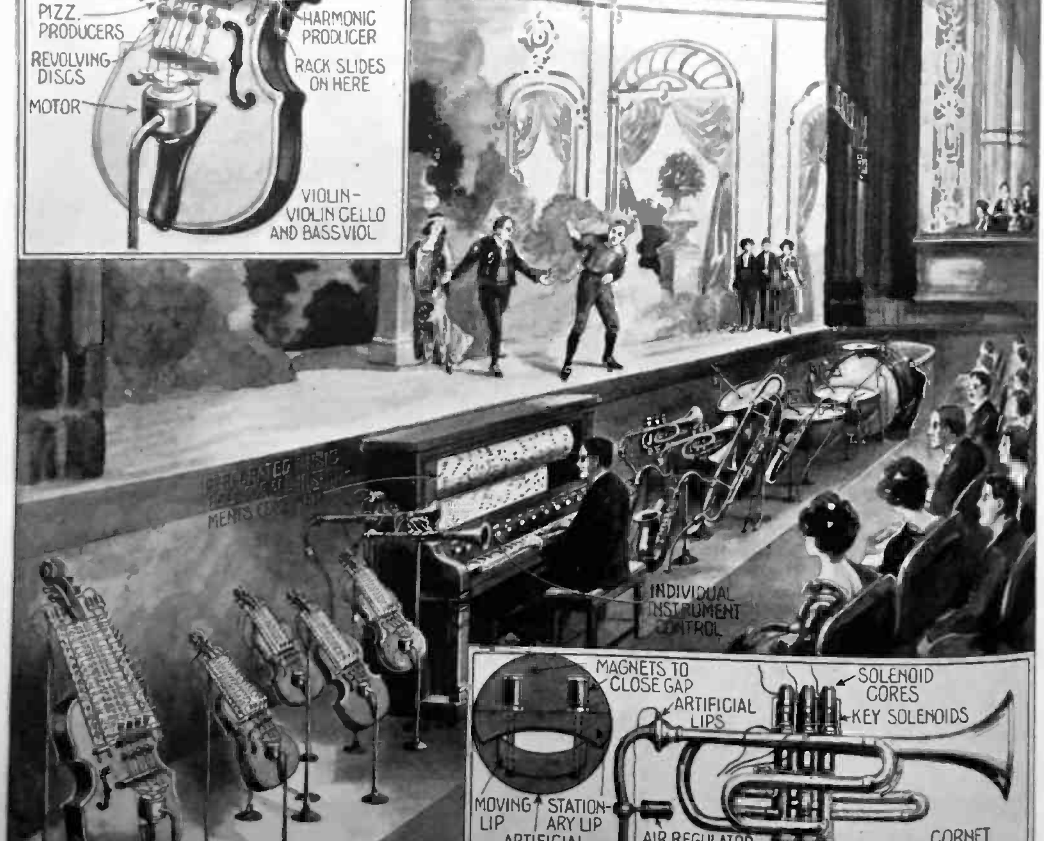
(EDITOR'S NOTE—Anyone desiring to purchase a copy of the above mentioned book may obtain the name and address of the publisher by addressing the Editor and enclosing a stamped self-addressed envelope.)

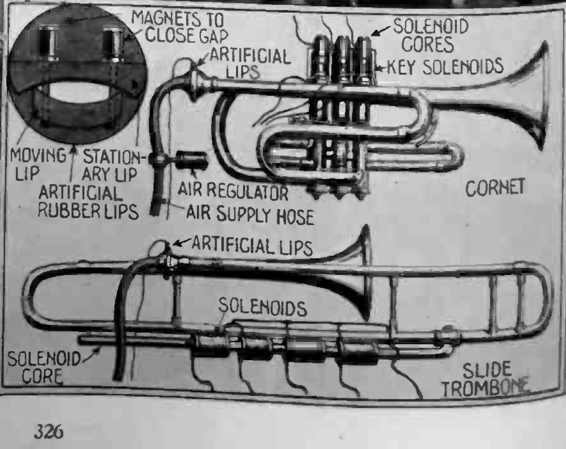
In the Violin, Violin Cello and Bass Viol, the Arrangement Shown Below is Applied. Solenoids Operate the Fingers, Which Press Heavily Upon the Strings. For Harmonic Notes a Second Solenoid Prevents the Fingers From Acting Fully by Interposing a Stop. This Light Touch, Thus Produced, Gives the Harmonic. The Bow and Pizzicato Effects Are Governed by Solenoids.





Solenoids and Magnets Control individual Strokes on the Bass Drum, Cymbal and Triangle, While a Motor-Driven Cog Causes the Rat-tat-tat of the Snare Drums.





The Complete One Man Orchestra Is Shown in the Above Diagram. A Perforated Music Roll Operates All the Instruments Simultaneously. Stops Regulate the Intensity of Volume of Each Instrument, While the Tempo is Likewise Controlled by the Conductor. At the Right We See the Apparatus Used on Both the Cornet and the Slide Trombone. Artificial Lips Enable These Wind Instruments to Duplicate the Playing of an Expert. Solenoids Control the Main Air Supply, and the Keys of the Cornet or the Slide of the Trombone.

The One Man Orchestra

By H. GERNSBACK

IN these days of labor saving, strikes, and what not, it becomes more and more necessary to save man-power wherever possible. When we visit the average first class theater, we seen anywhere from forty to ninety musicians in the orchestra pit, while if we come to the smaller cities, we find that good productions of operas and musical comedies have been suffering from lack of musicians. Good musicians tend to flock to the great centers more and more because they know more money can be made there. So the smaller cities usually have not much talent left. The idea therefore to have a mechanical orchestra that would replace twenty to fifty first class musicians is not so absurd as it seems to be at first. Furthermore the idea is neither improbable nor impossible.

One of our big musical instrument companies is already turning out mechanical musical instruments, and there is on the market now a small automatic orchestra which contains a piano, violin, drum, etc., and such instruments are in good demand. The next step was to develop the idea on a larger scale, not only for the piano and the violin, but for *all* musical instruments. The adjoining illustration shows how it can be accomplished.

Let us first consider the electrically operated violin, 'cello and bass viol. There is nothing new about these instruments as they have already been made. It is possible by this means to reproduce any sound that human fingers and the bow can accomplish. On these instruments we have a number of solenoids which replace the fingers. A number of revolving disks operated by a small electric motor replace the bow. We even have the pizzicato notes produced as well as the harmonics, all of these being operated by solenoids. Once the violin or 'cello has been tuned, it will play any score from a regular perforated paper roll and with such fidelity that it is impossible to tell whether the instrument is being played mechanically or by hand.

The next instruments which so far have not been developed, are the cornet and slide trombone. These two instruments are operated by compressed air, and here again a number of solenoids operate the pistons to imitate the human fingers. An artificial rubber lip is represented by an electro-magnetic valve shaped to resemble the natural lips which open and close as desired. Then there is a regulator to control the amount of air from the source of air supply. The same thing holds true of the slide trombone, where a number of solenoids are coupled together to operate the slide backward and forward, the same as do the human hand and arm. The flute, piccolo, and other musical instruments are operated in much the same manner. The drums, such as snare drum, and bass drum, are operated by electro-magnets as well, as is clearly shown in our illustration. The drum sticks are operated by a small electric motor and the cog reproduces the drum tattoo, much the same as the human hand and even faster if so desired. The bass drum is operated by means of larger magnets, while the cymbal and the musical triangle are worked by small electro-magnets as shown in the illustration.

As for the operation of such an orchestra, it requires, of course, a regular conductor, for the reason that while the various musical instruments are electrically operated it is the function of the conductor to give the expression, the tempo, and all other refinement in music, the same as if the instruments were played by regular musicians. The perforated roll upon which the musical selection is stencilled will reproduce nothing except straight music, but when it comes to expression and real interpretation, the conductor is called upon, and you may rest assured that he will not have a simple task. There will be several keys on a piano-like board for each instrument. The conductor will have to play these keys the same as an organist works his keys. In this manner the full expression is brought out from the various instruments.

As soon as these various instruments have been commercially developed, there is no reason why a mechanical orchestra of sixty to one-hundred pieces cannot be played by one man. In this case, the conductor will have the glory that he really is conducting, as it is well known that many conductors these days, unless they are exceptional, do not really conduct, and as experiments have shown, the orchestra can get along without the conductor tolerably well, providing of course that it is a well trained one.

"How to Make Money"

By JAY G. HOBSON

THERE is an old saying that it isn't what you make but what you save that counts. That is true as far as it goes, but it doesn't go far enough to make a man rich. Before there is anything to save something must be made: and the more that it made, the more one can save if he will practice thrift and economy.

In this discourse we are particularly interested in making money and will let the thrift habit overtake us afterwards.

Making money enough to be called successful and saving such of it as to be called well-to-do is the most difficult part for the majority of us. However, there are more opportunities than you may imagine if you will but train your mind to observe them and then make the most of them as quickly as your ability and resources permit.

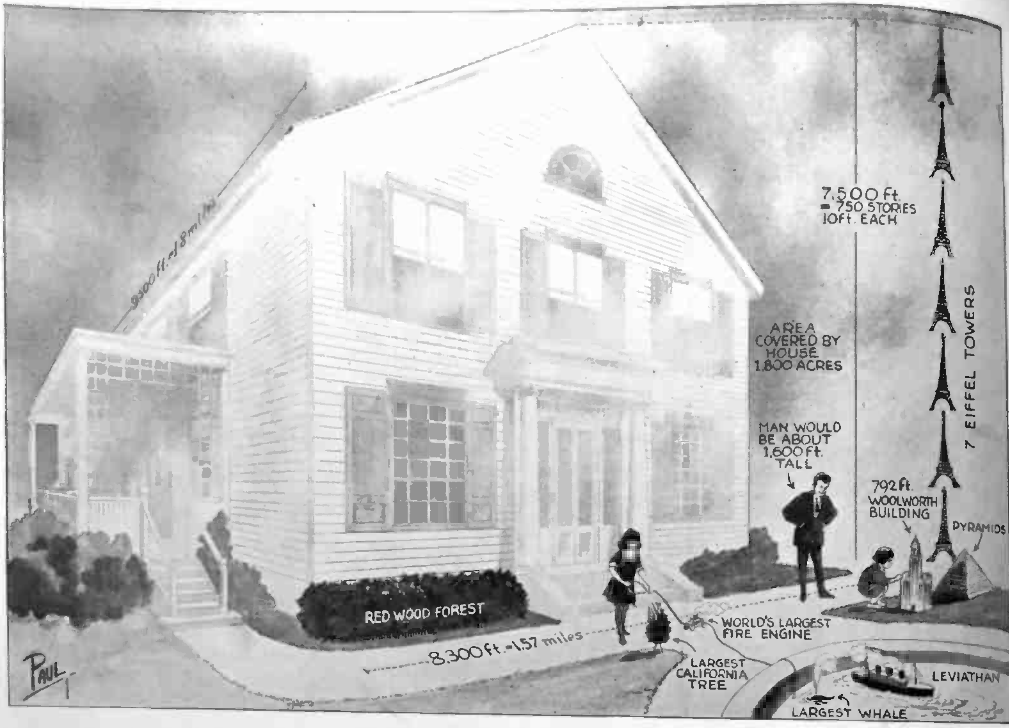
For instance there is a pressing need for an improved telegraph transmitter that will send telegrams more rapidly. The ancient finger method still employed is not speedy enough for present requirements. Something in the form of a perforated paper roll is needed—one upon which the message to be sent can be stenciled, then inserted into an automatic transmitter and a greater number of words per second could be sent over the wires that are so badly congested now with inert finger messages.

Any improvement in radio, properly perfected and protected undoubtedly will bring wealth to the originator. The prohibitive cost of building material creates many opportunities for new inventions in substitutes for lumber, and more economical designs of buildings of all kinds. The inventor who can design an attractive home that will cost less than the present kind certainly will profit well from his improvement and also do much good for his fellow men.

A most lucrative field for inventors is the advertising novelty line. Anything new and novel, that will attract the eye of the public, and that can be made in large quantities at small cost will find a great sale, because this is the age of publicity and anything that will help to place a product before the potential buyer's eye will interest the average business man.

One of the successful advertising novelties that has made its inventor wealthy is the small, round dime savings bank. It is inexpensive, attractive and effective. Puzzle devices that have space for the advertiser's name always make good money. The field for new advertising inventions is so extensive and success so certain, that I often wonder why inventors overlook it. Something small, inexpensive and simple is usually preferred. If it works or runs, so much the better. It will create interest in its operation and advertise the article it represents quite forcefully. Start your thinking machinery to work for something practical, protect it with a patent when perfected, and your chance for wealth is good.

Another field which is open to the resourceful inventor, particularly one with a chemical turn of mind is that of beauty preparations. It seems that the women are particularly susceptible to any new cream or powder which will give them the youthful complexion which they so greatly desire. Of course, there are many such compounds on the market today, but there is always room for more, particularly, if it has any great merit. The chemist in working on such a formula should always remember that anything which will be the least injurious to the skin is absolutely taboo. The compound must be easily applied and if it is one that is designed to present a beautiful exterior, it must be so made that it will not easily wear off or otherwise become less presentable in the course of a day. Beauty clays have lately come into great popularity and an inventor with a new one is sure to find a good sale for it, if it is properly advertised and otherwise brought to the attention of the women. The usual clays on the market today require some time for preparation, and usually have to be left on the face for a considerable length of time. One that could be placed on the face and not be noticeable would be very useful, or one that would do its work instantaneously would be sure to find a ready market.



If All the People in the United States Lived in One Dwelling House It Would Be of the Size Illustrated Above. Its Total Height Would Be 1½ Miles or Slightly More Than the Height of Mount Washington. Its Width Would Be 1 6-10 Miles or Slightly Less Than the Total Length of Brooklyn Bridge. The Woolworth Building and one of California's Largest Red-Wood Trees Are Shown in Comparison with This Building. The "Leviathan," Looking Like a Toy Boat, Is Also Shown for Comparison.

If All the People in the United States Lived in One Vast Dwelling

By CHARLES NEVERS HOLMES

ABOUT forty years ago, fifty million people lived in the United States. They occupied 9 million dwellings, from Atlantic to Pacific, and, on an average, each dwelling housed 5 6/10ths people. Ten years later, almost sixty-three million people lived in the United States, occupying about 11,483,000 dwellings. At the beginning of the 20th century, our country possessed 76,000,000 citizens, young and old, and more than 14,000,000 dwellings. In 1910, there were 92,000,000 citizens, who dwelt within almost 18,000,000 homes. At this present time, the population in the United States approximates 109,000,000, and our country possesses, in all probability, about 21,300,000 dwellings.

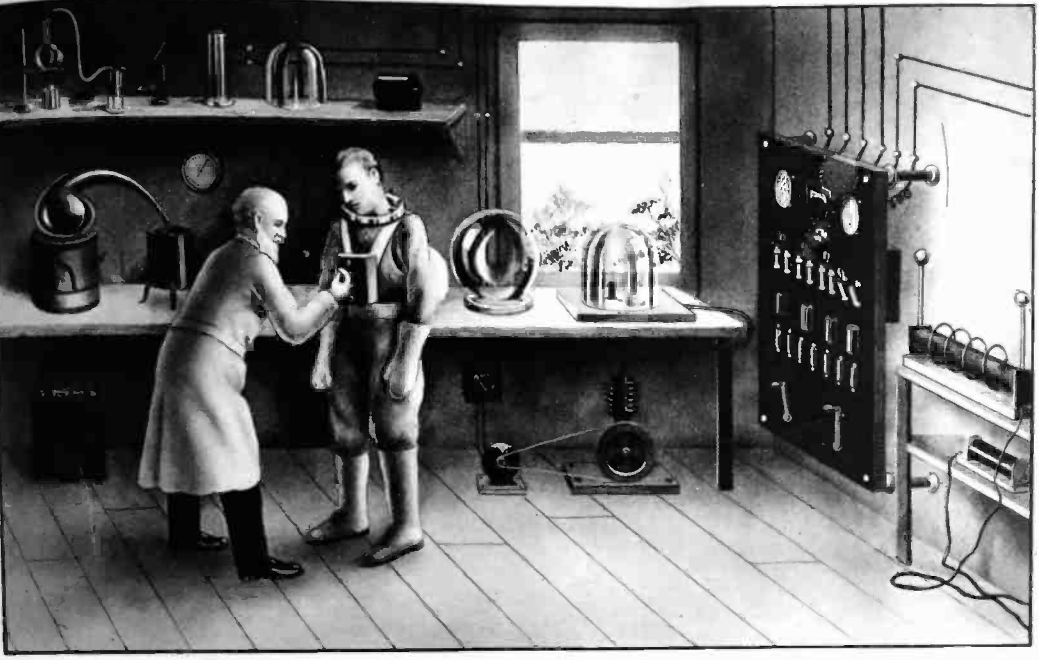
Accordingly, there are about 5 1/10th persons to each dwelling. Or, 4 3/10ths persons to a family. As we should expect, the state of New York averages a larger number per dwelling than any of the other states, 7 8/10th persons to each of its more than 1,300,000 abodes. The state of Massachusetts comes next to New York in the number of occupants per dwelling, about 6½ persons. After Massachusetts, there follow the states of New Jersey, Rhode Island, and Connecticut. The District of Columbia has about 6 1/10th occupants per dwelling, and the state having the smallest average per dwelling is Nevada, about 3 7/10ths persons.

These 109,000,000 citizens of the United States, domiciled beneath 21,300,000 roofs, are scattered over a surface-area of about 3,000,000 square miles. That is, were each citizen—men, women and children—to own exactly his average share of national real estate, he would possess almost 3/100ths of a square mile. Accordingly, he would own about 17 acres of land and water. Were all these 109,000,000 people to live within the District of Columbia, each of them would occupy, on an average, about 17 square feet of land. Were all of them to live together, under one roof, inside of one vast dwelling, such a dwelling, mountainous in height, would occupy only a little more than twice the area of Central Park, in New York City.

That is, such a vast national dwelling would have a height equal to, or higher than, Mount Kosciusko, the loftiest peak in Australia. Its foundation would rest upon a surface-area covering, approximately, 1,800 acres. Our country's entire population could not be crowded together into the foundation area occupied by this huge domicile, and this dwelling would have to possess 750 stories, each 10 feet in height in order to provide each of its occupants with an individual space equalling about 4,500 cubic feet. In other words, each of its occupants would then have a cubical home, about 16½ feet for each of its three dimensions.

Of course such a huge national home would have to be very much larger to be really comfortable, but this 750-storied dwelling is equal in capacity to the 21,300,000 domiciles in the United States multiplied by the capacity of a single, average domicile. As it is, this huge national abode would have a frontage or width approximating 8,300 feet, a distance equivalent to a line of about 6,640 men, standing close together. If everybody were "at home," the planks and beams of this vast building would have to support an additional weight of about 6,500,000 tons. Were all the citizens of New York City to reside within such a structure, each New Yorker would have a large apartment. This apartment would approximate 104 feet in length, 78 feet in width, and would be about 10 feet in height.

However, if a home were built for the people of New York City alone it would have to be fully 4/10 of a mile wide and would contain a cubical contents of more than 9 million cubic feet. From this it can be easily seen what a large proportion of the population of the United States is contained within the boundaries of New York City. These figures would seem somewhat astounding to one not used to the large cities, but a glimpse of Broadway and 42nd Street in New York City during the rush hours would almost convince one that the figures are too small. The uninitiated would view the Woolworth building and would then be in doubt as to whether a house of the dimensions given would be sufficient for its purpose.



Fitting On the Apparatus With Which the Professor Hopes to Make Kirby Grow To An Enormous Size, Compared To Whom the Stars Would Seem Like Billiard Balls.

The Man From the Atom

By G. PEYTON WERTENBAKER

IF you are interested in Einstein's Theory of Relativity, you cannot afford to miss this story. It is one of the big scientific stories of the year and is worth reading and rereading many times. If the Theory of Relativity has been a puzzle to you, this story, written in plain English, cannot fail to hold your interest from start to finish. The thoughts expressed in this story are tremendous. It will give you a great insight, not only into the infinitely large, but also the infinitely small. Better yet, relativity is brought home to you in a most ingenious and easily understandable manner.—EDITOR.

I

I AM a lost soul, and I am homesick. Yes, homesick. Yet how vain is homesickness when one is without a home! I can but be sick for a home that has gone. For my home departed millions of years ago, and there is now not even a trace of its former existence. Millions of years ago, I say, in all truth and earnestness. But I must tell the tale—though there is no man left to understand it.

I well remember that morning when my friend, Professor Martyn, called me to him on a matter of the greatest importance. I may explain that the Professor was one of those mysterious outcasts, geniuses whom Science would not recognize because they scorned the pettiness of the men who represented Science. Martyn was first of all a scientist, but almost as equally he was a man of intense imagination, and where the ordinary man crept along from detail to detail and required a complete model before being able to visualize the results of his work, Professor Martyn first grasped the great results of his contemplated work, the vast, far-reaching effects, and then built with the end in view.

The Professor had few friends. Ordinary men avoided him because they were unable to understand the greatness of his vision. Where he plainly saw pictures of worlds and universes, they vainly groped among pictures of his words on printed pages. That was their impression of a word. A group of letters. His was of the picture it presented in his mind. I, however, though I had not the slightest claim to scientific knowledge, was romantic to a high degree, and always willing to carry out his strange experiments for the sake of the adventure and the strangeness of it all. And so the advantages were equal. I had a mysterious personage ready to furnish me with the unusual. He had a willing subject to try out his inventions, for he reasoned quite naturally that should he himself perform the experiments, the world would be in danger of losing a mentality it might eventually have need of.

And so it was that I hurried to him without the slightest hesitation upon that, to me, momentous day of days in my life. I little realized the great change that soon would come over my existence, yet I knew that I was in for an adventure, certainly startling, possibly fatal. I had no delusions concerning my luck.

I found Professor Martyn in his laboratory bending with the eyes of a miser counting his gold over a tiny machine that might easily have fitted in my pocket. He did not see me for a moment, but when he finally looked up with a sigh of regret that he must tear his eyes away from this new and wonderful brain-child, whatever it might be, he waved me a little unsteadily into a chair, and sank down in one himself, with the machine in his lap. I waited, placing myself in what I considered a receptive mood.

"Kirby," he began abruptly at last, "have you ever read your Alice in Wonderland?" I gasped, perhaps, in my surprise.

"Alice in—! are you joking, Professor?"

"Certainly not," he assured me. "I speak in all seriousness."

"Why, yes, I have read it many times. In fact, it has always struck me as a book to appeal more to an adult than to a child. But what—I can't see just how that is important." He smiled.

"Perhaps I am playing with you unduly," he said, "but do you remember the episode of the two pieces of cheese, if my own recollection is correct, one of which made one grow, the other shrink?"

I assented. "But," I said incredulously, "certainly you cannot tell me you have spent your time in preparing magical cheeses?" He laughed aloud this time, and then, seeing my discomfort, unburdened himself of his latest triumph.

"No, Kirby, not just that, but I have indeed constructed a machine that you will be incapable of believing until you try it.

(Continued on page 386)

Doctor Hackensaw's Secrets

By CLEMENT FEZANDIÉ

(AUTHOR'S NOTE.—*Shall we ever be able to make telescopes sufficiently powerful to reveal living beings on the moon, if any such exist. Unquestionably, yes; and in my opinion the thing would not be impossible at the present day, by successive magnification, using due care to reduce distortions to a minimum and illuminating each successive image to make up for the loss of light at each illumination. The fact that we have found neither air nor water on the moon is by no means proof that living beings of some sort do not dwell there.*)

No. 19
The Secret of the Super-Telescope

"SILAS," said Doctor Hackensaw, impressively, "I'm going to reveal to you another of my secrets to-day, one that may have far-reaching consequences and prove of greater importance than any of my other inventions. I am going to let you have a look through my super-telescope."

"You have invented an improved telescope?"

"'Yes' and 'No' to that question. In reality I have devised a new instrument to take the place of the telescope, and far superior to the latter in its power of magnifying bodies without detracting from their clearness. I spent many years trying to improve our present telescope, but only with partial success. I began by offering fabulous sums to a celebrated firm of opticians if they would produce for me a telescope far superior to any before made. The result was almost nil. A big bill to pay and nothing to show for it. Not a single new discovery of any consequence resulted. I then decided to take matters into my own hands, break loose from tradition, and start on a new tack. A telescope is nothing but a magnifying instrument, and there seemed to me no reason why the image of a star or planet could not be received on a mirror and then magnified to any desired extent.

SEVERAL PROBLEMS TO SOLVE

"Of course there were several problems to solve: 1. As each magnification diminishes the light, there must be means of increasing the original light received from the star or planet itself. 2. Every refraction, and hence every magnification, produces a certain amount of distortion in the image, the distortion of course increasing with each increase of size. This distortion must be reduced to a minimum or my telescope would be worthless. 3. Refraction is not the same for light of different colors. Hence at each magnification there is a tendency for the light to separate into all the colors of the rainbow. This is known as "chromatic aberration" and must be guarded against. 4. Any imperfection in the lenses themselves, or any impurities in the earth's atmosphere will be greatly magnified. These are the four principal troubles.

TELESCOPE IMAGE ENLARGED IN SUCCESSIVE STAGES

"I accordingly used the following method. I received the first magnified image of the moon on a mirror. This mirror I illuminated by a powerful electric light, and then threw a magnified image from this on a screen, which was in reality a second mir-

(*Continued on page 393*)

Silas Somewhat Skeptically Took a Seat Before the Television Screen and Waited While Doctor Hackensaw Adjusted His Instruments. And Then the Reporter Gave a Cry of Surprise, for There Appeared on the Screen a Picture Unlike Anything He Had Ever Imagined. "That," Explained the Doctor, "Is a Small Portion of the Moon's Surface. It Is Somewhat Hazy and Distorted, Due to the Tremendous Magnifying Power Used, But it is Sufficient to Give You a Tolerably Clear Idea of Conditions on the Moon."

"Hello-o!" Tubby Called Incautiously. The Girl Sprang Erect; and Stood Trembling, Lyre in Hand, as They Hurried Forward. Tubby Saw She Was a Rather Small, Very Slim Girl, Dressed in a Flowing White Garment from Shoulder to Knee, Which was Gathered at the Waist with a Golden Cord Whose Tasseled Ends Hung Down Her Side. Her Bare Feet Were Sandaled; Her Arms Were Bare. Her Glossy Black Hair, Gathered at the Neck with a Single Golden Loop, Hung in Profusion Nearly to Her Waist. Her Face Was Delicately Oval—Her Cheeks a Pure Pink-White; Her Mouth Was Small, Her Lips Prettily Bowed. Her Dark Eyes, Which Had Long Black Lashes, Were at the Moment Wide With Surprise and Fear. She Stood as though About to Dash Away—a Startled Nymph Hesitating Before Flight.

Around the Universe

By RAY CUMMINGS

SECOND INSTALLMENT

CHAPTER III

IN WHICH TUBBY AND SIR ISAAC MEET THE VENUS-GIRL AND LEARN OF THE PLOT TO DESTROY THE EARTH

TUBBY had gone to sleep in the starlight and very dim moonlight. He awoke, most uncomfortably warm, to find the glaring sunlight beating directly on his bed through the bedroom window. For a moment he did not know where he was. The sun, larger than he had ever seen it before, was about level with the window—shining among the stars in the black sky, intolerably bright, excessively hot. He lay blinking and gasping; then with returning memory, he leaped out of bed and jerked down the green roller shade.

The vehicle was without vibration, silent as before. The room was hotter than midsummer. Where was the professor? Was anything wrong? What time was it?

"Oh-h, perfessor!" Tubby bellowed.

Sir Isaac's voice answered him from below.

"Oh, you're awake, are you? Come on down. Dress as coolly as possible."

Tubby was dressed in a few moments, putting on his thinnest clothes—white flannel trousers, white buckskin shoes and white negligee shirt—which he had found in the bureau drawers and the wardrobe. He was glad to find them there, and glad that they fitted him so perfectly, for he wanted to look his best when arriving on Venus.

When he got downstairs he found Sir Isaac also dressed all in white, with his shirt sleeves rolled up and his shirt open at the throat exposing half his boney but broad chest. Around his forehead was tied a white silk handkerchief to keep the hair out of his eyes. He was sitting at the instrument room table, working at his interminable figures.

The side window of the room, which was now turned away from the sun, showed only the black void of space with its glittering stars. Through another window, in the floor directly under Sir Isaac's feet—which Tubby had not known to be there since it had been covered the night before—a soft, pale-blue light was streaming. It flooded the entire room, more intense than moonlight, but blue rather than silver.

Sir Isaac looked up from his calculations and smiled.

"Good morning. I was just coming up to call you."

"The sun woke me up," said Tubby. "It's awful hot up there. . . . It ain't so cool down here either. . . . What's that blue light from? How are we gettin' on? What time is it?"

Sir Isaac laid down his pencil reluctantly.

"Seven thirty-three," he said. "You've had a good long sleep. I just altered our course again. We intersected the orbit of Venus twenty-seven minutes ago, so I thought I had better turn and head directly for her. That's why the sun swung up to your window."

Tubby hung his natty Panama hat on a rack and approached Sir Isaac.

"What's that blue light? Venus?"

Looking down through the window, Tubby saw directly beneath them an enormous blue half moon, with dark, irregular patches all over it. Against the black background of space it glowed with intense purity—its pale-blue light making it seem ethereal—unreal.

"That is Venus," said Sir Isaac softly. "You can see the whole of the sphere when your eyes become accustomed to the light."

A moment more and Tubby saw the dark, unilluminated portion. He saw, too, that where the edge of the light crossed the face of the globe, it was not a continuous line, but was broken into many bright spots and patches of darkness.

(*Continued on page 398*)

Miraculously Professor Carbonic Opened His Eyes, and Rose To His Feet. His Eyes Were Like Balls of Fire; His Lips Moved Inaudibly, and As They Moved Little Blue Sparks Were Seen To Pass From One To Another. His Hair Stood Out From His Head. The Chemical Reaction Was Going On In the Professor's Brain, With a Dose Powerful Enough To Restore Ten Men. He Tottered Slightly.

Advanced Chemistry

By JACK G. HUEKELS

PROFESSOR CARBONIC was diligently at work in his spacious laboratory, analyzing, mixing and experimenting. He had been employed for more than fifteen years in the same pursuit of happiness, in the same house, same laboratory, and attended by the same servant woman, a negress, who in her long period of service had attained the plumpness and respectability of two hundred and ninety pounds.

"Mag Nesia," called the professor. The servant's name was Maggie Nesia—Professor Carbonic had contracted the title to save time, for in fifteen years he had not mounted the heights of greatness; he must work harder and faster as life is short, and eliminate such shameful waste of time as putting the "gie" on Maggie.

"Mag Nesia!" the professor repeated.

The old negress rolled slowly into the room.

"Get rid of these and bring the one the boy brought today."

He handed her a tray containing three dead rats, whose brains had been subjected to analysis.

"Yes, Marse," answered Mag Nesia in a tone like citrate.

The professor busied himself with a new preparation of zinc oxide and copper sulphate and sal ammoniac, his latest concoction, which was about to be used and, like its predecesssors, be abandoned.

Mag Nesia appeared bringing another rat, dead. The professor made no experiments on live animals. He had hired a boy in the neighborhood to bring him fresh dead rats at twenty-five cents per head.

Taking the tray he prepared a hypodermic filled with the new preparation. Carefully he made an incision above the right eye of the carcass through the bone. He lifted the hypodermic, half hopelessly, half expectantly. The old negress watched him, as she had done many times before, with always the same pitiful expression. Pitiful, either for the man himself or for the dead rat. Mag Nesia seldom expressed her views.

Inserting the hypodermic needle and injecting the contents of the syringe, Professor Carbonic stepped back.

WE are certain that you will enjoy "Advanced Chemistry." It is a satire that cannot fail to amuse you. While Mr. Huekels has treated the subject lightly and is poking fun at our scientists, nevertheless, there is more truth than satire in his story.

For the up-to-date scientist today is pretty well convinced that all chemical, as well as physiological actions, have their origin in the electric current. We are certain you will like this story.—EDITOR.

PROF. CARBONIC MAKES A GREAT DISCOVERY

"Great Saints!" His voice could have been heard a mile. Slowly the rat's tail began to point skyward; and as slowly Mag Nesia began to turn white. Professor Carbonic stood as paralyzed. The rat trembled and moved his feet. The man of sixty years made one jump with the alacrity of a boy of sixteen, he grabbed the enlivened animal, and held it high above his head as he jumped about the room.

Spying the negress, who until now had seemed unable to move, he threw both arms around her, bringing the rat close to her face. Around the laboratory they danced to the tune of the negress's shrieks. The professor held on, and the negress yelled

(*Continued on page 378*)

The Electric Duel

By H. GERNSBACK

A NEWS item from Milan, Italy, reports the strangest duel that probably ever was fought between two men. It was supposed to be a contest to the death—the first electric duel in history. The story has it that two young Italians employed in one of Milan's great industrial electric works, became enamored of the Superintendent's daughter and fought many fistic battles over the titian haired, comely young woman, reported to be one of the belles of Milan. She could not make up her mind whether she was to be the future Mrs. Alessandro Fabiano or Mrs. Benedetto Luigi, these being the names of the two swains.

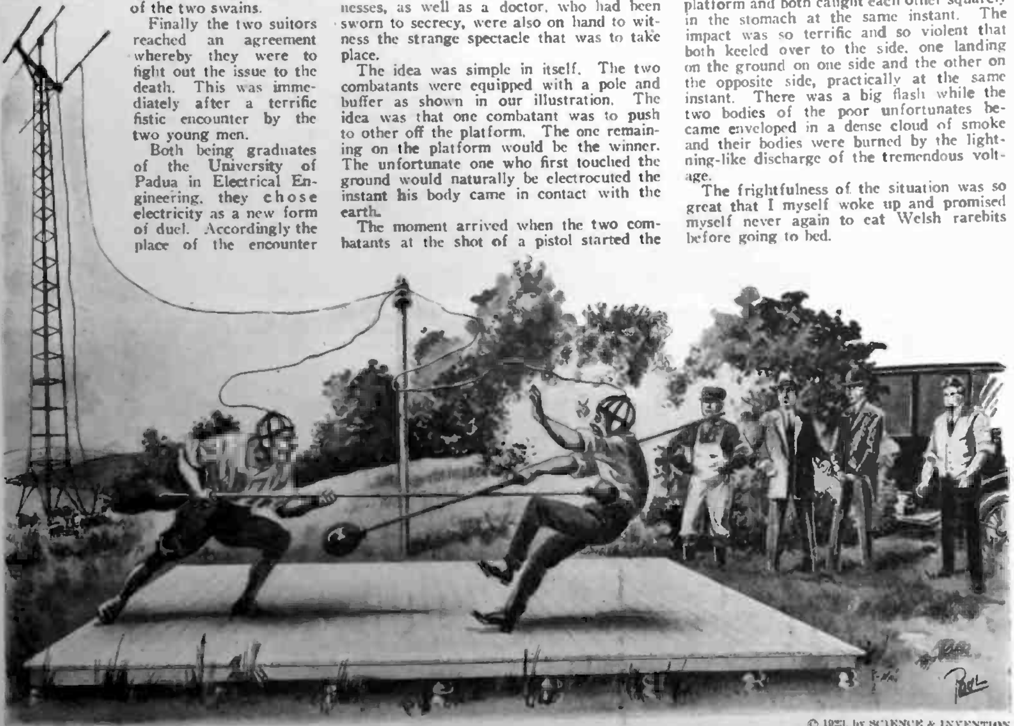
Finally the two suitors reached an agreement whereby they were to fight out the issue to the death. This was immediately after a terrific fistic encounter by the two young men.

Both being graduates of the University of Padua in Electrical Engineering, they chose electricity as a new form of duel. Accordingly the place of the encounter was chosen some thirty miles from the outskirts of Milan at a spot where a high tension line carrying over twenty thousand volts passed through the open country. One of the wires was connected as shown in the illustration and the other wire was attached to one of the feeders which came down to an insulator attached to a pole nearby. A wooden platform which had been used in building a bridge not far away was utilized as an insulating means. The two duelists had brought along large insulators from their factory upon which the platform rested. The wires were then led to the headmasks as shown in our illustration. Three witnesses, as well as a doctor, who had been sworn to secrecy, were also on hand to witness the strange spectacle that was to take place.

The idea was simple in itself. The two combatants were equipped with a pole and buffer as shown in our illustration. The idea was that one combatant was to push to other off the platform. The one remaining on the platform would be the winner. The unfortunate one who first touched the ground would naturally be electrocuted the instant his body came in contact with the earth.

The moment arrived when the two combatants at the shot of a pistol started the battle. The two rivals were wary of each other for the first fifteen minutes, and not much headway was made in the dangerous business. First Benedetto, then Alessandro was nearly pushed over the edge of the board only to recover by a supreme effort. At one time when Benedetto was almost on the brink of going over he grabbed hold of the pole of his antagonist and managed to pull himself forward to the other side again. After a while the men were fighting hard and furious, till finally a most extraordinary thing happened which had not been foreseen by either of them. They were rushing at each other, savagely, diagonally across the platform and both caught each other squarely in the stomach at the same instant. The impact was so terrific and so violent that both keeled over to the side, one landing on the ground on one side and the other on the opposite side, practically at the same instant. There was a big flash while the two bodies of the poor unfortunates became enveloped in a dense cloud of smoke and their bodies were burned by the lightning-like discharge of the tremendous voltage.

The frightfulness of the situation was so great that I myself woke up and promised myself never again to eat Welsh rarebits before going to bed.



Something Brand New Is the Electric Duel Here Portrayed the Wires Secured To the Metal Helmets Worn By the Contestants Connect To a High Voltage Transmission Line. The First Contestant Who Is Pushed Off the Insulated Platform Is, of Course, Electrocuted, Due To the Current Passing Through the Body To Earth, Thus Completing the Circuit.

Another Of Our Prophecies Comes True

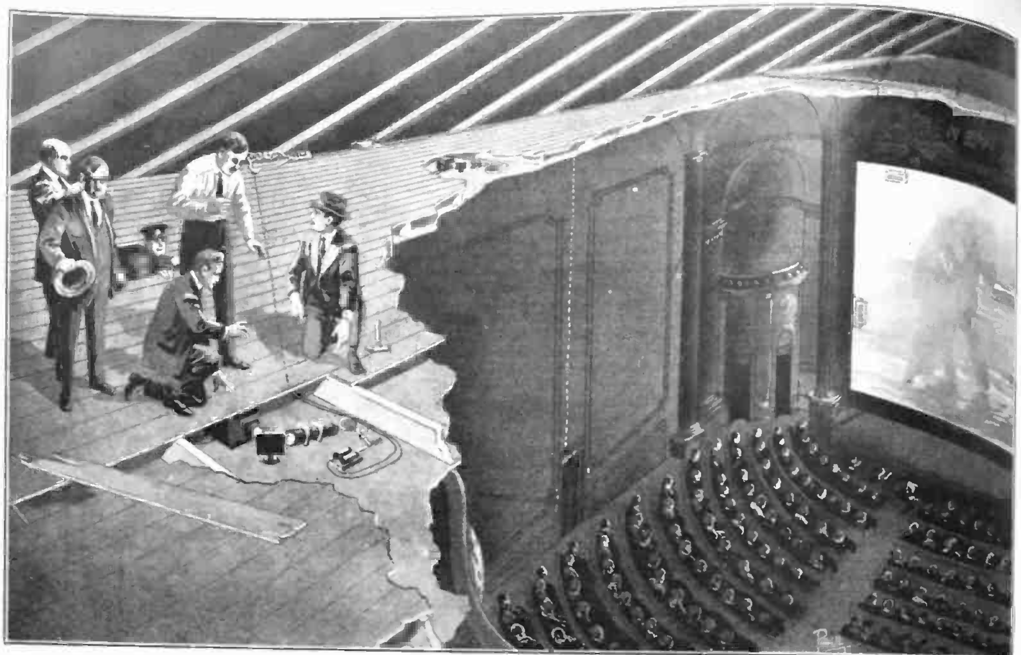
SEVERAL years ago (August, 1918 issue) during the progress of the World War, we published a story called "The Magnetic Storm," by H. Gernsback, in which a great electrical scheme was described for use in war, whereby powerful radio or electric waves were radiated from a gigantic generating plant, which waves induced intense electric currents in the metallic frames and electric coils and wires of automobiles, tanks, airplanes, etc., of the enemy, and caused the electric windings of magnetos, spark coils, etc., to be burned out.

At the time this story was published the editors had faith in the theme, due to the fact that Dr. Tesla's wonderful experiments, over a score of years ago in his Colorado laboratory, had proved that strong electric waves radiated from high frequency oscillators could and did burn out generators ten miles away.

Now comes a report from Berlin, Germany, of an experiment carried out recently wherein a number of automobiles were taken on a mysterious trip from Berlin toward the powerful Nauen radio plant. After the machines had gone on for many miles, the leader of the party of automobiles who had been invited on the mystery trip (each car was fitted with a high-tension magneto), told the members of the expedition that within the next half hour something mysterious yet harmless to the persons in the party, would happen. Everyone wondered what was going to happen, but they did not have long to wait.

Suddenly the cars all stopped and the twenty drivers tried to start their engines, but found it useless. The mysterious leader of the party then came up to a group of the auto drivers and said:

"It is Nauen, that big wireless station, which has stopped all our cars by sending out waves that killed our magnetos. It is an entirely new invention, and a special wave is being used for this purpose. This experiment is the first of a series which will be applied eventually to airplanes, electric trains and even submarines. If every trial we make proves as successful as this, warfare in the future will be completely revolutionized."



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There in Front of Them They Saw the Reason for the Mysterious Vanishing Movies. A Projector Mounted Beneath the Floor Boards Threw Its Light Upon the Screen, the Opening in the Ceiling Being Operated by an Electro-Magnetically Controlled Shutter, Which in Turn Was Controlled by Selenium Cells Located Near the Screen.

Vanishing Movies

By TEDDY J. HOLMAN

"SO you refuse to accept my offer?" inquired Jack Dandly, rising and reaching for his hat.

"Certainly, and what's more, you'd better steer clear of this place." Ben Jackson replied vehemently.

Centerville, a town of about ten thousand population, boasted two movies, the Princess, and the New. The New had only recently been built by Jackson, but, having more modern fixtures and equipment and running better films than the Princess, had greatly decreased the patronage of the latter. At the present time the owner, Dandly, of the Princess, had offered to buy the New. Jackson had indignantly refused and, in return, had offered to buy the Princess. In this way they had failed to come to an agreement so the argument finally became hot.

"My offer holds good for one week," Dandly promised as he left Jackson's office, "but, mind you, after that you will be forced to accept my own figure."

"Accept *your figure*," Jackson snorted. "You're crazy!"

Early one morning about a week after the above incidents, Frank Lowrie, who had the night before returned with Fred Mathews from a camping trip, flung himself out of bed to answer the insistent ringing of the door bell. "Hello, Fred!" he cried as he opened the door. "How did you get up so early?"

"You surely judge me by your own habits. How are you feeling by now?"

"Fine! We shall have to make another trip in the fall."

"Yes, but here is something more immediate. This is yesterday's *Star*. Read that!"

MOVIE MYSTERY
Vanishing Pictures at New Inexplicable

A startling mystery deeper than any of those on the films astonished all present at the New last night. Just as the "Dutchman's Scream" was reaching its most interesting stage, the picture became invisible! The machine was immediately stopped and the film carefully examined. Nothing could be found wrong. The part a moment before invisible was as clear as could be desired when it was again flashed on the screen. As the film continued, however, the picture would vanish intermittently. Some attributed the phenomenon to a fault of the film while others considered that it was caused by the machine. The first hypothesis was disproved by trying several films known to be good. The mystery was deepened when nothing could be found wrong with the machine; nor could such a fault be adequate to produce the observed results. The screen was brilliantly illuminated as if the film had been run off thereby leaving the light focused on it. As yet no plausible explanation has been offered.

THE MYSTERY BECOMES DEEPER

"Well, what do you think of it?" Fred inquired.

"It is hard to say, but what do you make of it?"

"I intend to wait until I know more of the matter before forming a conclusion. Suppose we drop in and see Jackson?"

"It is a good idea, but I'll have to visit the pantry first as that hike yesterday left me empty."

"Yes!" Jackson exclaimed savagely, "yes, we've got a corking good riddle to solve. Last night things went off the same as night before last. A peculiar thing is the pictures only disappear when we have a crowd and then, the same part of the film seldom vanishes when it is flashed on again. After we had dismissed the crowd last night it went on without a flaw. This eliminates all the plausible explanations: it can be a fault neither of the film nor of the machine. Can you see where that leaves us?"

"Up a tree; still, do you think there is treachery or mischief behind it?" Frank asked.

"That's the deuce of the question. I have personally inspected everything thoroughly several times so I think my employees are honest and are not implicated in this; but," he added significantly, "I am not so certain about outsiders, though, to save my life, I can't imagine how anyone can get by with it."

"I understand that the screen becomes brilliantly lighted when the picture fades."

"It does."

"Do you think it is possible for anyone to flash a light on it?"

"No. I had over a dozen men stationed in various parts of the house last night to watch."

"But might not a light be concealed somewhere?"

A POSSIBLE CLUE

Jackson looked at him scornfully for a moment and then exploded, "That is as impossible as the rest! No one, in the first place, could get in here unless in league with an employee to conceal it. Second, he could not conceal it without leaving a

A N entirely new mystery story is presented herewith. It is a story that will hold your interest from start to finish. If you are at all scientifically inclined, this story will keep you guessing quite a little on account of its unusual plot and the unusual ending. And what is more, the idea is not only feasible, but you can try it out yourself on a small scale, should you be inclined that way, for your own amusement purpose. We are quite certain you will like this story.—Editor.

trace. Third, it would be impossible to conceal the glow or reflection. Last, I have inspected absolutely every square inch of the ceiling, floor, and walls without finding any such place for the light which would of a necessity be very strong. In fact, only an arc could produce the observed results. Do you think that such a light could be hidden? Absurd! Nor is this all. Last night I tried throwing a shield in front of the projector while the picture was invisible. In no instance was I able to see a light on the screen even for a fraction of a second after the shield cut off the light. Also, when I jerked the shield away the picture was still invisible. It would be impossible for a person to control a hidden light in exact synchronism with the shield; further, the shadow of the shield was seen to *progress* across the screen with the picture still remaining invisible. Oh no! I've fully considered that phase of the question."

"You are quite right, but what do you intend to do?"

"That's another puzzle. Of course for a night or two we shall have large crowds but it will not last as they will soon be dissatisfied. I am ruined if this mystery cannot be cleared."

"Do you know of anyone who would profit by such a thing?"

"No—— by Jove! That reminds me. Dandly was in here last week offering to buy me out. I guess his business has suffered quite a bit since I set up my rig. He said that his offer would hold good for a week and that if I didn't accept I would be *forced* to come to terms."

"He's the man you're after."

"So I believe, now, but what good will it do us to know who it is unless we can get the goods on him? We would be sent to the mad house if we said what we believe. He is covering his tracks well although how he does it is beyond me. Hello! I believe that's him coming now."

JACKSON SUSPECTS DANDLY

"How are you?" greeted Dandly as he entered. "I hope you are more reasonable than you were last week."

"What do you want?" Jackson demanded angrily.

"Are you ready to sell?"

"Sell! I'd go bankrupt a dozen times before I'd sell to you at a profit."

"I was hoping you would be rational enough to accept a reasonable offer. Very well! I suppose you will change your mind before long."

"What do you mean?"

"Precisely what I say."

"Why are you ruining my shows?"

"Who said I was?"

"Never mind. I know you, and, if this present business keeps up I'll see that you get yours."

"Are you mad? Who could believe such an incredible story!"

"Begone and stay gone!"

"Let's look over the building," Fred suggested after Dandly had left.

"Sure," agreed Jackson.

A long and careful examination only verified Jackson's statements. The idea of vanishing pictures in a modern movie seemed to be insanity itself, but it was, nevertheless, true. They examined and tried the machine but could find nothing wrong; it threw a flawless picture on the screen.

"Isn't that the deuce?" exclaimed Jackson. "I suppose you will be here tonight? Very good! You will see for yourself how things go."

"What do you think of it now?" Frank asked as he and Fred left the building. "I can hardly believe that such a thing is possible."

"That's how I feel, exactly."

"E-e-e-vening Sta-a-a-r," cried a newsboy. "All about the movie mystery."

A FALSE SOLUTION

"Here, boy!" yelled Fred, tossing him a coin. He hastily glanced over the sheet. "What's this?" he gasped, startled.

FILM MYSTERY NO MYSTERY AT ALL

Reporter Detects Fraud. Purpose Can Only Be Guessed

It was learned today that the recent mystery at the New was nothing but a sham, a deliberate fraud perpetrated to arouse interest and increase the attendance which, we are informed, has decreased considerably here lately. In fact, it was made known today that the manager of the Princess is negotiating for its purchase. No decision has as yet been reached but Dandly, of the Princess, seems confident that he and Jackson will soon reach a mutually satisfactory agreement.

Just what method was employed by the New to effect the surprising disappearances can only be conjectured. It is probable that full details will soon be available. After all, it is a clever scheme, one the patrons doubtless appreciate.

"Well! Of all the mysteries, this is the greatest, the most intangible," Frank cried.

"What does it mean, I wonder. Can this report be true? Has Jackson been deceiving us?"

"There's no telling. It's too much for me to digest at one time. Come on, let's go eat. We can see Jackson later."

"Have you seen the evening paper?" Jackson bellowed as they entered his office. "That's the biggest outrage of the year! Dandly will pay for it. It's some more of that subtle rascal's work."

"What about it? Is it a lie?"

"A lie! The dirtiest, most abominable lie ever uttered. It's a frame-up, I tell you, another score for which that underhanded scoundrel must answer."

"But, what can his purpose be?"

"Dandly is desperate, my dears," he declared grimly. "There is no telling how much money that reporter received, and through channels too devious to be traced, too, I'll wager! He wants the attendance to be unusually large tonight so that he can thoroughly disgust them. This is the rottenest thing a villain ever conceived! I'd give a thousand dollars to be able to turn the tables on him tonight. However, it will soon be time for the show to start. We shall see!"

JACKSON'S SUSPICIONS ARE CONFIRMED

Jackson's inferences were well founded for the crowd *was large*. Fred and Frank secured seats on the side of the room. The show finally started and continued for about twenty minutes without any irregularities. Then things began to happen. The screen became illuminated with a silvery light, thereby, apparently, reducing the picture to a vague shadow.

"Can you beat it?" exclaimed Fred. "Look at that!"

As he spoke something tragic happened for on the screen were flashed the words "The New will soon be sold to the management of the Princess." The words vanished and the picture reappeared.

Fred gave a long whistle. "Of all the jumping, howling, screaming surprises! What next!"

This phenomenon had also astounded another. The crowd was only mildly surprised, since it was a natural sequence of the newspaper notice; but it was not so with Jackson. "If that lying, sneaking scoundrel doesn't do time I'll die of disappointment," he muttered.

The show continued for some time but the pictures continued to "vanish" at short intervals. The crowd gradually dispersed, evidently disgusted, so Jackson stopped the machine.

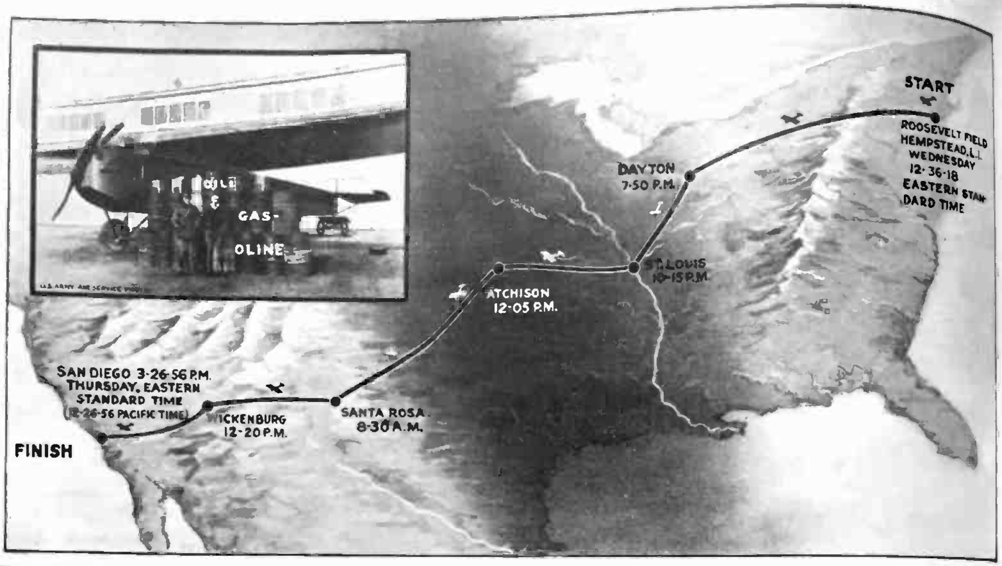
"Unless we can solve this riddle, boys," he said to Fred and Frank, "I am ruined. There is no doubt in my mind that Dandly is behind it. Proving it is the problem. I had at least a dozen men on watch tonight. Since you yourselves saw everything that happened, you can readily understand why they failed to discover anything."

LIGHT MUST BE THE BASIS OF THE TROUBLE

"We shall do our best to help you," promised Frank. "Now let's get down to business and study this matter rationally. Deep as it is, there must be an explanation depending on natural laws. It is quite evident that it cannot be caused by a fault of the film or of the machine; nor is it *likely* to be treachery on the part of any of the employees. This can lead to but one explanation: somebody is in some way producing this phenomenon, which, we must conclude in spite of the apparent impossibilities, can only be produced by flashing a powerful light on the screen. Let us work on this hypothesis at least until we have proved it impossible. I believe you said it would be impossible to conceal the glow and rays of a powerful light. Now listen! Light rays of themselves are invisible and can only be seen when reflected to the eyes by matter. Pure air and similar *invisible* gases refracts light to a very limited extent. Naturally, the amount refracted would be dependent upon the intensity of the ray. However, if there are any solid or liquid particles in the air, such as chalk-dust or water vapor, light is reflected, thus showing the path of the ray. The theater is well ventilated so a weak ray would be invisible. You know yourself that the ray from the machine is visible only within a few feet of it and that this is practically invisible when a "dark" picture is being flashed. You say, though, that a powerful light corresponding in strength to that flashed on the screen by the projector would be necessary to "vanish" the picture. Now what is there to prevent someone locating many very weak lights in strategic parts of the room? Of course it would be hard to put in such a system but if it has been done it would not be impossible.

"The 'glow' from the lights presents another seemingly insuperable difficulty. Shadows, you know, have two parts, the *umbra* and the *penumbra*, the first being the dark center and the latter the lighter circle around it. The penumbra is the part from which a *portion* of the radiating body is

(*Continued on page 390*)



This Birdseye View of the United States From East to West Shows the Route Followed by the Daring U. S. Army Birdmen, Lieutenants Oakley G. Kelly and John A. Macready in Their Flight From Roosevelt Field, Hempstead, L. I., to San Diego, Calif., Which Non-Stop Flight Established a New Record and Was Completed in 26 Hours, 50 Minutes, and 38 2/5th Seconds. The Route is about 2,700 Miles Long, or 1,000 Miles Longer Than the Trans-Atlantic Non-Stop Flight Made in 1919 by Captain J. Alcock and Lieutenant Brown. The Large Amount of Gasoline and Oil Carried For the Non-Stop Flight is Shown in Photo Above of the Two Aviators and Their T-2 Plane. The Darkened Section Shows the Night Route.

Non-Stop Flight Across Continent

A NON-STOP flight across the United States and a race against time and weather was successfully completed on May 3rd, when two American army lieutenants, Oakley G. Kelly and John A. Macready, flew the army monoplane T-2 from Hempstead, L. I., to San Diego, California, in twenty-six hours, fifty minutes and thirty eight and two-fifth seconds. The distance covered, approximately two thousand seven hundred and twenty miles, established a new non-stop flight record, and is about one thousand miles longer than the flight made by Captain J. Alcock and Lieutenant Brown across the Atlantic Ocean in 1919. The plane carried over seven hundred gallons of gasoline, the great space occupied by this amount of gasoline being forcibly demonstrated by the accompanying photograph, which shows the two intrepid fliers with their gasoline and oil supply. A speed of more than one hundred miles an hour was maintained practically all the way.

FLEW AT NIGHT

The fliers had nearly reached Indianapolis when darkness set in, as the relief map herewith shows. "We were flying at an altitude of 2,000 feet, trusting solely to our compass when we approached Belleville," said Lieut. Kelly. "A huge beam of light, showing through the clouds over that point proved that our course was correct, and we headed for the Missouri River. A light rain fell at this time. As we neared the Missouri-Kansas line we were going more than 110 miles an hour at 5,000 feet altitude and saw the moonlight break through the clouds."

The moonlight was a great aid to the fliers as they passed rapidly over Indiana, Illinois, Missouri, Kansas, Oklahoma, Texas and part of New Mexico, the first rays of dawn finding the speeding plane in sight of Tucumcari, N. M.

TECHNICAL DETAILS OF MONOPLANE

The Fokker F 4 monoplane which, named by its army symbol T 2, has become world famous within a few months through the remarkable series of flights by Lieutenants O. G. Kelly and J. A. Macready was originally designed and built early in 1922 by the Fokker Company as an 8 to 10 passenger commercial transport plane. In design, in constructional details and in efficiency, it is a direct development of the well known F 3 type used with such conspicuous success on the European air lines. Combined with the unfailing reliability and power output of the Liberty engine, the same qualities which have largely contributed to the success of the Fokker planes in commercial service.

Originally designed for a total commercially loaded weight of 8,500 pounds, the Air Service found it possible to overload this airplane up to 10,860 pounds and achieved a safe start and maintain safe flying qualities in the air. The plane carried about 225 gallons of water and about an equal quantity of oil.

WING CONSTRUCTION

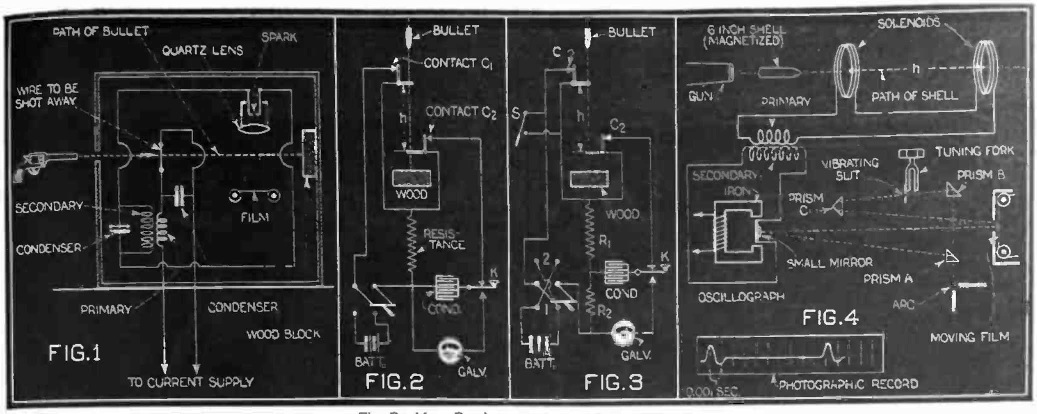
The monoplane wing is of a construction similar to that of the small Fokker pursuit monoplane and the F 3 commercial type, excepting that while the smaller types have one piece wings, the F 4 wing is built in three sections to facilitate transportation by road or rail, which will be understood, in view of the fact that the span of this wing is over 80 feet. The wing is built up on two immense box-girder spars of spruce and birch veneer, with ribs of solid but thin birch veneer. The covering of the wings is of 3/64th inch three ply veneer, a type of construction which has also been proved in practice during the last three years to be of extraordinary durability under all weather and service conditions.

The main changes made by the Army Air Service in the original Fokker F 4 monoplane for the purpose of the record flights are in the fuel system and other engine installations. Originally one gravity tank containing fuel for six hours' flight was fitted and to this were added further tanks in the wings and in the forward part of the cabin to increase the gasoline capacity to 735 gallons, which quantity proved sufficient for the World's Endurance Record made April 17th, 1923, of 36 hours and five minutes. The gasoline is fed to the carburetor by pump from the lower tank, into which the other tanks can be emptied under control of the occupant of the cabin.

PILOT CONTROL

Originally controls for only one pilot up forward beside the engine were provided, but the new installation made by the Air Service added a complete pilot's control and instruments inside the cabin; on the left hand side the windows were enlarged down to the floor and a sliding door was provided in the side of the fuselage next to the assistant pilot's seat. A small triangular door was made in the front cabin wall behind the original pilot's seat. The entire arrangement enables the occupant of the cabin to take the controls while the pilot comes through into the cabin and changes places with him. In the flights of Lieutenants Kelly and Macready this arrangement was carried out so that the pilots changed places every six hours.

Besides the fitting of the large gasoline tanks and the reinforcing of the center section of the wing to support the weight of the suspended tank, a great many auxiliary installations never before fitted to an airplane were installed and the greatest credit must be given to Lieutenants Kelly and Macready, assisted by the engineers of the Engineering Division at McCook Field, for the exceedingly clever and thorough way in which these details were carried out. As an illustration of the thought expended it may be mentioned that during the Endurance Record flight, the glass tube gasoline gauge on the main tank was broken and replaced by a spare which was carefully stowed on board. The new installations made included a tank for catching expansion water from the cooling system and pumping it back into the system. An arrangement was also installed whereby an anti-leak compound can be injected into the cooling water.



The Bullet Cuts a Wire and Causes An Electric Spark To Flash Just Before the Bullet Passes By the Photographic Film, Thereby Furnishing a Record of the Flight of the Missile.

The Bullet Breaks Two Contacts, Partially Discharging the Condenser. The Galvanometer Measures the Remaining Charge.

The Addition Shown Above, To Fig. 2, Makes Possible the Detection of Any Error In Measurement.

Fig. 4 Shows the Electric Speedometer For Measuring Bullet Velocities. The Magnetized Shell Passes Through Two Solenoids and the Electrical Impulses Generated Are Recorded On a Moving Film By Means of An Oscillograph.

By HAROLD F. RICHARDS, Ph. D.

HERE is a problem for all those practical electricians who think that electricity is good only for lighting lamps and running subway trains and energizing magnets that lift locomotives. We have a stout little cannon, a few tons of powder, all the six-inch shells we care to use, and plenty of room, and somebody interested in such things tells us to find out how fast those shells can be made to travel. He cautions us specifically that the speed must be given in feet per second, to the fraction of a foot, since he already knows that the shell ordinarily reaches a target ten miles away soon after being fired; and furthermore, he says, it may be a good idea to use different charges of powder and find how the speed varies; and also to measure the speed at several different points of the same path without touching the shell, in order to learn how rapidly the speed falls off on account of air-resistance; and as a final suggestion he wants us to determine exactly how much slower the shell looses given speed if it is fired at an angle upwards so as to pass through the rarer air of the upper atmosphere.

We may picture ourselves balancing in an airplane trying to dodge while snapping a stop-watch as the shell passes the two ends of a yardstick, and conclude audibly that speed is a problem for mechanicians and not for electricians. The gentleman who for some reason desires all this information mutters something about fine electricians and goes off; and after firing a trial shot and discovering that the shell reaches a distant target a good while before the sound of the explosion gets there, we conclude that there may be something about electricity which cannot be found in the *Handbook for Electrical Engineers*. Finally we look up the members of the Clark Institute of Ballistics and the London Physical Society and the Ordnance Division of the U. S. Army, and learn how electricity can be used to measure high speeds such as 2,400 miles per hour and intervals of time as short as a millionth of a second. After digesting this information we perform certain interesting experiments.

III. Electrical Speedometers for Six-inch Shells

PHOTOGRAPHING A BULLET IN FLIGHT

Before actually measuring the speed of the large shell it seems best to experiment with ordinary rifle bullets, and we begin by photographing the bullet at a given point of its path in order to find whether it is still traveling nose foremost.

For this purpose the electrical camera shown in Fig. 1 proves to be very satisfactory. Obviously the photograph must be taken instantaneously, and no shutter can be made to work with sufficient rapidity to catch the bullet in its flight; so the ballistician takes advantage of the lag of an electrical circuit to produce a flash of the spark-gap at the instant the bullet passes above the photographic plate. The power switch is closed just before the gun is fired, and then the projectile breaks the primary circuit by cutting a thin wire. This causes a single heavy electro-magnetic pulse in the secondary, by induction, and if the capacities of the condensers in the two circuits are properly chosen the flash at the spark-gap can easily be made to occur just as the bullet passes between the quartz lens and the film. The wire which is severed can be made very thin, because if the switch is thrown just before the gun is fired, the wire will not have time to fuse before being cut. A falling body can conveniently be used to close the circuit and fire the gun in rapid succession. By properly adjusting the resistances and capacities of the two circuits, the experimenter can control the position of the photograph on the plate to within one-quarter of an inch, corresponding to a time-interval of the order of 1/100,000 of a second.

DETERMINING THE SPEED OF THE BULLET

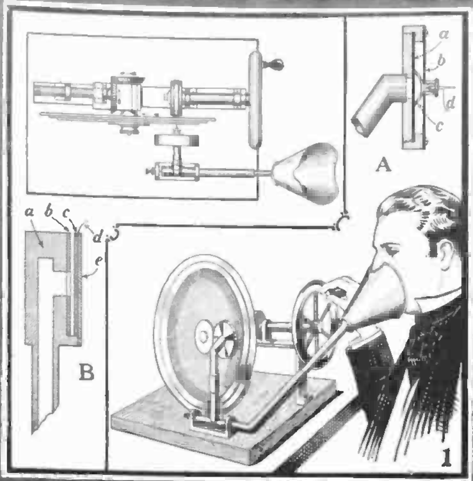
The speed of the bullet is then easily determined with an apparatus such as that shown in Fig. 2. The measurement depends on the fact that when the two plates of a charged condenser are short-circuited, the discharge does not take place instantaneously, but during a finite time. The period of discharge is very brief, of course, as anyone who has joined the terminals of a charged condenser and seen the resulting flash will appreciate at once; but nevertheless the actual time required for an approximately complete discharge can readily be calculated as soon as the capacity of the condenser and the resistance of the discharging circuit are known. Furthermore, if the terminals of the condenser remain connected for so short an interval that only a partial discharge occurs, it is possible, by measuring the remaining charge with a ballistic galvanometer, to determine exactly, to the millionth of a second, how long the discharge continued. The principle of the experiment is now apparent: contacts are so arranged that the bullet, by breaking them in succession, allows the condenser to discharge during the time required for the bullet to pass from one contact to the other.

The battery switch (Fig. 2) is closed, charging the condenser to the full voltage of the battery, and the bullet is then projected so as to break the upper contact first. The battery is thus cut out, and the condenser discharges through the resistance until the lower contact is broken by the bullet. This terminates the discharge, and the condenser stands insulated with its remaining charge. The condenser key is then depressed, causing the charge to pass through the ballistic galvanometer, which swings under the electric impulse very much as a suspended pendulum moves under a mechanical blow; and by reading the maximum deflection of the needle, and knowing the sensitivity of the galvanometer, the capacity of the condenser, the original voltage, and the value of the discharge resistance, the time during which the condenser discharged can readily be calculated by the well known logarithmic equation. Dividing the distance between the contacts by this time, we then have the speed of the projectile.

For example, if it is found that the original charge of the condenser was twice as large as that which remained after the bullet was fired, we take the Napierian

(*Continued on page* 380)

PHONOGRAPH EVOLUTION



In the Upper Left Hand Corner of Fig. 1 is a Top View of the Original Bell and Tainter Phonograph. "A" Shows the Recorder and "B" the Reproducer. The Lower Right Hand Corner Shows the Apparatus in Use.

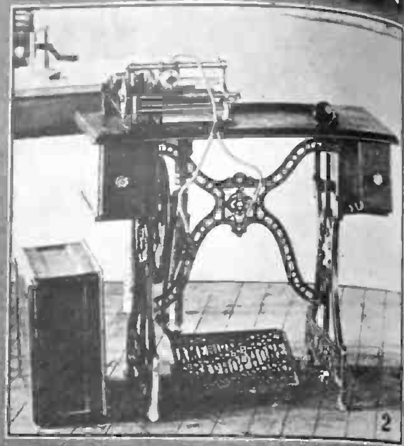
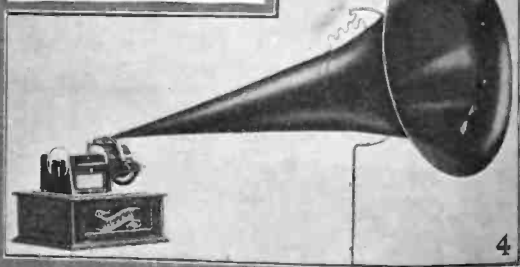


Fig. 2 Shows One of the Original Commercial Phonographs Manufactured. It Is Equipped for Recording and Reproducing and Works by a Foot Treadle.

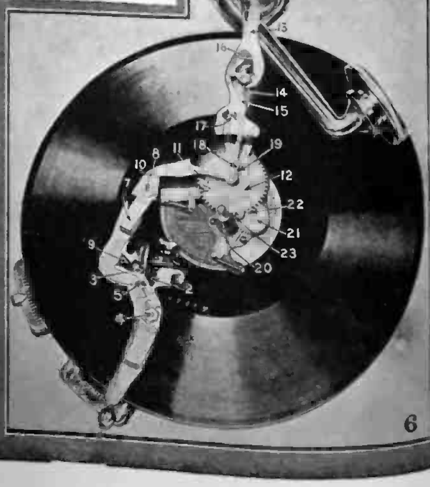
Above in Fig. 3 is Shown One of the First Cylindrical Graphophones to be Placed on the Market.

A Large Cylinder Type of Graphophone is Shown Below in Fig. 4. Note the Large Horn Which Gave Quite a Volume of Sound.



One of the First Disc Type Graphophones is Shown Above in Fig. 5. The Horn and Reproducer Are Fastened Rigidly Together and Pivoted so as to Follow the Groove in the Record.

The Non-Set Automatic Stop Which is Fully Described in the Text is Illustrated Below in Fig. 6.



Phonograph Evolution

EVERYONE is familiar with the account of the first phonograph as built by Thomas A. Edison, which consisted of a cylinder coated with tinfoil, upon which was impressed vibrations by means of the human voice. Mr. Edison did some experimental work along this line in 1878, but it was not until 1887 that he developed his findings to an extent which rendered the results commercially practical.

BELL AND TAINTOR'S EARLY TALKING MACHINE

In 1886, Chinchester A. Bell and Sumner Tainter obtained a patent on an apparatus for recording and reproducing speech and sounds. We are illustrating in Fig. 1 some of the drawings taken from their patent specifications. It will be noticed that instead of having the recorder or reproducer move along the face of the record as is done in the present-day machines, the record is made to move horizontally as well as rotate, and the recorder or reproducer is maintained in a stationary position. This apparatus was worked by hand and the sounds were recorded by one type of stylus and reproduced by another, both of which are shown in Fig. 1. A metal plate was used for supporting the disc and on the face of it was clamped a cardboard circle coated with a mixture of beeswax and paraffin, on which was impressed the voice or sound vibrations.

UNIQUE STYLUS USED

The recording stylus was composed of a piece of steel wire ground to a conical point. One side was then ground off to the axis of the wire. This method left a sharp cutting edge which removed the material from the disc when making grooves in it, on the bottom of which the sound record was impressed.

The details of the recorder or reproducer may be seen in Fig. 1. Fig. 1 A is the recorder and Fig. 1 B is the reproducer. In the former, a, denotes a diaphragm placed over the end of the tube connecting with the mouth-piece. Over this is placed a rubber cup, c, in contact with which is a plate, b, on which is mounted, in a standard, the stylus, d. As the sound virations pass through the tube they vibrate the diaphragm, which vibrations are transmitted through the rubber cup-shaped piece to the stylus. The stylus then cuts indentations corresponding to the sound vibrations.

In Fig. 1 B we have the reproducer with the needle or stylus shown at d. This is held between a strip, e, and a circular piece of hard rubber c. a is the metallic standard through which passes an air tube which ends at disc, b, in the center of which is a hole. When the stylus, d, is vibrated by the impressions on the record it causes the column of air to vibrate, whose vibrations are in turn transmitted to the ear which is placed either at the mouthpiece or to a special pair of ear pieces.

In recording with this instrument a person spoke into the mouthpiece as illustrated and when he desired to hear his own voice he removed the recorder and substituted for it the reproducer. Then, by listening at the mouth piece or making use of special ear tubes it was possible to hear the sounds. It must be remembered that during all this process it was necessary to have the disc rotated by hand.

MANY STYLES EVOLVED

Our second photograph shows one of the first commercial machines which allowed both recording and reproducing. It was actuated by means of a foot-treadle similar to that used on a sewing machine. In fact, the entire apparatus bore a great resemblance to that household necessity.

Our third, fourth and fifth photographs show different types of instruments produced at different stages of development; the third and fourth using the obsolete cylinder records and the fifth bearing a great resemblance to our phonograph of today, in that it used a disc record. In the latter it was necessary to balance the horn and reproducer carefully so as to reduce the wear and tear on the record to a minimum.

NEW AUTOMATIC NON-SET STOP

Our sixth illustration shows one of the latest devices applied to phonographs by one of the prominent manufacturers, which provides a clever means for automatically stopping the motor when the end of the voice record is reached. This is done without any previous setting or any attention whatsoever from the operator. A short description is given below of the action of this apparatus, which may be readily understood by following the figures on our illustration.

When the motor is started by the manual lever it will be seen that the governor brake, 9, will be released by the action of the square hole, 5, on the pin, as the lever pivots on its fulcrum, 4. This action allows the motor to start, and also causes the pawl, 10, to snap past the pin 11 to the position shown. It also releases the so-called interrupted wheel, 12.

The arm, 13, is frictionally clutched to the tone arm so that it can move with the same, but upon being stopped will not interfere with the movement of the arm. As the reproducing needle travels along the grooves, the lever, 13, presses on 14, which is attached to the lever, 15, which causes the latter to pivot on 16 till it hits the stop, 17, causing the end, 18, to slip past the pin, 19. Wheel 12 then rotates for nearly one full turn in a clockwise direction until pin, 22, engages with the small tooth, 23. Also pin, 11, clears the pawl, 10, and the pin, 19, is in contact with the end 18.

ACTION AN OSCILLATING ONE

The movement of the wheel, 12, is now changed to a limited oscillating action which action occurs every two revolutions of the disc shaft, the nose, 18, causing it to move in one direction and the pin 22 causing it to move in the opposite direction. Wheel 21, is moved by the gear, 20. The lever, 13, also progresses and retrogresses alternately without interfering with the movement of the tone arm, being pushed by the projection, 14.

When the needle reaches the end of the sound spiral, the progressional action of the levers, 13, and 15, cease but that of the pin, 22, continues. Therefore, it will swing over to the curved side of the large tooth and cause the wheel, 12, to move clockwise, carrying the pin, 11, against the nose of the pawl, 10, and causing the brake lever to act upon the governor disc, thereupon stopping the motor.

This feature is one of the latest developments in the phonograph world and has achieved great popularity due to its features of being foolproof and entirely eliminating the human factor, as it needs no setting.

While it is entirely possible that many greater features will be added to the phonograph in coming years still it can easily be seen that wonderful advances have been made to this date over the antiquated apparatus shown in Fig. 2.—Photos, courtesy Columbia Graphophone Company.

A Pocket Field Glass

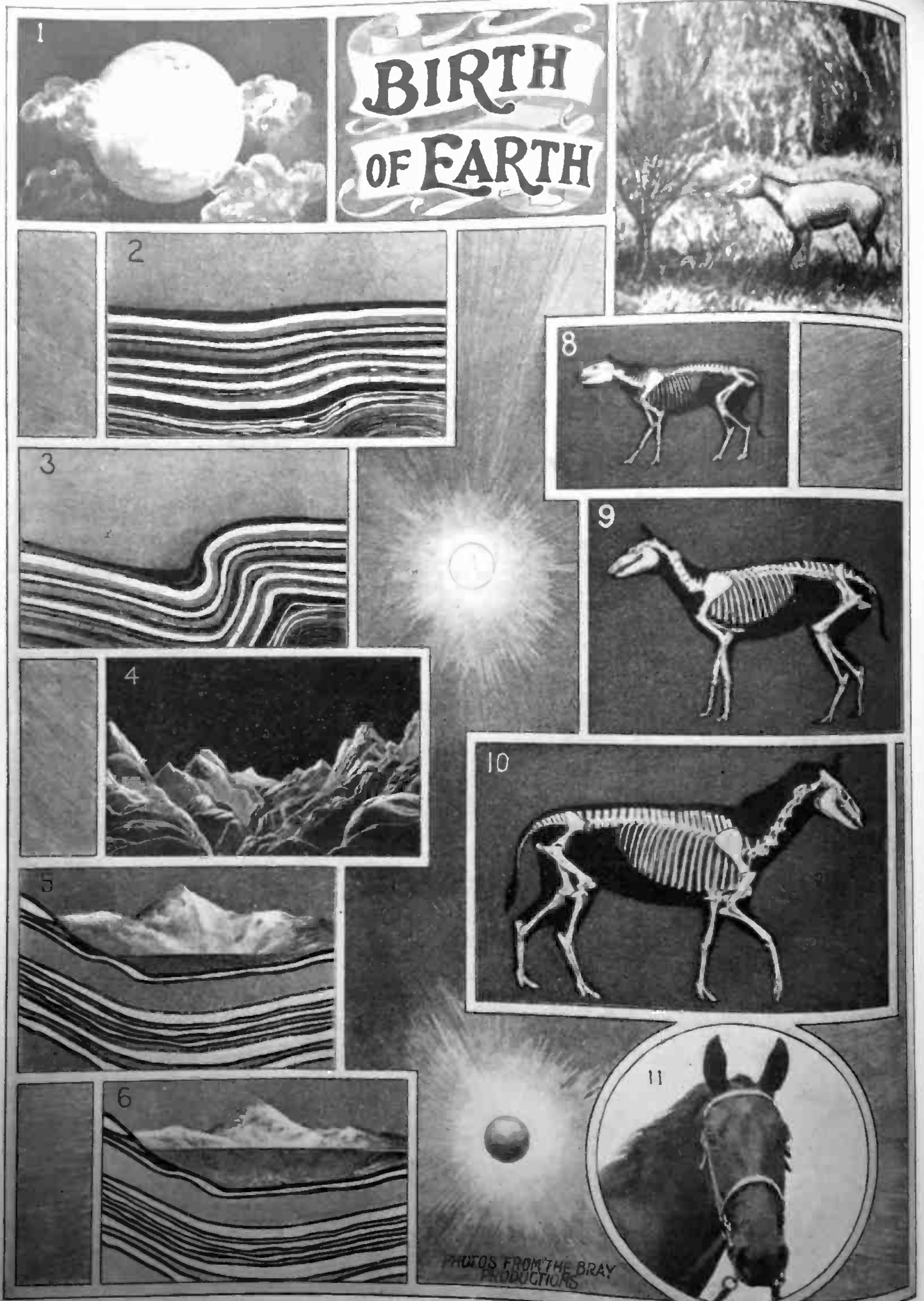
A sort of big brother to the pocket telescope described in the pages of this magazine several months ago has been produced by the same company and is illustrated herewith. It is known as the Biascope and gives a magnification power of six. In size, it is 3¼ inches long and 3⅝ inches maximum width. The lenses are carefully ground and afford an ample field of vision. The glass is supplied with a leather case.

A feature of the apparatus is the diopter scale by means of which one may set his glass at the necessary focusing point without any fumbling. This point is ascertained by experiment; by using the scale provided, the glass can be instantly adjusted for the necessary focus.

Being very small and compact yet at the same time powerful, these glasses are adapted very well for the uses of sportsmen and others interested in the great outdoors.

The Neat Little Pocket Size Field Glass Illustrated on the Left Has a Magnification Power of Six Times. It Can be Contained in the Leather Case Shown and Very Easily Slipped Into the Pocket.

A pair or two of these glasses should be a very great aid to any boy scout troop inasmuch as it will enable them to carry on practice in long distance visual signaling, and other field work where a large glass would be too cumbersome.



The Birth of the Earth Is Shown In a Recent Movie Production From Which the Above Views Have Been Taken. Pictures Show Following Events: No. 1—Red Hot Earth Spinning In Clouds of Steam; No. 2—Soft Crust Layers of Earth Gradually Solidifying; No. 3—Later Stage of Scene 2; No. 4—Showing Mountains Forming; No. 5—This Scene Shows Layers of Earth's Crust Solidified, Mountains, and Water Filtering Into the Basins Formed; No. 6—Further Development of Scene 5; No. 7—Eohippus, Forerunner of the Horse; No. 8—Skeleton of the Eohippus; No. 9—Skeleton View of Intermediate Animal In the Evolution of the Horse; No. 10—A Still Later Development In the Genus Horse; No. 11—The Present Day Horse.

Movie Shows Dawn of Life

ONE of the most entrancing subjects which cinema producers and photographers have endeavored to place before the public time and again, is that showing the dawn of creation, and especially the beginning of our earth. The editor recently had the pleasure of being present at a private presentation of a new film, forming reel No. 1 of a series on "The Science of Life." This movie shows at the beginning the earth revolving in space, and clouds of hot vapor enveloping it. A caption tells us that—the earth was not always in the condition that we know now, and informs us that once it was a hot body revolving in space, like myriads of stars that we now watch and study through our giant telescopes.

The next scene shows the earth's crust starting to cool and wrinkle up, this part of the picture being done in a very clever way, illustrating the various strata of rock. Cavities are formed due to the wrinkling process, and it is very instructive and interesting to see the various ground layers of the earth rising and falling under the play of natural forces. Shortly some of the hollows formed by the wrinkling of the earth's crust fill with water, and we have oceans, lakes and rivers.

This film would be an excellent one in the editor's opinion, for use in public schools and other educational institutions, and should form a part in the instruction in geography and astronomy. The beginning of life is shown in an authoritative scientific manner and it is most absorbing even to the layman who knows nothing of biology, for he can easily understand pictures. The first form of life on the earth is illustrated as single celled beings, which were taken with the aid of a very powerful microscope and high-powered electric lights, under the direction of the U. S. Bureau of Public Health Service. One of the first stages of life shown, is, of course, the amoeba, and several fossil imprints on rock are shown, and it is explained how from the study of these fossil remains found in rocks, the history of life on earth has been traced.

To give a clear idea of how the first forms of animal life on earth gradually grew and changed into other larger forms, a little animal called the *eohippus* and resembling a horse, and measuring but a few inches in length, is shown; this corresponds accurately to researches and studies carried out in tracing the history of life on earth. Following this several other animals (checked with fossil life remains at the New York Museum of Natural History) are shown with X-ray views of their bony structure, until finally we come down to the present-day horse. It is hard to exaggerate the value this picture would have in the hands of practically any teacher of geography, biology and astronomy, in the average public school or high school, where a suitable lecture is given with it. *Illustrations Courtesy The Bray Productions.*

A Telescopic Microscope

By DR. ALBERT NEUBURGER

THE two notions *telescope* and *microscope* seem to exclude themselves and the composition *telescopic microscope* seems to be a contradiction. A telescope is, as is well known, an optical instrument, which serves for the observation of objects which are far away. On the contrary a microscope is used for very small objects which are always in the nearest neighborhood of our eyes. What is, then, a *telescopic microscope?* Well, it is a very useful instrument, which makes the observation of small objects a good deal easier and more comfortable than by using a common magnifying system of lenses or a simple microscope. The telescopic microscope is particularly useful in all cases where it is either not practicable or not desirable to bring the magnifying combination close up to the object which is to be viewed.

Therefore they are certainly a valuable instrument for institutions working in widely differing fields, in schools, agricultural laboratories, public offices, libraries, museums, scientific instrument workshops, engraving offices, and many other establishments, in weaving and spinning mills, by zoologists, botanists, medical men, collectors, and connoisseurs.

The telescope itself, without front lens attachment, is available for use as a field glass or in the theater. With the aid of the central conjoint focussing mechanism or by rotation of the eyepieces it can be focussed upon objects only two yards distant. Its capacity for being focussed within such extensive limits will cause the instrument to meet with a wide appreciation among nature students, frequenters of picture galleries, museums, theaters, and such like.

Telescopic magnifiers are available either for use with one eye (monocular pattern) or for use with both eyes (binocular pattern). The binocular telescopic magnifiers have this material advantage that they enable objects to be seen in solid relief. Solid objects seen through a binocular glass present a far more realistic appearance than when viewed through a monocular one. The monocular telescopic magnifiers would naturally be quite adequate for viewing objects on the flat, such as documents, drawings, art prints, etc., and in all cases where it is essential to obtain the highest available degree of magnification.

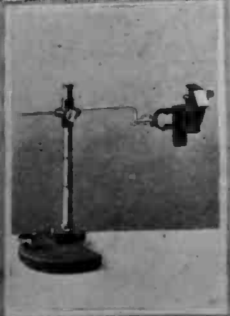
The customary field-glasses (single and double patterns) are adaptable for use as telescopic magnifiers (field-glass magnifiers). When equipped with two identical front lens attachments, binoculars become available for use as stereo-telescopes.

The telescopic magnifiers can be especially useful as an aid to vision in cases of weak sight, especially when the visual capacity is far impaired.

For intermittent use, when it is not necessary to have the hands disengaged, the most convenient method is to hold the telescopic magnifier in the hand without any supporting device. Where these are required they may take the form of head bands, head clips, or stands (with or without fine adjustment). The latter are mainly intended for the use of weak-sighted persons, for whose convenience there is also a special reading desk.

Binocular Telescopic Microscope Provided With Illuminating Attachment and Head Band.

84X Telescopic Microscope (Telescope 6x and Front Objective Attachment.)



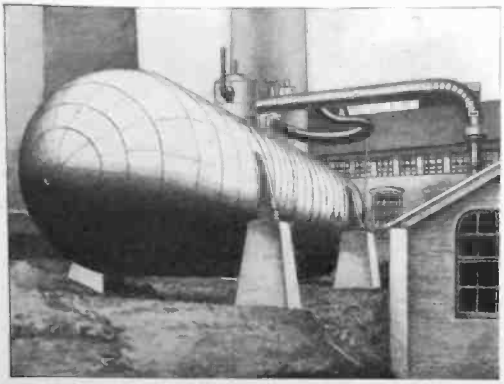
Binocular Telescope Magnifier With Drawing Prism Supported on Focusing Stand.

Binocular Telescopic Microscope Attached to a Head Band But Without Illuminating Attachment.

Storing Steam for Use When Needed

By ISMAR GINSBERG, B. Sc., Chem. Eng.

STEAM is evaporated water. It is the liquid, water, converted by heat through elevation of temperature into the gaseous condition. We never see steam. The white cloud, escaping from the water kettle, from the valves on radiators, from exhaust pipes of locomotives and stationary engines, is not steam, but fine



On the Left Is Shown the Steam Storage Tank In Actual Operation. The Steam is First Generated and Then Lead Into the Storage Tank Where it is Condensed by the Water Within. A Full Explanation of the Action of This Tank is Contained in the Text.

particles of condensed water. Steam is colorless just like air. When steam comes in contact with a surface or any other medium, as for example air, which is at a temperature below the boiling point of water, or 212 degrees Fahrenheit, a part of the steam is immediately condensed with the formation of a white cloud.

DR. RUTHS, SWEDISH ENGINEER, INVENTS STEAM STORER

Steam is made as and when it is needed. It has not been possible to store steam economically and practically for future use by any means known up to the present time, before the Swedish engineer Dr. Ruths devised his steam storer or accumulator. The reasons for this are quite obvious. In the first place steam can only exist as such when the temperature is high. As soon as the temperature decreases, the steam condenses and forms water. Then again, the volume of steam is very great. For example, one pound of water at 212 degrees Fahrenheit and atmospheric pressure will produce 26.79 cubic feet of steam. A pound of water will occupy only 1-62.5 cubic feet or 0.016 cubic foot, while the steam, produced therefrom, will occupy 26.79 cubic feet. It is easy to see that it would be a practical impossibilty to store very much steam, even if the temperature conditions were favorable. Of course, it is possible to store the steam under pressure just as any gas is stored under pressure, where a large volume of the gas is squeezed into a small cylinder, as in the case of oxygen or hydrogen gas, but this method is also not economically feasible for many reasons, the required high temperature being an obstacle to its use.

So, the steam plant, that is the boiler plant, has continually made steam as it was required by the power producing machines and other apparatus in the works. When the plant shut down in part or in entirety, the steam plant was shut down correspondingly. When the steam demand increased, the banked fires were started again or another boiler or two was set into operation. In a plant where the steam demand varies constantly from hour to hour, and in many chemical plants, paper mills, steel works, etc., this is practically the case, there must necessarily be constant stopping and starting of boilers. The result is low efficiency of operation. The reason for this variable demand for steam is due to the fact that the steam is used for other purposes in the plant than for producing power. In a paper mill, for example, it is used in heating up the digesters which convert wood and other paper making materials into pulp; it is also employed in the drying cylinders on the paper making machine for drying the moist sheet of paper after it leaves the Fourdrinier wire. It finds similar uses in chemical plants, plants making soap, dyes, food products, rubber, steel, and in fact in almost any establishment where heat is required in the manufacturing process. In every case this means variation in steam consumption and high cost of steam production.

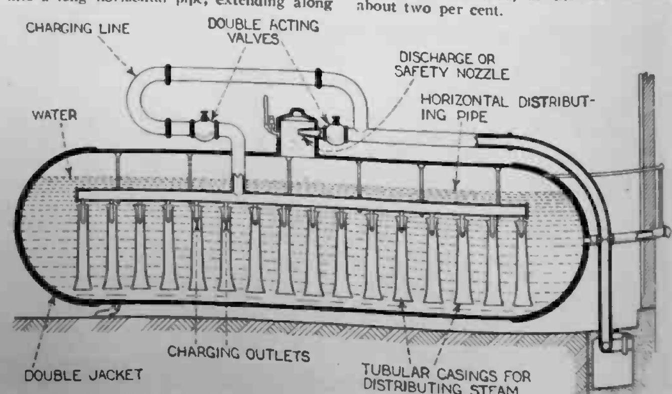
DETAILS OF STEAM STORER

The new machine that stores steam and delivers it in excellent condition for use in various operations is known as the Ruths steam accumulator. It is a large steel tank with rounded ends. The tank is provided with double walls and the best heat insulation available. It is filled about nine-tenths full of water, and the insulation is so perfect that no matter what the temperature is on the inside, it is cold on the outside surface. The tank is provided with a steam dome on top in which the discharge or safety pipe is connected. The charging pipe passes through the top of the tank and opens into a long horizontal pipe, extending along the entire length of the tank, provided with numerous small charging necks, connected at right angles to the horizontal pipe. The steam enters the apparatus through these necks and is condensed by the water, coming in direct contact with it. The steam is practically speaking, stored in the water, the quantity of which is accurately determined before the apparatus is put into operation. The charging outlets are surrounded with tubular casings to distribute the steam as it enters the apparatus. Both the charging pipe and the discharging pipe are provided with double acting valves of special construction and possessing a high degree of sensitivity.

The apparatus is located on the main steam line. The valves are adjusted so that they work at the proper pressures. The capacity of the boiler plant is calculated to supply a certain average quantity of steam per hour to take care of normal operations of the plant. When the mill is not working to capacity or when a part of the manufacturing process is temporarily shut down, waiting for another part to catch up with it, the boiler plant is of course producing more steam than is required. The result is that the pressure of steam in the steam line builds up and the double acting valve on the steam inlet line to the accumulator opens and allows the excess steam to flow into the machine and store up in the water. If the demand for steam suddenly increases, the first thing that happens is that the flow of steam towards the accumulator is stopped and then the double acting valve on the steam discharge line opens and the stored steam from the accumulator is permitted to enter the steam line.

RESULTS OBTAINED

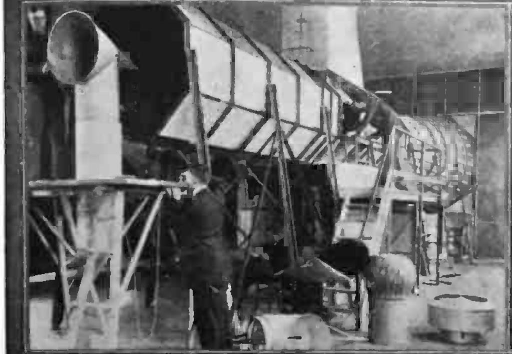
Very remarkable results have been obtained with this apparatus. The use of the machine has made it possible to work with fewer boilers and less labor. The largest Ruths accumulators built up to the present time allow the discharge at the maximum rate of 100,000 kilograms of steam per hour from the machine, that is more than 220,000 pounds of steam per hour, without the steam losing any appreciable pressure. It has been remarked by the President of one of the largest paper concerns in the country, after he had seen the machines in action in Europe, that in one case the steam lay dormant, was stored up for three weeks in the accumulator and then practically all of it was recovered, as the loss was only about two per cent.



A Sectional Diagram of the Steam Storage Tank Illustrated in the Upper Left Hand Corner is Shown Herewith. All the Various Parts Are Labeled and by Comparison With the Text Their Uses Will Be Understood.

How Uncle Sam "Keeps Tab" on Fliers

By S. R. WINTERS

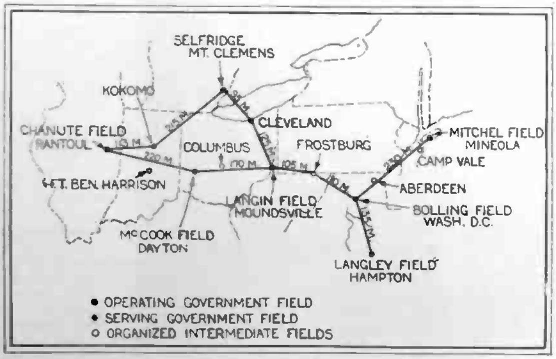


U. S. Bureau of Standards Wind Tunnel For Making Airplane Test. This Tunnel is Also Used to Test Automatic Roof Ventilators. The Air is Drawn Through the Wind Tunnel by a Powerful Motor-driven Fan.

How Uncle Sam Keeps Track of His Airplanes. The Blackboard Map Corresponding to the One Shown Below, is Kept Up To Date every Few Minutes by Radio and Wire Reports on Airplane Positions and Weather.

"LIEUT. WRIGHT makes forced landing near Rantoul, Illinois. No injuries to personnel. D. H. 4 plane is partially wrecked. Repairs being made at Chanute Field."

With a variation in the text, this imaginary message is likely to be true to life at any time, and although the accident may occur hundreds of miles from the National Capital, the report is written on a blackboard in a room at Bolling Field, Washington, D. C., a few minutes after the mishap. And, thereby hangs a tale of "How Uncle Sam Keeps Tab on Airplanes in Flight."



The Air Service of the War Department has a network of seven fields for the *landing* and *taking off* of aircraft, these points forming the so-called *Model Airway*. These flying stations are located at Rantoul, Illinois; Dayton, Ohio; Mt. Clemens, Michigan; Moundsville, West Virginia; Hampton Roads, Virginia; Mineola, New York; and Washington, D. C. Then, too, there are intermediate points serving these respective Air Service flying fields, including Kokomo, Columbus, and Cleveland, Ohio; Fort Benjamin Harrison, Indiana; Frostburg, Pennsylvania; Aberdeen, Maryland; and Camp Vale, New Jersey.

Bolling Field, located at the National Capital, and the place where the Air Service conducts many of its experimental aircraft flights, has been, quite logically, selected as the *control station* for the network of flying fields comprising the model airway. At this point, the branch of the Government service concerned with the development of aircraft has stationed a control officer, radio control officer, and meteorological control officer, each having functions to perform in conjunction with the operations of the airway. Air-going machines from any of the seven air service stations named in a preceding paragraph, take to the air in accordance with well-defined schedules. Each of these seven Government flying fields assign every other week an airplane to fly over the "Model Airway," and the dates on which these flying machines make cross-country flights are so arranged that at least one airplane flies either east or west over the Allegheny Mountains daily.

The *Airways Office* of the Air Service, in Washington, under the direction of Captain Burdette S. Wright, controls the movements of Uncle Sam's aircraft on these periodical flights over a vast and populous area of the United States. Out at Bolling Field, under the active guidance of Captain St. Clair Street, the *Operations Office* marks a departure in the control of the movements of these mechanical birds of flight. Here, in a room, 110 by 20 feet in dimensions, designed and built for this specific purpose, a crash occurring at Mitchell Field, Long Island, New York, hundreds of miles away, is almost instantly flashed by means of radio-telegraphy to Washington.

Fastened on the wall of the operations office at Bolling Field, District of Columbia, is a huge map (incased in glass) of the United States. On this figured representation of our physical country, is posted daily a chart from the Weather Bureau of the United States Department of Agriculture, which is a forecast of weather conditions; this chart or map is similar to those widely issued daily by the Weather Bureau. Supplementing this chart, indicating whether the weather for the forthcoming twenty-four hours is to be fair or foul, is a board reserved for posting meteorological information existing at each of the seven Air Service flying fields. These data are in the form of advance weather forecasts based on reports made available to the control office of each of the stations along the model airway. The reverse side of this board contains information of particular value to aviators contemplating flights, and this is known as the *Aviation Weather Forecast*, predicting the state of the upper atmosphere for the different sections of the airway.

A blackboard, extending over nearly one-half of the side wall of the 110 by 20 feet of the *Operations Office*, is reserved for the dispatching of aircraft on these periodical cross-country flights. One section of this board indicates the flying schedule in effect; another portion contains a line drawing of the model airway, or a section for posting weather conditions as they relate to the different points along the Government airway. Also, this board carries in suspension a group of miniature models of aircraft, these representations serving, in a graphic manner, to show the location of each airplane in flight, according to the latest information received by radio-telegraphy.

If a unit of aircraft is delayed at a station—say, for instance, at Chanute Field, at Rantoul, Illinois—this is indicated on the blackboard, as well as information pertaining to the cause of the delay, and the name and type of the machine are given. A third section of this large bulletin board is reserved for announcing the arrivals, departures, expected arrivals and expected departures of air-going machines. In a measure, it is a railway-train bulletin board adapted to the facilities of transportation through the air. The names of the personnel, the home station, and the type and number of the airplane are supplementary information contained on the *Model Airway*

(*Continued on page 376*)

New X-Ray Plates

By DR. H. BECHER

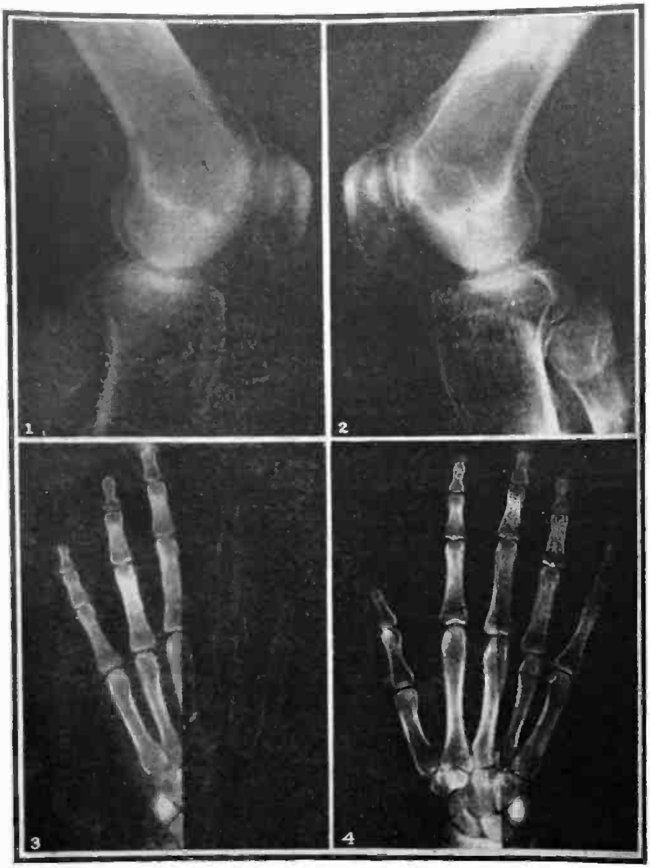


Photo No. 1 Is An X-Ray Picture of the Knee Taken With Ordinary Plates. No. 2 Is the Effect Produced on Neo-Rontgen Plates. No. 3 Is a Photo of the Hand Taken On An Ordinary Plate, Half of Which Was Subsequently Exposed To Yellow Light, Blotting Out the Image Almost Entirely. The Same Effect Tried On Photo No. 4 Produced No Loss of Detail.

IT is almost universally known that the ordinary photographic plate is very sensitive to the blue and violet end of the spectrum, and nearly entirely insensitive to the red, orange and yellow side. Upon such a plate even a dark blue sky will appear almost white, while flowers of a radiant yellow and trees of a light green are seen in the photograph darkly outlined. By adding various chemicals or coatings to the ordinary plate, it is quite easy to sensitize it, so that a chromatic plate will be produced, which plate will record light waves of a longer wave-length, such as yellow, red, and green. A picture taken with this plate will be produced with the same degrees of light and dark, which the natural scene would establish in the human eye. For instance, yellow would appear light, while dark blue would appear dark.

Röntgen or X-rays differ from the ordinary rays of light in one important detail. The wave-length is extraordinarily short. Although many plates have been developed for X-ray work, which gave more satisfactory results than the standard plates found upon the market, no attempt has been made up to the present time to sensitize the plates for extraordinarily short wave-lengths, such as those emitted by the X-ray tube. The X-ray photographic plate, therefore, has differed in no way from plates for other purposes. For this reason the exposure required was rather long due to the relative insensitivity of the plate to the shorter wave-lengths, and there was little difference between hard and soft rays; in other words, short wave and long wave X-rays. On this account, there was little contrast in X-ray photographs. In addition to that X-ray plates were far too sensitive to ordinary light.

Dr. Schleussner, a well known German authority in photo-chemical matters, has succeeded, after years of investigation, in sensitizing photographic plates for X-ray use by an addition of certain organic salts which are absorbed by the grains of silver bromide on the photographic plate. The plate thus formed is very responsive to the soft rays of an X-ray tube. The soft rays are relatively longer than the hard Röntgen rays. One could compare the soft rays with visible yellow-red light, and hard rays to blue-violet light, if their effects on this new photographic plate are used for the comparison. Photographs taken with such plates give very real contrasting effects.

In the picture of the elbow reproduced here, the first photograph was taken with the ordinary plate, and the second with the new Neo-Röntgen plate. These new plates are hardly affected if exposed wholly or in

(*Continued on page 376*)

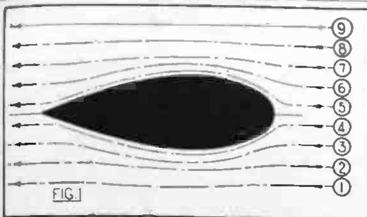
An Unusual Meteorite

On Thursday, January 25th, an unusual phenomenon was witnessed in the Cantonment of Quetta, on the Northwest Frontier of India, a large meteorite falling to earth during the course of a thunderstorm, at about half past two in the afternoon.

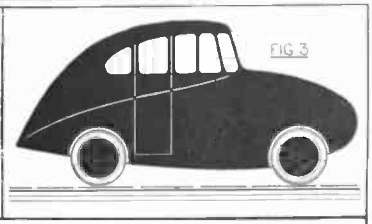
A Strange Meteorite Phenomenon Is Shown In the Accompanying Picture, the Meteorite Penetrating the Huge Stack of Baled Straw Neatly To the Ground and Not Setting Fire To the Straw Until Several Hours Afterward.

Previous to its impact, a house near the point of its arrival was struck by lightning. About a minute later, came the meteorite itself, hitting a large stack of baled straw about a hundred feet long and thirty feet high. The force of its impact may be

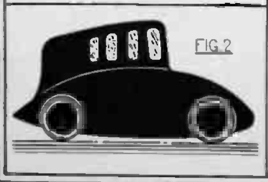
(*Continued on page 375*)



In Fig. 2 a Compromise in Streamline Body Design is Shown, the Upper Part of the Body Being Placed as Far Back as Possible to Avoid Sharp Interference with the Air Currents. A Still Better Design is Shown In Fig. 3.



Above is Shown Ideal Streamline Body for Automobile. As Will Be Seen Eddies Are Formed, and the Resulting Resistance is Very Little More Than the Skin Friction Between the Air and the Surface of the Model. In the Diagram Nine Smoke Threads Are Shown; of These Nos. 4 and 5 Are Diverted to the Greatest Extent, the Adjoining Threads 3 and 6 Already Show Flatter Curves



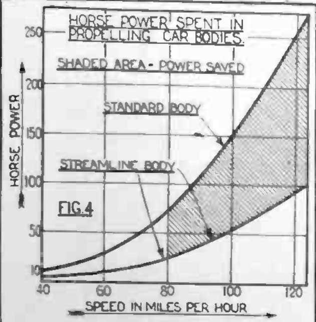
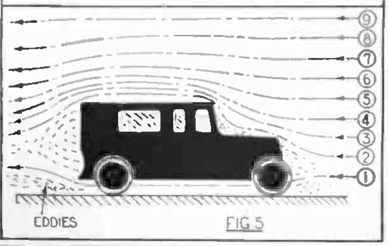


Fig. 5 Shows the Flow of Air Around a Standard Type of Closed Auto Body Traveling at High Speed. The Eddy Currents Formed In the Various Angles About a Body of This Design, Cause a Greater Amount of Power to Be Consumed in Driving Such a Body Through the Air at a Given Speed.



By Suitably Streamlining Automobile Bodies, More Speed with Less Power Becomes Possible, as Will Be Evident by Studying the Accompanying Diagrams Made with the Aid of Smoke Streams and Wooden Body Models of Different Shapes. By Studying the Diagram, Fig. 4, It Will Be Seen at Once that the Horsepower Required to Overcome the Air Resistance Alone of a Standard Closed Body Is Much Greater Than That of a Streamline Body. At 100 Miles per Hour, One Hundred and Fifty Horsepower Are Required or Rather Wasted, in Forcing a Standard Closed Body Through the Air, While a Streamline Body Only Absorbs Slightly Over Fifty Horsepower.

More Auto Speed With Less Power

By C. A. OLDROYD

WHEN the motorcar designer had exhausted all possibilities of speeding up his cars without further increasing their power, he consulted his colleague, the aeronautical engineer, and the latter showed him how he could actually construct much faster cars, using even less power than that of present standard types of automobile engines.

Small wooden auto models of about one-tenth full size were made and suspended in a windtunnel.

Around such a shape as shown in Fig. 1 the air flows in steady curves, as indicated in the diagram; no eddies are formed, and the resulting resistance is very little more than the skin friction between the air and the surface of the model. In the diagram, nine smoke-threads are shown; of these, number 4 and 5, are diverted to the greatest extent, the adjoining threads, 3 and 6, already show flatter curves. Threads 1 and 8 are only very slightly affected, and number 9 is not deflected at all.

Unfortunately, a true streamline shape does not lend itself readily to a car body design, first for purely constructional reasons, and second, because a streamline shape is at its best when in a free current of air.

The streamline, therefore, had to be modified by flattening the underside. As a fast touring car must be comfortable in all weathers, a closed body had to be provided. This was done by placing a second streamline shape, this time only streamlined in plan, on top of the first body, the lower one. The upper body ends in a knife-edge to prevent the formation of eddies.

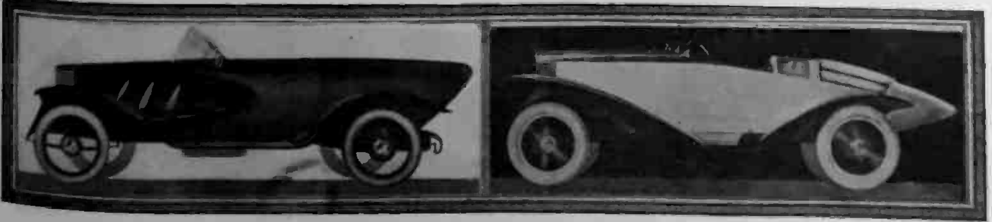
At first sight (see Figs. 2 and 3), the new type of body seems rather strange, and one is inclined to wonder why the upper body has been placed so far back, as otherwise the outline would appear more balanced. It was, however, necessary to place the upper part so far back, if high efficiency was to be obtained, because the streamline shape is very sensitive to any disturbance in the flow of air, and with the body set back, this interference occurs too late to be harmful.

When studying the diagram (see Fig. 4), which shows the horsepower needed to overcome the air-resistance alone, one will see at a glance what a tremendous step forward a streamline car is. The curves show the horsepower needed to overcome the air-resistance of a standard closed body in one case, and of a streamline body in the other case.

Figure 5 gives the explanation, it shows the flow of air around a standard type of closed body travelling at high speed.

The "washing away" of the eddies takes place between lines 1 and 2, some of the eddies also disappear around the body sides.

But Fig. 5 shows us even more than that, it gives an idea, how far the disturbance of the air reaches. Lines 1 to 4 are severely deflected, the following curves are easier, but even line 8 and 9 are not yet straight lines, and the disturbance extends still further.

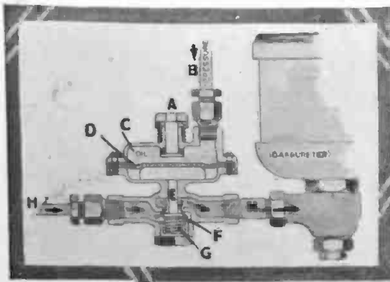


The Two Photos Above Show Recent Streamline Automobile Bodies of German Design.

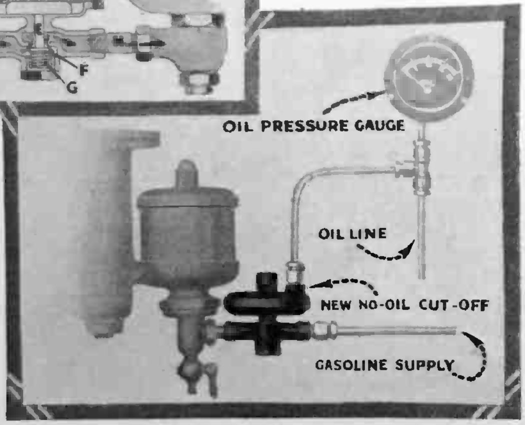
No Oil--Engine Stops

A DEVICE has recently been designed for use on any internal combustion engine with a pressure lubricating system, which will stop the engine at any time when the oil system does not act properly. The bottom part of the device is connected to the gasoline line, near the carburetor, while the top opening of it is connected to the oil line. A diaphragm made of specially treated Austrian goat skin, separates the oil compartment from the lower compartment where the gasoline flows through. As long as the engine is running and the lubricating system acting properly, the oil pressure against this diaphragm will keep the valve in the gasoline section wide open, allowing the gasoline to flow freely to the carburetor; but when the oil supply runs low, or the pump fails, the oil pressure ceases and the spring beneath the gasoline valve causes the valve to close immediately, thus stopping the engine.

When the engine is voluntarily stopped by the driver, the valve in the gasoline line automatically closes until the engine is started again, this preventing gasoline leakage. Should his engine stop and the driver be undecided as to the cause, he can press down a tester which is on top of the device, and if the engine starts, and then stops as soon as the carburetor is emptied, he may feel assured that the lubrication is not working properly. One can also use this tester to refill the carburetor that has been drained.



When the Oil Pressure Falls, Owing to the Shortage of Oil, the Gasoline Flow to the Carburetor is Cut Off, as Explained in the Accompanying Article. The Oil Pressure as Long as It is Kept at Normal or Nearly Normal Value, Acts on a Flexible Diaphragm D, Which in Turn Holds Open the Gasoline Valve E.



The Automatic "No-Oil" Cut-Off Here Illustrated, Should Prove a Boon to Motorists, and Prevent Scoring the Cylinders of Engines, Due to the Oil Having Leaked Out Because of a Broken Fitting or to Neglect on the Part of the Autoist.

A. Testing rod to use when the driver is undecided as to cause of the engine stopping. B. Oil line. C. Upper compartment where oil pressure bears against the goat skin diaphragm. D. Specially treated Australian Goat skin which separates the oil compartment from the gasoline compartment. The pressure of the oil system against this goat skin pushes the plunger that opens the valve allowing the gas to flow freely. E. Valve plunger. F. Valve. G. Spring which lifts the valve thus closing it as soon as the oil system ceases to function, and does not have the proper pressure against the top of the diaphragm. H. Gasoline line.

It is a wonder that some genius did not long ago, bring out a device similar to this as there is more trouble encountered from improper lubricating conditions in automobile engines than one would imagine offhand. Some of the reasons that automobile engines have their bearings burned, or sometimes have their cylinders badly scored and grooved because of no oil, is due to negligence of the driver not watching the oil level in the tank; in other cases a leak has perhaps developed unknown to the driver as he spun along.

Contributed by HENRY S. WOOD.

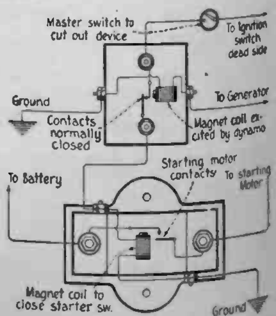
New Engine Anti-Stall Device

MORE than a few of our automobile disasters arise from stalling of engines. It is very easy indeed when taking a rough railroad crossing at cautious pace with engine closely throttled, or when running in heavy traffic, with just enough gas to keep it alive, for the roadway or the driver to make a sudden demand for more power—a demand which cannot be met with the small amount of gas which the engine is getting. The resulting stalling of the engine is always embarrassing at the very least, and it always brings within the realm of possibility a crash from behind or from the side.

A very ingenious anti-stall device has been placed upon the market by a Brooklyn, N. Y., concern. The starting motor is connected into the ignition switch circuit in such a manner that the act of switching on the ignition, switches on the starter as well. This has been done in the past, of course, an automatic cut-out being supplied to put the starter out of action as soon as it had done its duty. But these cut-outs have been regulated solely by the engine speed, and have had to be set for the speed, at which the engine just starting is certain to remain started, rather than from a zero speed. The result has been that when the engine stalled, or was closely throttled, the starter came into play and drained off the life blood of the battery.

The anti-stall device illustrated is constructed differently, and does not act until the engine comes to a dead stop. When this occurs, however, it acts instantaneously, and the engine presumably being warm, comes right out of its stall. One's hasty impression might be that it would be impossible to stop at all, but this, of course, is not the case. Switching off the ignition cuts off the spark and cuts out the starter also, so that the anti-stall apparatus does not come into play. A master switch is provided in addition to the regular ignition switch. If for any reason it is desired to run the car with the anti-stall device inoperative, this switch is opened. The ignition circuit remains undisturbed, and the starter will work when the starting pedal is depressed in the usual way, but the ignition and starting circuits have lost their connection, and the car performs in the ordinary way, just as though the anti-stall device were not present.

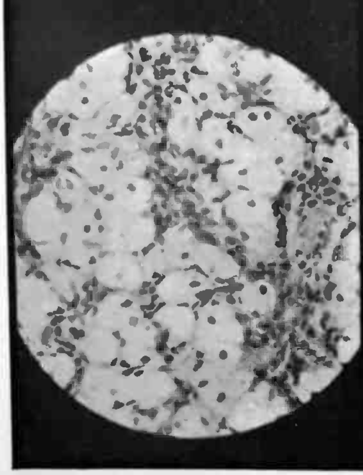
It will be possible, for instance, to explore for trouble by spinning the engine with the starter. It is pointed out that there is really no good reason why one should have to close two electrical circuits to start the engine. Separate switches for ignition and for starting motor are a relic of the day when the starter was new and a novel attachment superimposed upon the car and not an integral part thereof. Incidentally, the device makes it impossible to have the ignition current flowing and exhausting the battery, for one can stop the engine only by turning off the spark, and if one should then turn the ignition switch over accidentally, the engine will at once start and attract the owner's attention.



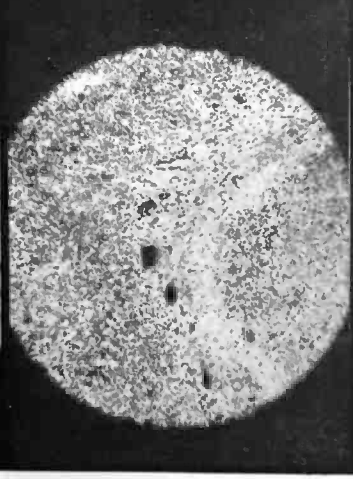
The Device Here Shown in Detail is of Nominal Cost and Effectively Prevents the Automobile Engine from Stalling at a Moment When it Should Not—for Example, When you Happen to Be on the Railroad Track. As soon as the Ignition Current is Switched On, the Automatic Starter Switch Here Shown, Comes Into Play and Turns the Engine Over, Thus Throwing the Starter Motor into Gear. It is Thus Seen that Whenever the Charging-Dynamo Speed and Voltage Drop Below Normal Value, This Device Will Come Into Play and Start the Engine Just as it Stops, Preventing Stalling.

New Apparatus for Micro-Photography

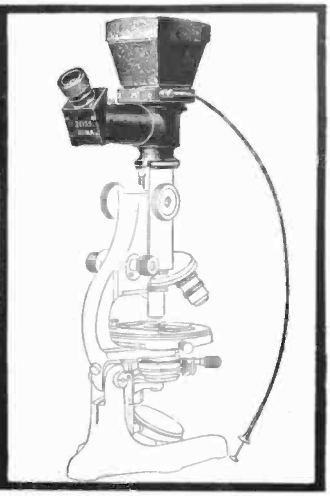
By Dr. H. BECHER



A Microphotograph of an Infectious Disease of the Nose is Shown in the Reproduction Above.



A Syphilitic Disease of the Aorta Is Reproduced in This Photograph Which May Be Enlarged Without Losing Its Sharpness.



The Phoku Attached to the Top of a Microscope Is Shown in the Illustration Here Given. With This Device the Excellent Microphotographic Pictures Shown at the Left Were Taken.

IN taking micro-photographs the crudest extemporized arrangements have frequently been employed. Perhaps standing on the seat of a chair or top of a table, the person taking the magnified picture of a microscopic object had to do his focusing in a very uncomfortable position accentuated by the necessity of using a camera with a very long bellows, or he may have had to connect the microscope with the camera in a horizontal position, almost as awkward if done without special camera and stand. Furthermore an intensive source of light was necessary and above all the whole procedure demanded a very great experience. For instance, the focusing upon the ground glass plate of the camera was exceedingly difficult if moving objects had to be taken, for before the slide could be gotten into place, this moving object would have disappeared. If ever it was possible to take a photograph by such methods, it must be considered as a mere piece of good luck.

Notice the Fibers in This Linen Cloth Magnified 375 Diameters. The Wonderfully Even Illumination is Obtained by the Lighting Device at the Right.

The photographic objective "Phoku" and the camera belonging to it, which has been devised by Mr. Siedentopf and now manufactured by the Zeiss-Werke of Jena, Germany, does away with all these draw-backs. As the figure shows, the "Phoku" camera is an exceedingly compact instrument, having a height of but 3½ inches, while all other cameras for micro-photography, even those of smallest size, are 12 to 20 inches high.

The most important merit, however, belonging to the "Phoku" is the fact that focusing upon the ground glass is completely avoided. Intead of this the picture is thrown upon the photographic plate by a triangular prism which at the same time focuses the picture in a horizontally adjusted side tube, from which it is reflected again by a second prism. This latter brings the picture slantingly upward to the surface, thus allowing the photographer to watch and control it quite comfortably through the objective in the vertical tube of the camera. This enables the person taking the picture to snap the moving object at the very moment when it shows itself most advantageously. The photographs are about 1¾ by 2¼ inches in size. The apparatus can easily be connected directly with any larger camera. The adjustment for securing sharp pictures is also quite simple. In fact, anybody can within a very short time get acquainted with the instrument and gather the necessary experience for making fine micro-photographs.

NOVEL MICROSCOPE ILLUMINATOR

A device giving a uniform and intensive illumination from all sides, is the apparatus invented and patented by Professor William A. Beck, of the University of Dayton, called "An Illuminating Device for Microscopes." The medium for the transmission of light in this mechanism is circular in shape; it has a central depression or well into which is fitted a shell containing the object-platform or stage. This platform can be moved up or down by means of a knurled screw. The inside portion of the medium above the stage is beveled to form an angle of 99°, 20′ with the horizontal, while the outside portion of the medium has a slant of 135° with the horizontal. The edges of the two beveled slopes do not meet but terminate in a flat surface to prevent injury while in use. When in service, the light enters at A_1, is reflected at C_1, and again refracted at D_1, so as to strike the object on the stage at E_1.

It will be readily seen that, on account of the circular form of the medium, every part of the object receives a maximum of concentrated light, which illuminates the object

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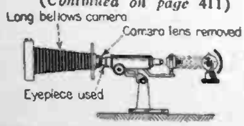
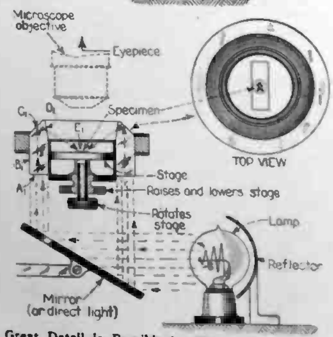




Great Detail Is Possible by Means of This New Beck Microscope Illuminator.

Popular Astronomy

By ISABEL M. LEWIS, M. A.

OF THE U. S. NAVAL OBSERVATORY

The Sociable Stars

STARS, like human beings, have the social instinct. They travel through the universe in groups and clusters, streams and drifts. Their small family units consist of two or more members in revolution about a common center of gravity. We refer to these family

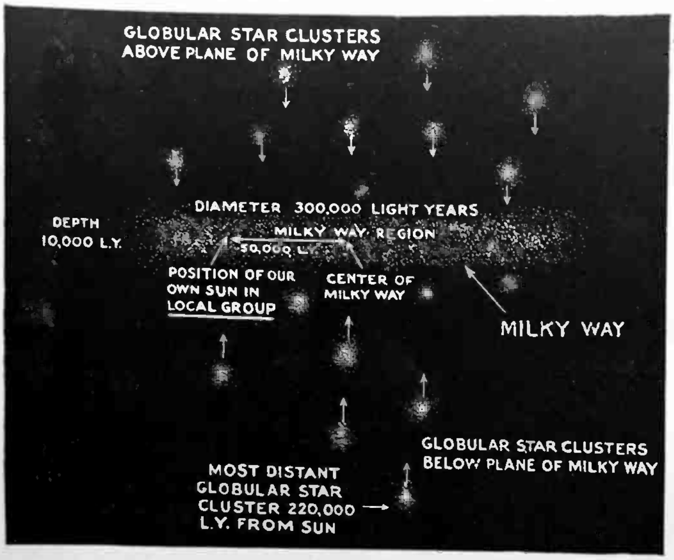


Diagram Showing General Plan of the Visible Stellar Universe and Relation of the Globular Star Clusters to the "Milky Way" Which Forms the Equatorial Segment. The Globular Star Clusters Are Approaching the Plane of the Milky Way at High Velocities. None Are Known to Exist Within it. The Milky Way May Consist Partly of Disintegrating Clusters.

groups as the binaries or the multiple stars. The two members of a binary star system may revolve almost in contact in a period of a few hours or days or they may be so widely separated that years or centuries pass before a single revolution is completed.

The larger family units of three, four, five or six members, the multiple stars, usually form into sub-groups, two stars close together and in mutual revolution revolving about a common center of gravity with a more distant pair or an isolated star in a period of many centuries. We know many of these star-families by name.

Who has not heard of Epsilon Lyrae, the quadruple star that consists of a widely separated pair each member of which is in itself a close double? Then there is Algol, the Demon Star in Perseus, a close binary made up of two stars revolving nearly in contact, egg-shaped as a result of strong tidal reactions arising from a too close proximity. And who that has seen will ever forget the regal family group of Theta Orionis in the heart of the Great Orion Nebula which is a sextuple star? Here is a group of unrivaled splendor and noble distances. All of these stars are massive giants and light takes many months, if not years, to cross their domain which is filled with soft nebulous light due to electrical excitation produced by the stars themselves.

There seem to be few hermits among the stars. Our own sun, reluctant as it may appear to share its glory with another sun, has its brood of small dependent worlds that it is piloting proudly and safely through the universe.

Just as among humans family groups become associated forming communities with interests more or less in common, so among the stars we find that these small family groups frequently are gathered into loosely bound star clusters that are drifting along or speeding along, as the case may be, in the same general direction and with equal speeds. Fully a dozen of these loose or open star clusters, as they are called, are known to exist within a few hundred light-years of the sun and his family.

OUR SUN IN A STAR CLUSTER

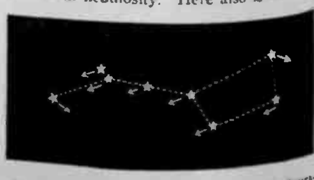
Our own sun is in, though not of, one of these open clusters as one may be in, though not of, a crowd. The cluster to which we refer is the Ursa Major cluster which contains, among others, five of the seven stars in the Big Dipper as well as Sirius, the brightest of the stars, which is only eight and a fraction light years away. Most of the stars of this Ursa Major group are extremely hot, white, hydrogen type stars and they are moving parallel to the Milky Way in the general direction of the constellation of Ophiuchus with a common velocity of twenty miles per second. They appear to be gathered into a disk-like formation for all of the members are included within a region that is approximately fifteen light-years in depth and about one hundred and fifty light-years in diameter. Within the limits of this group there are many stars that do not belong to it including, as we have said, the sun. It seems indeed to be a remarkable fact that such an associated cluster of stars is so little affected by chance stars that lie within it and, vice versa, that stars that pass through the midst of such a group pursue their course undisturbed by its presence. Though the stars are evidently sociably inclined they are, at the same time, not to be swerved from a chosen path.

Another well-known moving cluster is the Pleiades cluster which is at a distance of approximately three hundred light-years. This group has been very extensively studied in recent years and it has been found that in a region two degrees square with Alcyone, the brightest of the Pleiades, at the center there are more than two hundred stars that are moving in the same general direction with equal velocities. The naked-eye stars of the Pleiades with which we are all familiar—the brilliant, helium stars that are popularly referred to as "The Seven Stars" or "The Seven Sisters"—and a few other prominent stars in this group of the same type, that are closely associated with the nebulosity of the Pleiades, are all massive, giant stars fully one hundred times more luminous than the sun. Yet the great majority of the stars in this cluster are dwarfs, the brightest of which do not surpass our own sun in brilliancy and many of which do not possess more than one hundredth of its luminosity. This Pleiades cluster is one of the nearest and most thoroughly investigated of all the dwarf star clusters and its stars do not appear to be confined to any one particular type. It represents a heterogeneous collection of many classes.

One of the most important and best-known of all moving star clusters is the Taurus group or stream which contains more than two score members whose motions have been thoroughly investigated. Among these stars are some of the well-known naked eye stars in the Hyades and other neighboring stars, distributed over an area of some fifteen square degrees. It has the appearance of a globular star cluster with a small condensation toward the center. Its distance from the earth is about one hundred and thirty light-years and its diameter is a little over thirty light-years. It is moving with high velocity relative to the sun in the direction of the constellation of Orion and it has been calculated that if its motion remains undisturbed it will appear after a lapse of some sixty-five million years as an ordinary globular star cluster of faint stars with an apparent diameter about two-thirds that of the moon. The stars in the Taurus cluster are giants from ten to one hundred times more luminous than the sun and there is in our immediate stellar neighborhood no association of stars to be compared with this magnificent assemblage.

THE ORION FAMILY CLUSTER

Some six hundred light years away is the magnificent Orion cluster consisting chiefly of brilliant helium and hydrogen stars involved in nebulosity. Here also is an asso-



The Stars in This Universally Known Configuration Are Moving in the Direction Indicated by the Arrows. Five of Them Belong to the Moving Cluster Known as the Ursa Major (Big Dipper Shown) Group, Which Also Includes Sirius—the Brightest Star in the Sky.

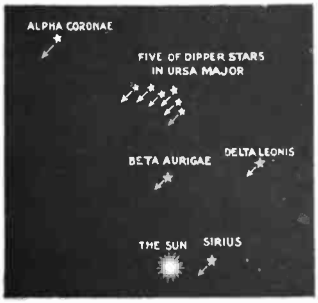
ciation of stars including many of the giants of the universe, though in this, as in all clusters, it is the giants that receive the lion's share of attention while in actual numbers they may be greatly exceeded by the inconspicuous, dwarf stars. In general, the members of these clusters or streams of stars are not of any one class or type, though in some instances they seem to be dominated by stars of a certain type, such as the hydrogen stars in the Ursa Major group and the helium stars in the Orion group.

The groups of stars that we have been considering so far have, apparently, a comparatively small membership, a few score of stars at the most, which the region that each cluster occupies is comparatively restricted, being only a hundred light-years or so in extent, and considerably less in depth. Now it has been known for some time that the sun lies in the midst of a local group of stars that includes all of the clusters we have mentioned and a number of others in addition. The Pleiades, the Ursa Major group, and Taurus stream, the Orion group and others appear to be sub-groups in a greater organization that in contents and dimensions resembles the Magellanic clouds or one of the star-clouds of the Milky Way. This local cluster consists, evidently, of a conglomeration of stars of all types intermingled with extensive nebulosity that is broken up more or less into sub-groups and clusters. Its extent is probably of the order of a thousand light-years and it lies close to the plane of the Milky Way or Galaxy of which it, in turn, is a subdivision or partially detached portion. Owing to the fact that our own sun is near the center of this extensive local group of stars and is at the same time close to the plane of the Milky Way, toward which the majority of all the stars of the universe crowd in a lens-shaped formation, it appears as if our solar system were at the center of the Milky Way. Simply as a result of perspective we seem to be at the center of a broad encircling band of stars while as a matter of fact the sun is very eccentrically placed with respect to the center of the Milky Way which is, according to the estimates of Shapely, some fifty thousand light-years away in the direction of Sagittarius. And, lest we draw too much satisfaction from contemplation of the fact that we are at the center of things in our own local star cloud or cluster, it must be recalled that we are moving at the rate of a million miles a day and in a few million years the sun will be beyond the bounds of this local group. The man with geocentric tendencies finds small satisfaction in pondering over some of the discoveries of modern science. He is apparently the center of nothing in the universe permanently except of his own thoughts.

The Milky Way is the most important of all stellar organizations. It is the equatorial segment of the visible universe. Though there is still some controversy as to its probable dimensions we would favor the evidence upon which Shapely bases his conclusion that its diameter is of the order of three hundred thousand light-years. Within this great central organization the stars show their social tendencies by congregating in groups, clusters, local star-clouds, streams and drifts flowing to and fro, some toward the center of the Milky Way, some away from it. To classify these groups, drifts and streams and to discover the plan and purpose of stellar motions is one of the most important and fascinating problems of modern astronomy.

THE GREAT HERCULES STAR CLUSTER

Exterior to the Milky Way and quite evenly distributed above and below it are certain compact organizations of stars numbering in all, so far as is known, less than one hundred. These are the globular star clusters, characterized by their enormous distances, high velocities and the large number of stars of which they consist, as well as their strong central condensations. Though the diameters of these globular clusters do not exceed several hundred light-years at the most, they contain anywhere from ten thousand to one hundred thousand giant stars and doubtless many dwarf stars in addition, that are too faint to be visible in the most powerful telescopes at the enormous distances at which these clusters lie. The great Hercules cluster faintly visible to the naked eye lies at a distance of thirty-six thousand light-years from the solar system and it contains some thirty thousand stars that are visible upon the photographs taken with the most powerful telescopes. It is probable that there are also many dwarfs in the cluster that lie beyond the reach of the telescope, how many it is difficult to estimate. As the diameter of the cluster does not exceed one hundred light-years the stellar density must be very great, far in excess of what it is in our own stellar neighborhood. In a sphere of radius sixteen light-years with its center at the sun it has been estimated that there are about thirty stars including dwarfs and giants of all sizes and types. It is certain that near the center of a globular star cluster, where the condensation is greatest the stellar density must be far in excess of what it is in the neighborhood of the sun. The magnificence of the heavens near the center of a globular cluster such as the great Hercules cluster, with brilliant orbs closely grouped on all sides, lies far beyond our powers to conceive for such a stellar vision has never been granted to our eyes. The periodic fluctuations in brightness that are so characteristic of many giant stars in globular clusters may possibly originate in the close crowding together of giant suns.



Some Members of the Ursa Major Star Cluster Traveling With Equal Velocities Toward a Point in Ophiuchus Near the Milky Way. All of These Stars Are Marshaled in a Disk-Like Formation About 150 Light-Years in Diameter and 15 Light-Years in Depth With the Longer Axis Perpendicular to the Milky Way. The Sun is Temporarily Located Within This Region, But It is Not a Member of the Cluster.

VELOCITY OF STAR CLUSTERS

There are many globular clusters far more distant than the Great Hercules cluster. The distances of these formations range from about ten thousand to two hundred and twenty thousand light-years, according to Shapley's estimates. They are all moving with high velocities and in general toward the central plane of the Galaxy. The average space velocity of a typical globular cluster is about two hundred miles per second. It is inevitable that after a lapse of some millions of years certain of these clusters will reach the Milky Way and probable that they will be more or less disrupted by the encounter. Indeed, Dr. Shapley has advanced a most interesting theory of the origin of the numerous loose star clusters and local stellar groups of the Milky Way, such as exist in our own stellar neighborhood, on the assumption that in their attempt to cross the plane of the Milky Way, many globular star clusters have become partially disintegrated and dispersed. This would account for the existence in the Milky Way of many isolated stars, as well as of streams and drifts of high velocity stars, such as the Cepheid variables, that are characteristic of the globular star clusters.

We have started with a consideration of the smallest of stellar groups the double and multiple stars, the family units, and we have ended with the Milky Way the most extensive and heterogeneous of all stellar organization and the globular star clusters, enormous stellar units, exterior to it, but subject to its control. In all of these stellar units, from the simplest and smallest to the most complex, we see the associative tendency, the working of the law of gravitation which binds star to star and star-cloud to star-cloud and produces star-drifts and streams flowing to and fro through the universe. The sociable and friendly stars have their family groups and their communities, their fraternal organizations, their parades and their marches, as well as we humans, and there is no splendor to be compared with that presented by these glittering orbs of night, as they march down through the ages to realms unknown.

CORRECTION NOTICE

In the Popular Astronomy article by Isabel M. Lewis, M.A., entitled VENUS—THE PLANET OF MYSTERY, which appeared on page 136 of the June, 1923, issue of this magazine, there was a mistake in one of the illustrations. In the lower right hand diagram on page 136, the distance from Venus to the earth was indicated as being 262 million miles. This figure should read 62 million miles, as is obvious in comparison with the 26 million miles indicated between the earth and Venus when the latter two planets and the sun are in a straight line.

CALLS STARLIGHT SUNSHINE

According to Jean Durfay, who has just reported the results of his observations for several months to the French Academy of Sciences, starlight has its origin and source in the sun.

M. Durfay prepared extra-rapid photographic plates and fitted his apparatus with an extra-luminous spectroscope for study. He waited till the sun was 20 degrees below the horizon to be sure to eliminate all action of twilight and turned his apparatus to the north. The plates, however, registered no rays except those characteristic of sunlight.

M. Durfay concludes that the mysterious night light is reflected from the sun and suggests that a medium, either of solid bodies, such as meteors, or some rarefied gas, occupies a considerable space in the heavens.

RED STREAK IN THE SKY SEEN AT POUGHKEEPSIE

A bright red perpendicular streak visible to the naked eye, appearing in the northeastern sky shortly after 9 o'clock on March 15, attracted attention for a radius of twenty-five miles. Members of the Astronomy Department at Vassar College were unable to classify the appearance, after viewing it through a telescope in the College observatory.

Shaped like a lead pencil with its point up, the streak glowed and faded at intervals.

Rev. Father Hedwig, astronomical expert at the Jesuit Novitiate of St. Andrews-on-the-Hudson, a mile north of Poughkeepsie, gave his opinion that the disturbance was terrestrial. The body was not changing its position with the stars.

Magic For Everybody

By PROFESSOR JOSEPH DUNNINGER

NO. 5 OF A SERIES

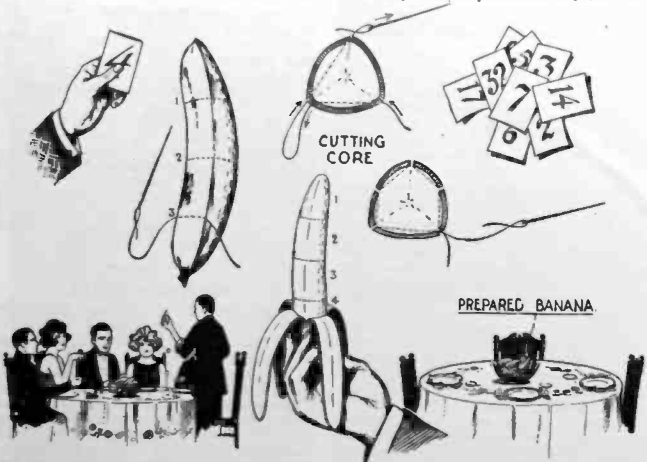
MYSTIC FRUIT

PERHAPS it would be impossible to find a more mystifying and effective experiment in the entire field of impromptu conjuring than the one I am about to describe. This experiment is not only exceedingly effective, but is one that is of double value to the amateur conjurer inasmuch as it is an after-dinner trick, and is one of the few items in magic that can be presented with apparently no paraphernalia other than that of unprepared available objects.

The Effect: After the conjurer and his friends who have been gathered around the dinner table have feasted to their heart's content, the magician announces that he is about to present a trick which in his belief is little short of a miracle. A package of unprepared cigarette papers are passed about to various members of the audience with a request that they write a variety of numbers respectively on each of the sheets, numerated, we will say, from 1 to 20. These are collected by the magician, and after the stack of sheets have been shuffled he requests that one of the many be selected. The number chosen is now found to be, we will say for example, the digit 4. The wizard now passes a plate of fruit about with a request to someone in his audience that one of the bananas be selected therefrom and after the same is thoroughly inspected, it is to be used as the item for the experiment. The selected fruit is placed on a plate by itself and the others removed from the table.

The conjurer claims by a weird method of control he will perform a most unexplainable phenomena. The magician takes up the selected banana and strips the peal from off the fruit which is found to have been mysteriously divided into four parts corresponding with the number upon the chosen cigarette paper. The audience is, of course, led to believe that if the number chosen had been 5 or 12, the banana would have been divided into whatever number of pieces would have been necessary for the success of the trick.

The Secret: The number upon the paper is forced, as it is a simple matter for the conjurer to exchange the stack of sheets for a set of duplicates. This exchange is made quite unnoticed beneath the cover of the table cloth while the seated conjurer is directing attention to the bananas upon the fruit tray. The duplicate set of papers have all been numbered 4's so it is quite impossible for the spectators to secure any other number when the selection is made. One banana is especially prepared for the trick. The magician takes a needle and thread and passes the needle through one side of the same, leaving the end of the thread hanging outside the fruit. He then passes the needle back through the same hole by which it was drawn out, and passes it across another side of the banana. This is repeated and so at the end the needle is brought out through the small hole in which it was first inserted. The other end of the thread naturally is still in that hole.



By Cutting a Banana With a Piece of Thread and a Needle as Illustrated Above One Can Perform a Very Surprising Feat. By Clever Manipulation of the Various Numbered Cards, it is Possible to Have One Draw a Certain Card and Then Peel a Banana and Find the Fruit to be Cut Into Just the Number of Parts Indicated on the Drawn Card.

It will be seen that in reality the magician has really threaded the piece of cotton all around the banana directly under the peal. The diagrams help to make this clear. The two ends of the thread are now taken and gently drawn out together, the thread cutting the banana. This process is repeated until the necessary cuts have been made, dividing the fruit into the required number of parts for bringing out the desired effect.

It is needless to remark that the holes made by the needle are so small that detection is quite impossible. Should the small hole, however, be discovered it would not be of any direct importance, inasmuch as no one could possibly suppose that it would be the means of tampering with the banana to bring about a complete cut in the fruit. My readers will, of course, understand that the prepared banana is forced upon the spectator when the selection is made. One or two unprepared bananas should be hidden well below a group of apples, oranges, grapes and other fruits contained in the fruit dish. The prearranged fruit on the top will naturally be the first to be taken when a request is made that a banana be selected.

Still another plan to heighten the effect of this trick would be to prepare two or three bananas, dividing them into a different number of pieces, let us say, for example, one banana into 4, another into 5, and still another into 7. In this event the fruits would have to be of three different sizes, the smallest of them divided into 4, the next size into the 5, and the largest into the 7 pieces. When the fruit is selected, the magician at once knows the number of pieces contained within the peel, the information being easily imparted to him by the various sizes. He, of course, has prearranged three duplicate sets of cigarette papers respectively numbered 4, 5 and 7, in different pockets about his clothing and secures the necessary set to force the desired number upon one of his spectators. A little practice in the preparing part of the trick will enable anyone to divide the banana in such a way that practically no trace or evidence of the action will be left upon the peel.

THE HINDU APPLE AND SWORD MYSTERY

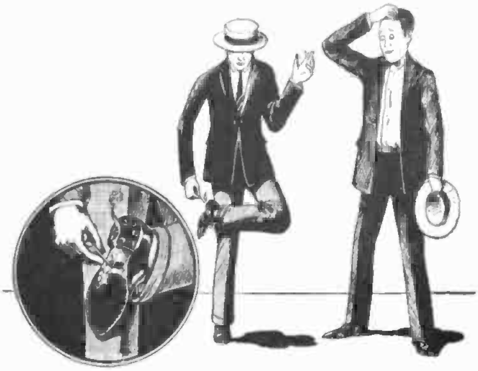
Tourists passing through India cannot overlook many of the so-called startling effects in conjuring presented by the fakirs so plentiful in the Orient. As my readers

It Would Seem that Our Hindu Friend on the Right Is Contemplating Cold Blooded Murder and That the One on His Knees is Calmly Submitting to the Same. However, it is Only a Trick and We Find That the Wicked Looking Gentleman With the Sword is Merely Going to Cut the Apple in Half Without as Much as Touching the Neck of His Partner. The Trick Lies in an Ordinary Sewing Needle Passed Through the Apple as Illustrated on the Left.

undoubtedly know this land of mystery is credited with many problems or so-called unexplainable feats that have never been duplicated in America or Europe. Conjurers in this part of the globe, however, who have studied methods of East Indian magicians express disappointment, inasmuch as they state that their methods of mysticism are limited, and their truly impressive tricks are few and far between. Our magicians have found but little difficulty generally in duplicating the effects employed by these wizards, and the famous Hindu basket trick, turban trick, duck trick, and ball-on-string trick, have been discarded from many up-to-date programs of present day magicians. Still, as originally stated, there are a few mysteries presented in this land of enchantment that are still generally unsolved and have not been reproduced by European countries. The effect I am about to describe is one that is often referred to as one of the most daring and unbelievable feats of Oriental magic, and still to my knowledge has not been presented other than in the land of the Yogi, due to the fact that its secret is so little known.

The effect upon the spectator is as follows: The Hindu magician passes a large razor-edged sword or Oriental knife for inspection. It is found to be quite intact and its sharpness is demonstrated by slicing bits of paper. The conjurer's assistant, a rather indifferent seeming individual, whose body is bared from the waist up, is introduced to the audience. The attendant kneels to the ground and utters a short prayer to the spirit of the East. A plate of apples is now passed for thorough inspection and one of the fruit selected and freely inspected. It is found intact and apparently free from preparation. The fruit is placed upon the bare neck of the attendant in a position as indicated in the drawing. The fakir utters a few words in ceremony and with a quick sharp action brings the sharp edge of the knife down upon the surface of the apple, dividing it into two parts which drop to the floor. The attendant's neck, of course, is unharmed, much to the amazement of the onlookers. My readers will, of course, be led to believe that this is the work of a skilled performer who by years of practice is able to accomplish this seemingly impossible and unbelievable feat. It is this belief that has probably kept many of our aggressive magicians from duplicating this experiment.

Not so, however; merely a trick is responsible for the effect. A needle of good steel has been passed through the apple in a manner as indicated in the drawing. In fact, all of the apples which are passed for inspection have been treated in a similar way, so it matters not which one is selected, the result will still be the same. The razor-edged section does not extend throughout the entire blade of the knife, as a section of the edge nearest the handle is slightly dulled. It is this part of the blade that comes down and divides the apple, and, of course, is naturally prevented from passing further into the fruit than desired, as it stops mechanically when it strikes the needle. A certain amount of practice, of course, is necessary to prevent the performer from striking alongside the fruit, but even in this event results would not be serious inasmuch as the dullness of the blade and lack of sufficient force in bringing down the knife would prevent any serious accident. The fruit is permitted to remain in the sun as a rule for a short period of time prior to the performance which has a tendency of softening the apple considerably, thereby making the success of dividing the fruit with ease more positive.



Nothing is More Mysterious Than to Produce an Ordinary Safety Match and Strike it on the Sole of Your Shoe. Under Normal Circumstances Nothing Will Happen. But By Preparing the Sole as Outlined in the Text, You Will Find that the Match Will Light Immediately.

LIGHTING SAFETY MATCHES ON YOUR SHOE

I am sure that the readers of SCIENCE AND INVENTION will agree that a better experiment that one can present impromptu with less preparation than the trick I am herewith about to offer will be hard to find.

It is commonly supposed that a safety match cannot be struck other than on its original box. The magician, however, upon meeting a friend who requests a light, amazes his spectator by striking this match upon the sole of his shoe and then challenging anyone to duplicate the feat. Try as they will, they will find it impossible to do.

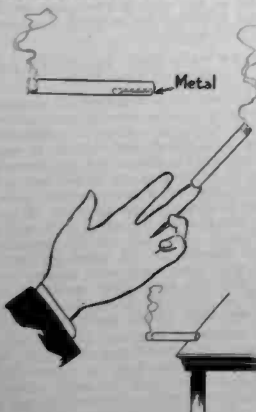
The secret is exceedingly simple. The striking side of a match box was previously rubbed against the performer's shoe at the instep. Some of the substance is in this manner transferred from the box to the shoe. One will, of course, understand that the striking of the match now becomes a simple matter. As the instep does not touch the ground in walking the application will not wear off for quite a time. Inasmuch as the conjurer knows that his friends had not previously prepared their shoes, he is free to challenge them without fear of the feat being duplicated.

THE MAGNETIC CIGARETTE TRICK

This is an excellent impromptu trick and an unusually effective pocket experiment. You offer a friend one of your cigarettes from your case and incidentally remove one yourself. After a few puffs the conjurer explains that he would like to demonstrate the power of mind over matter, and will demonstrate that in order to impress upon his audience the fact that he actually possesses this weird quality, he will defy all laws of gravitation.

The cigarette is placed upon his fingertips, the longer end of the cigarette projecting and much to the amazement of his spectator it remains so suspended. To further prove that as the magician claims it is all mind-power and has no bearing upon digital dexterity, he places the cigarette with its end upon a table or any other flat object, and still it remains suspended.

As to the secret:—A small piece of metal has been previously placed in one end of the cigarette. The conjurer, of course, knows where this prepared cigarette has been placed in his case and is careful to see that it is retained when offering the cigarettes to his friend. The weight is responsible for the miracle. The weighted end is of course the one that rests upon the fingers or table edge.



A Balancing Cigarette May be Made With the Aid of a Small Piece of Metal as Shown in the Upper Left Hand Corner. It Will Balance Very Nicely on the Finger Tips or on the Edge of the Table.

The Reversing Colors

By CHARLES D. TENNEY

Effect: The Magician shows two wineglasses partially filled, one with a red and the other with a blue liquid. He stirs the contents of the first glass with a wand, whereupon they immediately turn blue. He then remarks, "Turn-about is fair play," and on stirring the blue liquid with the same wand, it assumes a red color.

Explanation: The first glass is filled about half full of water in which a tiny pinch of the dye, Congo red, has been dissolved. The blue liquid consists of a nearly saturated solution of litmus.

The wand is a specially prepared glass tube. When one end of a soft-glass tube is heated strongly in the flame of a burner or spirit lamp, it gradually softens and begins to close. If the heating is carried to a certain point, the end will appear entirely closed but in reality, a tiny hole will remain. A foot length of glass tubing, treated in this manner at both ends and coated with black enamel, constitutes the wand.

Before working the trick, the wand is placed (out of sight of the audience) into a tall, narrow glass cylinder filled with hydrochloric acid. Then the palm is pressed tightly over the opening at the top and when the wand is withdrawn, a portion of the liquid remains in the tube. The principle is the same as that of the pipette. While stirring the first solution, the pressure of the palm is released momentarily and a small portion of the acid spills into the liquid, thus effecting the color change. The pressure is renewed, the rod transferred to the litmus solution and the rest of the acid is released.

There can be no hard and fast rules for preparing the solutions, but the strength should be adjusted so that the tints match.

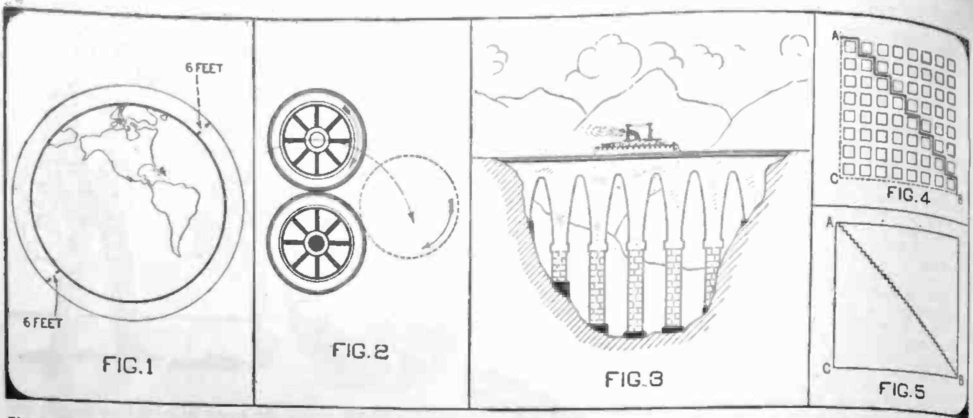


Fig. 1 Above—A Metal Band is First Theoretically Placed Around the Earth. Afterwards This Band is Increased in Diameter, so as to be Six Feet Away From the Earth All Around. How Much Longer Do You Think it Would Then Be Than in the First Case? Thirty-eight Feet is the Answer. In Fig. 2 the Problem is—How Many Revolutions Does the Upper Wheel Make While it is Rolling Around the Lower or Stationary Wheel? In Fig. 3 An Aqeduct Designed to Carry Water Only, Was Afterwards Changed Into a Ship Canal. Do You Think the Columns and Arches Would Support the Extra Weight of the Ship? In Figs. 4 and 5. Do You Think the Shortest Way Home is From A to B, or Around the Path, A, C, B?

Scientific Paradoxes

By EDWARD M. WEYER, Jr.

THE BAND AROUND THE EARTH PROBLEM

LET us imagine a half a million workers, side by side, laying a metal band completely around the earth. This band is to be the same size as the earth and is to touch the earth all around. Since the circumference of our world is approximately 24,800 miles, this band would be about 24,800 miles or 131,100,000 feet in length. In Fig. 1, the dark circle surrounding the world represents the strip. After the band has been completed, however, it is decided that it must be lengthened sufficiently to have it six feet from the earth at all points. This means that the strip will pass directly over the heads of the workers, who are standing side by side, all the way around the world. In Fig. 1, the thinner line around the world represents the band *after it has been lengthened.* Now stop here and make a common sense estimation of how much you think it must be lengthened. It will certainly seem strange when you learn that the correct amount is only 38 feet, or less than 13 yards. And this is the amount which must be added to any circle, no matter how large or how small it may be, in order to increase its radius by 6 feet.

The solution is indeed simple. The diameter of the earth is approximately 7,900 miles, or 41,700,000 feet, and the length of the band would be 3.1416 × 41,700,000 feet, or 131,004,720 feet. After the band was lengthened, its diameter would be 41,700,000 feet plus 12 feet, or 41,700,012 feet. Its length after it had been lengthened would be 3.1416 × 41,700,012 feet, or 131,004,757.6992 feet. Subtracting the length before it was lengthened from the length after it was lengthened, we have:

131,004,757.6992 feet
131,004,720. feet

37.6992 feet

We thus see that this paradox is a phenomenon contrary to opinion only and not contrary to reason—a phenomenon that exhibits some contradiction or conflict with preconceived notions of what is reasonable or possible. *Paradox* literally means contrary to opinion; it does not mean contrary to reason.

HOW MANY REVOLUTIONS DOES THE WHEEL MAKE?

Fig. 2 represents two wheels of equal size, in contact with each other. The lower one remains stationary while the upper one passes around it, rolling on its edge. Thus the upper wheel revolves about its own axis as it rolls around the rim of the lower one. The broken circle shows the upper wheel after it has started on its journey. The question, which is simple enough, is as follows: After the movable wheel has passed completely around the immovable one once, how many revolutions has it made about its *own* axis? How many would you suppose? Remember that the wheels are exactly the same size and therefore their circumferences must be equal in length. No point on either wheel will touch the other wheel more than once during one revolution. The correct answer, which is contrary to what is generally decided upon on first thought, is two revolutions. You can easily prove this for your own satisfaction by placing two coins of the same denomination on the table and revolving one around the other. This is well worth while.

SHIPS CAN PASS OVER AQUEDUCT NOT DESIGNED FOR THEM

Fig. 3 illustrates a hypothetical aquaduct constructed for the purpose of transporting water for public use. After its completion, however, it is found that it must be used as an avenue for ships, and the question arises as to whether or not its members will stand the strain when large heavily loaded ships are passing over the aqueduct. It now matters not whether the water is in motion or stationary. The fact of the matter is, that the aqueduct *would* stand the strain just as well when ships were passing over it, as when the same ships were up the canal 5 or 50 miles from the aqueduct. Where does their weight apparently vanish?

This surprising situation is understood easily when it is considered that when the ships are on the aqueduct, the water which they displace is *not,* and the water which a ship displaces weighs exactly the same as the ship itself. The principle is the same as in the case of a ship on a lake. The entire bottom of the lake shares in supporting the weight of the ship. Suppose that when a ship were on the aqueduct, it should spring a leak and sink to the bottom. Would this place an extra strain on the columns supporting the aqueduct? It would. Obviously there is a pressure on the bottom of the canal directly under the sunken ship. The force of gravity holds it against the bottom. There is still a certain amount of water displaced by the ship, however. This water, which would be where the ship is if the ship were not there, would press down on the bottom with its own weight. But this water would not have dropped from the top of the canal to the bottom as the ship did, and consequently the ship would exert a greater force on the bottom than the water which would be there if the ship were not. When the ship floats, its weight is distributed equally over the bottom; when the ship is lying on the bottom, a part of its weight is directly under it and the remainder is distributed over the rest of the bottom. What happens when a bather, swimming in the ocean, places his feet on the bottom and walks out of the water to the beach? This is a gradual shifting of his weight from the entire ocean bed to the spot directly under his feet.

THE LAW OF CHANCES

The laws of chance are simple, but at the same time exceedingly elusive, and for this reason there are quite a few tricky paradoxes connected with chance. It is said that at Monte Carlo there is a graveyard for suicides.

"How slight a chance may raise or sink a soul."—*Baily.*

When a coin is tossed ten times, what is to be expected? Five heads and five tails are to be expected, but this, of course, is not an invariable rule. Four heads and six tails, or seven heads and three tails might be the result, but no combination will be as common as five of each. Suppose we toss the coin ten times and the first five turn out heads. Still there is a chance of evening the number and having five of each. But suppose the first nine tosses come heads—a combination which will occur rarely. Then since the law of chance says that out of ten tosses the chances are that five will be heads and five tails, is it not to be expected that chance will try and even the number as best

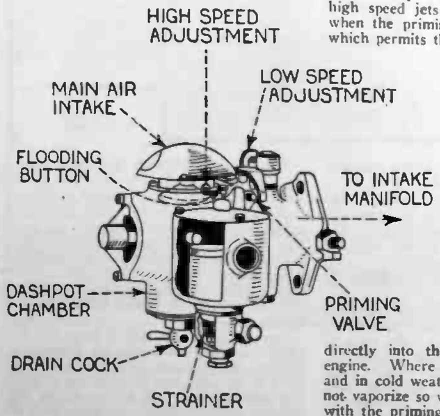
(*Continued on page* 391)

Practical Motor Hints

By H. WINFIELD SECOR

A FEW HINTS ON RAYFIELD CARBURETOR OPERATION

ONE of the accompanying drawings shows the Rayfield carburetor of the type used on some Lexington cars, and while it may seem unnecessary to say very much here about this well-known carburetor, there are a few hints which may prove of value to other motorists.



Semi-Sectional View Through Rayfield Carburetor Showing the Important Parts and Their Relation to Each Other. Some Personal Experiences in the Operation of This Carburetor Are Given Herewith.

This carburetor has a by-pass or priming valve on it, which is operated by a small push rod or button projecting through the side of the carburetor case; see illustration. This button is pushed inward by a small pivoted lever, which is connected with a flexible cable running to the dash control board. A peculiar thing happened shortly after this carburetor was in use, and of course, one having experience with these carburetors might have found the trouble quickly, but to one not used to them, the exact trouble would not become known right away. It was impossible to start the car, and the trouble lay in the fact that the flexible cable running from the dash to the priming valve mechanism had become loosened in some way, probably due to vibration, and even when this priming button on the dash was fully pulled out, the priming valve button on the carburetor was not pushed in the slightest bit.

Like other carburetors, the float chamber may be flooded by pulling up on the button on top of it on cold mornings, or in case the engine is stubborn and does not start. In one case, due to overflooding, or for some other reason, the engine simply would not start, and it was finally made to obey by placing the hand, and on another occasion a handkerchief, over the main air intake. This acted the same as the familiar choker valve on other carburetors. No trouble, however, has been experienced since the priming valve and control rod to the dash were properly adjusted. A Rayfield expert in New York City gives the following suggestions for starting the engine, especially on a cold morning. First, without spark on and throttle closed, and with priming button on dash all the way out, turn over the engine once with the self-starter. Don't attempt to start engine with spark fully advanced or you will be liable to knock teeth out of the fly-wheel or break the Bendix starter gear, or both. Second, push the priming button in a little, open throttle a short ways on the quadrant, close spark switch, and turn over engine, when it should start without trouble. He also said that it was not necessary to use choker valves on the air intake on this type of carbuetor, as this is compensated for when the idling and high speed jets are properly set, and also when the priming by-pass valve is opened, which permits the injection of raw gasoline directly into the intake manifold of the engine. Where either jet is a little lean, and in cold weather when the gasoline does not vaporize so well, the engine may be run with the priming button drawn out a short distance to enrichen the mixture.

This expert also suggests taking off all hot air heating pipes to the carburetor intake in the summer time; these are advisable when the cool weather comes on, during the fall and winter. With a Lexington car, he suggested that the hot air warming pipe from the exhaust pipes, is not as necessary as in other cars, due to the Lex-gasefier placed inside the intake manifold just past the carbuertor intake, which heats the mixture.

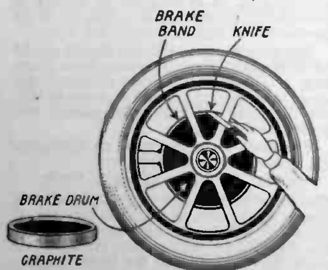
The adjustments of the Rayfield carburetor are simple once you become a little familiar with it. Both the high and low speed adjusting screws are turned to the right to enrich the mixture. A peculiar thing which happened to the writer, and is certainly worth mentioning in connection with this carburetor, was that in one case the dash-pot in the bottom part of the carburetor stuck, and the air cut off mechanism would not come up. It locked so securely that it could not be pulled up, even with a pair of strong pliers, and fearing to break some of the delicate mechanism inside the carburetor, it was finally decided to unscrew the brass cap on the bottom of the dash pot chamber. This was done and considerable water found therein, together with a slight amount of rust and dirt particles, which had helped to cause the dash pot to stick. A little oil was smeared around the inside of the dash-pot cylinder with the finger, and by pushing up on the dash-pot the whole mechanism was finally freed. The cap was replaced on the bottom of the carburetor and the engine ran along all right for a few miles. Sometimes that is all there is to this sticking down of the air valve and dash-pot mechanism, and the dash pot chamber should be drained once a week or so, to drain off any water or dirt which may have gotten into it. Water strainers are now available. But in the writer's case, the operation aforementioned, had to be repeated every few miles until we finally arrived at a carburetor station, when it was found that the spring and one or two other small members inside connected with the air intake valve, had become disarranged. This trouble was repaired and no further trouble experienced.

One more unusual occurrence which might be mentioned, as it may fool an inexperienced driver, and cause the engine to be heavily carboned, etc. This incident relates to the sticking of the air valve in the air intake opening. This happened once or twice, and the action of the engine in this case was that it had but very little power, and the trouble could hardly be diagnosed from the seat, until lifting the engine hood it was noticed that the air intake valve had apparently jammed or locked. By pushing down lightly with the fingers on this, it freed itself and examination disclosed a slight burr on the valve. This was removed and a little oil rubbed all around the air intake opening, thus obviating any further trouble in this respect. In some cases if the engine will not start and the main float chamber has been flooded by pulling up on the button in the center of this chamber, another expedient is to push down on the air intake valve for a few moments, which will flood the whole carburetor. The writer has found it advisable, especially during cold weather, to have at least three priming plugs in the engine, so that a mixture of alcohol and ether, or else plain gasoline, may be squirted through them, or into the cylinders, by means of a squirt can filled with the mixture. Some over-head valve motors can be primed by pouring a little gasoline or alcohol and ether mixture down the intake valve stems, but with some engines this should not be done, as it is liable to find its way down to the motor oil supply in the crank case, and thin the oil out, with very undesirable results of course.

GRAPHITE ON BRAKES STOPS SQUAWK

Squawking brakes is one of the most abominable nuisances and nerve racking things one could think of. After several garagemen had given up trying to eliminate a decided squawk, when they were applied even slowly, a graphite and oil mixture was applied, and the brakes worked fine and did not slip as much as one would think. The trouble seemed to have been that the brake linings were so dry, and owing to the way in which they coacted with the brake drums, that a terrific squeal resulted otherwise. It was found effective to mix up some fine graphite with some neatsfoot or other oil in a small dish, until it was like a thick paint.

(*Continued on page* 411)

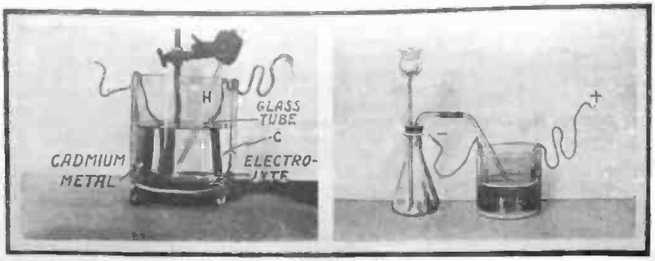


Squawking Brakes: If the Linings Are Worn Thin it May be That the Rivets Cause the Squealing Noise; in Any Event Graphite and Oil Mixed Together to a Thick Paste, and Placed Between the Brake Band and the Drum at Several Points Around the Latter, Will Usually Overcome This Noise.

Experimental Electro-Chemistry

By RAYMOND B. WAILES

PART 12.—ELECTROLYTIC PREPARATION OF PIGMENTS



The Photo at the Extreme Left Shows How Cadmium Yellow, Used as a Pigment in Paints Can Be Made by Electrolysis. The Other Photo Demonstrates the Electrolytic Preparation of White Lead.

AMONG the pigments used daily in the manufacture of paints, white lead is perhaps the most commonly used. This substance is usually made by the *Old Dutch* process, but many methods are now being introduced to supersede this method, satisfactory but long.

Just how white lead can be produced electrolytically is easily shown with the use of the apparatus shown at right. This consists of an electrolytic vessel containing sheet lead electrodes immersed in a solution of sodium nitrate. The containing vessel can be made, if desired, from a half gallon fruit or preserve jar by filing a mark upon the surface of the jar at the desired height and in the direction which the cut to follow, in this case around the bottle or along its circumference. A soft cotton string should then be wound once around the jar, covering this filed mark, and tied securely. With running cold water at hand, pour several drops of denatured alcohol upon the string, allowing none to spread over the surface or side of the jar, and apply a match to same. Rotate the jar and when the alcohol has burned off the string, immerse the jar under the running water. A crack will be made around the jar and the upper portion can be pulled from it. The filed mark can be an inch long if desired. The rough edges can be removed with emery paper or a file or, best of all, a whetstone. This makes a suitable container for many electrolytic and other experiments.

About 10 grams of sodium nitrate for every 100 cc. of water in the vessel should be used as the electrolyte. Two sheets of lead serve as a cathode and anode.

THE CARBON DIOXIDE GENERATOR

A carbon dioxide generator is needed for the experiment, and is shown at right. This consists of a flask (Erlenmeyer) fitted with a thistle tube passing through the two-holed stopper to the bottom, and a side tube fitted with a delivery tube, the latter dipping into the electrolytic vessel and placed in close proximity to the anode or positive electrode. Marble chips are placed in the flask, and acid (one part strong hydrochloric acid, to three parts of water) is poured into the thistle tube. This starts the production of carbon dioxide gas, CO_2.

The current passed through the cell should be ¾ ampere; it may be taken from a battery, or 110 volts D. C. with suitable resistances in parallel to produce ¾ amperes with the circuit as in previous experiments will serve equally as well.

The electric current tends to decompose the sodium nitrate as follows:

$$NaNO_3 + H_2O = NaOH + HNO_3.$$

The water present also enters into the reaction as can be seen above. The products of the above decomposition are sodium hydroxide, NaOH, and nitric acid, HNO_3. The nitric acid is formed at the leaden positive pole or electrode, and immediately attacks it, forming lead nitrate and hydrogen gas:

$$2HNO_3 + Pb = Pb(NO_3)_2 + H_2.$$

The hydrogen gas escapes during the electrolysis. By suitable collecting vessels, it could be caught and utilized. It must be remembered that Pb in the above equation represents lead (plumbum in Latin).

Now the sodium hydroxide or caustic soda formed in the first equation or step will react chemically with the lead nitrate $Pb(NO_3)_2$ formed in the second equation or step in the electrolytic process:

$$Pb(NO_3)_2 + 2NaOH = Pb(OH)_2 + 2NaNO_3.$$

Here, lead hydroxide, $Pb(OH)_2$, one constituent of white lead, forms, and during the electrolysis this formation takes place in the shape of a cloud, or precipitate, settling to the bottom of the vessel. It should be noted in the last (third) equation that sodium nitrate, $NaNO_3$, is also formed. In other words, the sodium nitrate electrolytically decomposed in the first equation is remade in this, the third equation or step, so that the sodium nitrate is never used up. The lead electrode, or anode, is, however, consumed, for the nitric acid attacks it and forms the soluble lead nitrate, which reacts with the caustic soda, forming lead hydroxide, insoluble, and consequently sinks to the bottom of the vessel. If the anode be weighed before starting the experiment and weighed afterward, a loss in weight will be found.

The carbon dioxide passing through the solution will form sodium carbonate with the sodium hydroxide formed in the first step, and the sodium carbonate formed here will react with the lead hydroxide forming lead carbonate:

$$Na_2CO_3 + Pb(OH)_2 = PbCO_3 + 2NaOH.$$

So that by continuing the passage of the carbon dioxide gas the lead of the anode will be converted into the lead carbonate.

White lead does not consist entirely of lead carbonate, however, but also of lead hydroxide. This hydroxide can be formed in the product by cutting off the current of *carbon dioxide gas* near the end of the experiment and allowing the electrolysis to take place alone for several minutes.

The cell should be placed in a pan of cold water, for the electrolysis sets up heat which causes the electrolyte to steam.

After the experiment has proceeded for about fifteen minutes, the lead hydroxide and carbonate can be filtered from the solution and after washing awhile upon the filter can be preserved for future use.

PREPARING CADMIUM YELLOW

Among the yellow paints or pigments, cadmium sulphide (cadmium yellow) and chrome yellow are much used. Electrolytic preparation of cadmium yellow is very fascinating, for the yellow cadmium sulphide precipitates by the action of hydrogen sulphide gas introduced into the electrolysis vessel, forming beautiful yellow clouds of the substance, which slowly settle to the bottom of the container.

The same vessel and apparatus used in the manufacture of white lead can be used for the preparation of cadmium yellow.

A 10 per cent solution of common salt is made and the vessel is filled with the resulting solution. A bar of cadmium metal should be used as the anode or positive pole and a carbon rod as the cathode. Before using it, the carbon should be heated on an iron plate until all volatile matter has been driven off.

The gas generator should be made to deliver a current of hydrogen sulphide gas through the solution of salt in the vessel. This is accomplished by allowing either of the acids as described before to act upon ferrous sulphide (iron sulphide). Iron sulphide can be made by heating equal quantities of powdered sulphur and iron filings, well mixed, in a test tube until the vigorous chemical reaction has ceased. The tube is then broken open and the lump of iron sulphide is used instead of the marble chips in the flask.

The current should be approximately the same as in the previous experiment. The experiment is rather objectionable to some because of the hydrogen sulphide gas which has the odor of spoiled eggs. If performed out of doors or in the chemical hood, it will not be noticeable.

In the electrolysis, the sodium chloride or salt solution is split apart by the electric current:

$$NaCl = Na + Cl$$

The chlorine atom, Cl, is liberated at the anode and attacks the stick of cadmium serving as the anode, forming cadmium chloride, $CdCl_2$. (Cd meaning cadmium). Now the hydrogen sulphide gas which is being passed into the solution or electrolyte while the current is passing converts this cadmium chloride into cadmium sulphide, which is yellow and insoluble, and therefore can be seen forming in the solution as a yellow cloud. As the hydrogen sulphide bubbles around the anode, a yellow cloud spurts up, due to the following reaction:

$$CdCl_2 + H_2S = CdS + 2HCl.$$

The *CdS* here is the yellow cadmium sulphide, or cadmium yellow.

In the first equation, sodium, Na, is formed. It must be remembered from previous installments of this series, that when water or water solutions are present, sodium when liberated by the electric current will never remain in the elementary or "ordinary" state, but will instantly react with the water about it, forming sodium hydroxide, and hydrogen gas:

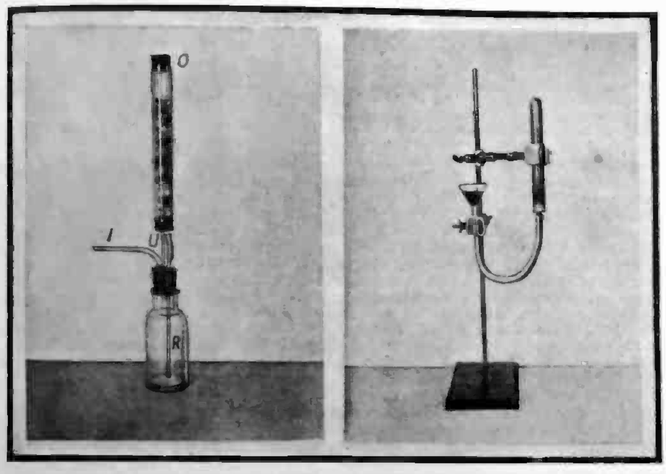
$$Na + H_2O = NaOH + H$$

The hydrogen gas escapes and can be seen coming from the cathode (—) during the electrolysis or passage of the current. Just as in the white lead production, it can be collected by suitable means.

Practical Chemical Experiments

By RAYMOND B. WAILES

NO. 4 THE AIR WE BREATHE



SIMPLEST AIR ANALYSIS APPARATUS

PERHAPS the first scientific experiment which any one of us saw demonstrated was the burning of a candle in an inverted tumbler resting in a saucer of water. As the candle burned, thus consuming the oxygen in the air of the tumbler, the water in the saucer gradually rose and took its place.

This combination of a tumbler, candle and a saucer is, perhaps, the simplest piece of chemical-analytical apparatus which could be devised, for with it, the per cent of oxygen in the tumbler, or in the air, is roughly determined. It was seen in this simple but fascinating experiment that the water rose into and filled the tumbler one-fifth full. Since the water replaced the oxygen which was burned, the per cent of oxygen in the air could be said to be twenty per cent.

But it may be asked of what is the remaining eighty per cent composed? Roughly speaking, the remaining eighty per cent is composed of nitrogen, but the following analysis shows the actual composition of the air we breathe:

Oxygen	20.9%	by volume
Nitrogen	78.13	"
Carbon dioxide	0.03	"
Argon	0.94	"

Water vapor, present in variable amounts.

Helium, neon, krypton, xenon, traces.

The oxygen is the active constituent of air, the nitrogen serving to dilute the oxygen. The argon, which, like oxygen and nitrogen is an *element*, has no function whatever. Helium, the gas used to fill non-inflammable balloons and dirigibles is present in the air in very small amounts. Neon, the gas in the little glass tubes which are held to automobile spark plugs to indicate a faulty plug, is also present, and in every breath of air taken into our lungs, this gas is present. Krypton and xenon, rare gases, are also present. The four last named gases have no influence on the respiration process.

Water vapor is always present in the air to varying extents. The carbon dioxide which is present may be due in part at least to the burning of combustible matter upon the surface of the earth, such as fires, and also the exhalation of the breath of animals, humans included. From the composition of air above we see that with every breath we take in about twenty-one per cent of oxygen. The oxygen in the exhaled breath is *about* sixteen per cent, and the carbon dioxide *about* four. These two constituents together should give the quantity of oxygen taken in, or about twenty-one per cent. Water, in the form of vapor is also eliminated during exhalation. This can be proved by breathing upon a cold surface, the moisture or water vapor being condensed upon it in the form of drops of dew.

HOW PLANTS PURIFY THE AIR

Man could not live in an atmosphere of carbon dioxide or of nitrogen. One of the factors which cause a replenishing effect of the consumption of atmospheric oxygen and the contamination of the atmosphere with

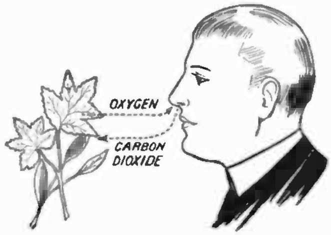


Fig. 1. A Very Simple Apparatus for Analyzing the Air Shown at the Immediate Left. The Liquid Occupies About One-fifth of the Space in the Tube Showing That This Amount of Air is Oxygen. Fig. 3. The Photograph at the Extreme Left Shows an Absorption Tube for Removing Oxygen from the Air While the Drawing Above Demonstrates the Cycle of Carbon. Man Inhales Oxygen and Exhales Carbon Dioxide. Green Leaves and Plants Absorb Carbon Dioxide and Give Off Oxygen.

carbon dioxide is green vegetable substances. Leaves of all growing plants containing *chlorophyll*, the green coloring matter, constantly absorb the carbon dioxide of the air and, after removing the carbon from it, exhale the oxygen into the air again. It is a matter of oxygen going into man with each inhalation, carbon dioxide eliminated upon exhalation, and an absorption of the carbon dioxide from the air by the leaves, and with a consequent liberation of life-giving oxygen by the plant.

A funnel fitted by means of a cork to a test tube, the whole being filled with water and inverted over freshly picked leaves submerged in water, will serve to collect for examination and experiment, the oxygen given off by green growing matter.

ANALYSIS OF AIR

A very simple apparatus by which the per cent of oxygen in the air can be estimated is shown in Fig. 1. This consists of a funnel connected to a test tube by means of a length of rubber tubing. To make an analysis of air, lower the test tube so that it is hanging by the rubber tube. Now place about a quarter of a gram of pyrogallic acid crystals in the funnel and pour over them several cc. of sodium or potassium hydroxide solution (1:1). A brown solution, quickly turning black will be formed, owing to the

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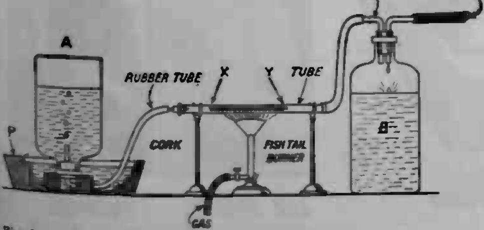
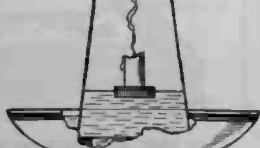
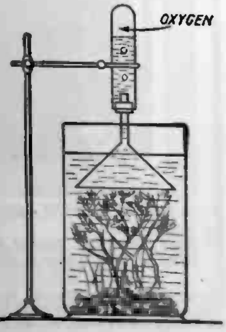


Fig. 2. A Porcelain Lead-in Insulator Makes a Good, Inexpensive Combustion Tube Used in Many Experiments. Here the Red Hot Copper Wire in Tube XY Removes Oxygen from the Air Passing Over it, the Nitrogen Entering Bottle A.





Above is a Method of Approximately Determining the Percentage of Oxygen in Air and to the Right is the Proof of the Fact that Green Leaves Give Off Oxygen Which Can Be Tested for, With a Glowing Splinter.

Tie-Less Stenciling

By JOSEPH CROTTY

NEARLY everyone is familiar with the old style cut-out paper stencil, with its numerous ties. It has advantages and disadvantages; the general method of procedure is familiar to all, but very few people know of or make use of the art to tie-less stenciling. This method has been in use in Europe for many years, in a limited way, and was never improved upon until recently, when American genius grasped the idea, seeing its possibilities, and adapted it to many different kinds of work, where quantities of such "stencils" or stencilled letters and designs are reproduced from the original cut-out.

USES FOR TIE-LESS STENCILS

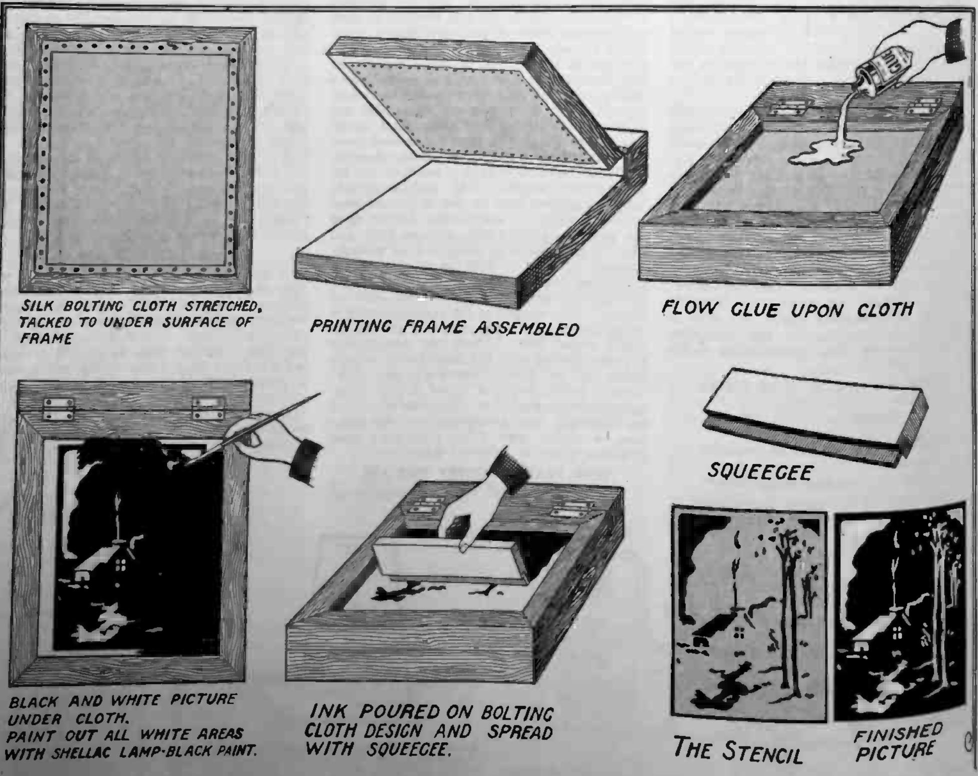
This modern stencil provided a very rapid method of reproducing pictures, designs, signs, cards and many different kinds of decorative work in a true, hard finished effect, in one or as many colors as you desire, on all smooth or semi-rough surfaces, such as wood, metal, paper, cards and all kinds of cloth. Oil and Japan colors can be used, and there are practically unlimited possibilities in this fascinating and interesting art.

The new stencils can be used with great success by handicraft workers to produce many artistic novelties; school teachers can reproduce useful pictures in quantities, such as birds, animals, etc., especially for children of the lower grades; boys and girls will find many uses for them, and the hostess will surprise her guests when she uses an original favor of her own design.

Tie-less stenciling is inexpensive, considering the results obtained. The few materials necessary for its successful operation, with the exception of one article, bolting-cloth, you will probably find around your tool chest. You surely have a hammer, nails and tacks, a few strips of wood about ½ to ⅞ in. square, and a couple of ounces each of glue, shellac and dry lampblack. Then you will need a couple of brushes (sables preferred), one large and one small, and enough silk bolting cloth to meet with your requirements. This cloth can be purchased at any mill-supply house (it is used in making sieves), or at the embroidery counters of any of the large department stores. It is very important that you obtain this particular cloth, as the nature and quality of the weave is very important in the tie-less stencil.

THE APPARATUS USED

The apparatus consists of a base board which holds the paper on which the design is to be made. A frame whose sides are perhaps an inch square in cross section, is made of the same size as the board, and is hinged so that it will swing up and



The Various Pieces of Material Necessary for the Production of Tie-Less Stencils are Illustrated Above. The Method of Tacking the Silk on the Frame is Shown in the Upper Right Hand Corner and the Entire Frame Assembled, in the Upper Center. The Glue is Then Placed on the Upper Side of the Cloth and the Picture Placed Under it. All White Parts are Then Painted Out With Black Paint. The Appearance of the Stencil and the Finished Picture are Shown in the Lower Right Hand Corner.

down. The frame is to be covered with bolting cloth. This may be tacked by a multiplicity of tacks to the lower face of the frame, or what is better, it may be carried up on the sides and tacked thereto. This comprises the complete apparatus. The bolting cloth must be perfectly smooth without the slightest wrinkle.

PREPARING THE STENCIL

A solution of glue in its own weight of water is brushed over the cloth, so as to fill all the meshes and is allowed to dry. When it is thoroughly dry, paint the design, using a solution of shellac in alcohol with lampblack stirred into it, so as to make it opaque. The glue will prevent the lamp black and shellac from spreading, so that you will get a perfectly sharp design on the cloth. When finishing hold the frame up to the light and touch up all weak places with more of the shellac preparation. After ten or fifteen minutes the shellac solution will be perfectly dry. Then with a sponge or soft cloth gently rub the glue so as to soften, and remove it. A second cloth will conduce to drying it, and after standing a little while the stencil is already for use. Now place a piece of paper on the base board and drop the stencil upon it. It should lie perfectly flat against it. If it does not do so, it may be padded up with paper underneath it; what the printers would call an "underlay," or "overlay" turned upside down. The paint in which the stenciling is done, must not contain turpentine, as it will prevent sharp outlines, and the paint must be rather thick like a thin paste, but if too thick it will clog the meshes and also interfere with the work. You may experiment with some lampblack in linseed oil with some dryer or Japan mixed in.

PAINTING THE PICTURES WITH THE STENCIL

We will next make a squeegee with a piece of rubber packing about one-eighth inch thick, fastened between two strips of wood which form a handle, and whose length must be a little bit less than the width of the frame. Now put a supply of the paint in the frame near the end as it lies horizontally on the paper. Then with the squeegee scrape a supply of the paint right across the stencil. Raise the frame and remove the picture which should be perfect, if you have done the work properly, but like everything else experience will tell you how to mix your paint, and how to apply your shellac solution, and how to carry out all the other details.

A hundred pictures per hour could be easily made, and an expert can speed the rate up to three hundred or more an hour, and some wonderful pictures can be produced. When through printing, immediately clean the cloth with kerosene, turpentine or gasoline, and when it is perfectly dry alcohol will remove the shellac.

How to Build a Swimmer's Sail-Board

By LAWRENCE B. ROBBINS

IF you want to create a sensation this summer when you go in swimming—launch one of these Sail-Boards and take a cruise across the harbor in your bathing suit.

The sail-board consists of a wide board attached to three points of buoyancy and equipped with a sail. The swimmer sits or lies upon the board and manages the sail and rudder exactly as he would in sailing a real sail-boat. The fun of it is, however, that he doesn't mind a ducking, a capsizing or even a squall of wind because his craft is unsinkable, can't spring a leak and will furnish wholesale fun in a stiff breeze. Several such sail-boards would furnish a watering-place with an endless amount of novel and exciting sport.

MAIN BODY MADE FROM PLANK

The back-bone consists of a straight grained plank 9 ft. long—12 in. wide and 1 in. thick. The bow end should be rounded off and then sprung up in a slight curve as shown. This can be accomplished by sawing several ¼ in. cuts about 1 in. apart across the board and extending for a distance of about a foot or more in the spot where the bend occurs. Soak this end of the board in warm water for a half an hour and then the bend can be easily made. A cleat with a curved edge should then be bolted to this portion so the curve will be retained when the board dries out.

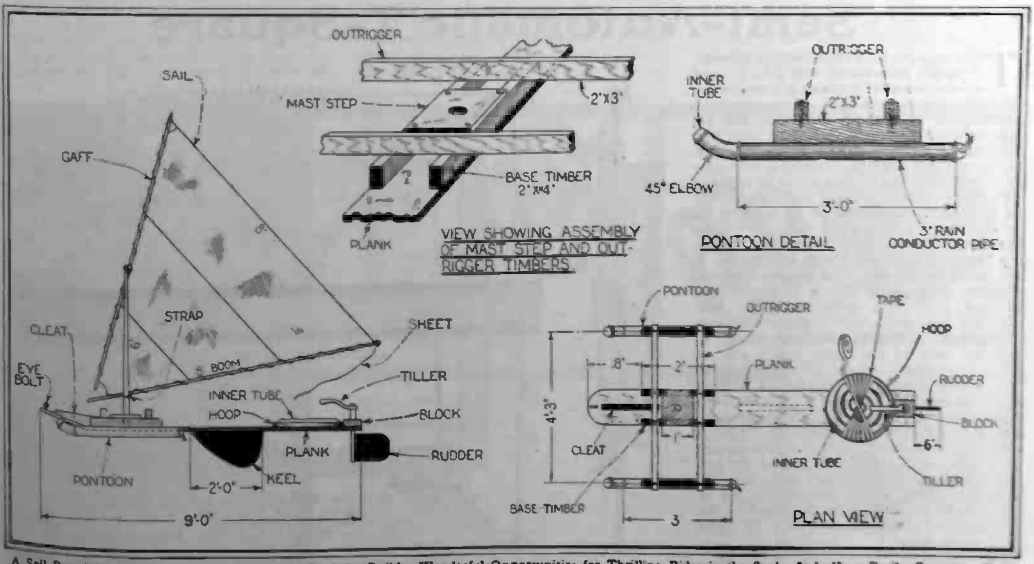
Put an eye-bolt in the bow, just forward of the cleat, to which should be attached the tie-rope.

PONTOON CONSTRUCTION

The outriggers and pontoons are constructed and attached as follows: Each pontoon consists of a 3-ft. length of galvanzed rain pipe 3 in. in diameter. To one end fit a 45° elbow and bolt a 2-ft. length of 2 in. x 3 in. along the middle of the straight portion. Buoyancy is obtained by cutting a 3-in. automobile inner-tube apart at a point as close to the valve stem as possible, and then closing both these open ends by vulcanizing them. Now push the long tube through the pipe until the valve stem is barely sticking out of the straight end. Inflate these tubes as full as practical with the tire pump, there being two such pontoons.

Now bolt two pieces of 2 in. x 4 in., 2 ft. long, to the plank—one at each edge. Set them so that the forward ends will be about 18 in. back from the bow. These are the base timbers to which are bolted the outriggers—two pieces of 2 in. by 3 in. set on edge—each 4 ft. 6 in. long. Their arrangement is clearly shown in detail in the sketeh. As will also be noticed—their ends are bolted to the pieces

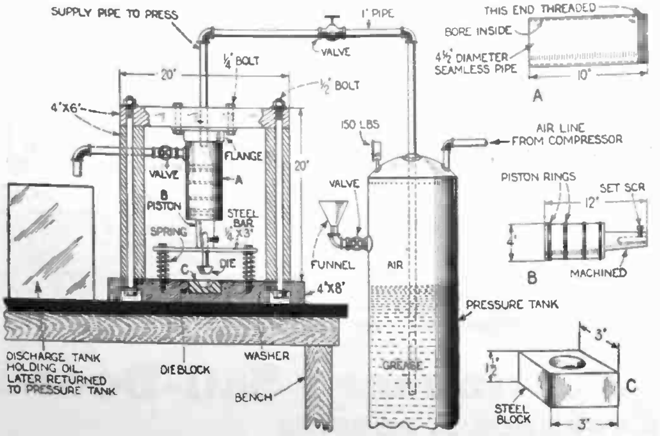
(*Continued on page 392*)



A Sail Board Such as Illustrated Above Will Afford the Builder Wonderful Opportunities for Thrilling Rides in the Surf. It Is Very Easily Constructed and All the Dimensions Necessary are Given in the Above Lay-out. The Pontoons Used Contribute to the Stability as Well as the Buoyant Powers of the Craft.

A Small Hydraulic Die and Punch Press

By DALE R. VAN HORN



At a Cost of But a Few Dollars the Hydraulic Die and Punch Press Shown At the Left Can Be Built. Very Rapid Work Can Be Turned Out In This Home-Made Device.

THE amateur craftsman often desires efficient tools that, because of the nature of the work, are too costly for his use. However, if a tool which will do the desired work efficiently can be made at low cost, omitting, of course, the labor item, then that tool is justified.

A small hydraulic die press is herewith described and illustrated which has a large capacity for its size, and which may be used not only for pressing light metal to shape, but may be used for a punch. Its action can be regulated at will. It has a total force of about 1,725 pounds under a working pressure of 150 pounds to the square inch. The medium used is lubricating oil mixed with grease to a consistency that will just pour.

Fig. 1 shows the machine assembled. It comprises the press, a pressure tank holding both grease and air under pressure, and a catch tank for holding the discharged grease until it can be returned to the pressure tank. The pressure tank derives its pressure from air from any air pump.

The piston is made from a cylinder of wrought iron four inches in diameter and one foot long. It is turned down to the shape shown, in a lathe, four recesses being allowed for four piston rings. The shank is cut away to reduce weight. This is also drilled in the end for the dies and punches, a set screw holding them in place. If desired, more metal can be cut away from the piston between the rings, while still in the lathe.

The cylinder consists of a ten-inch length of seamless steel pipe which is carefully milled, ground and polished on the inside to exactly four inches in diameter. It is probable that a piece four and one-half inches outside diameter will give the necessary amount to be cut from the inside.

This cylinder is threaded on one end and screwed into a floor flange. The flange is drilled and threaded for a one-inch pipe.

The frame consists of wood, the uprights being four by six studding, each piece twenty inches long, and a similar piece for the top, also twenty inches long. The base is a timber slightly longer, four inches thick and eight inches wide. The frame is assembled with one-half inch bolts, as shown, the heads on the under side being sunk flush.

Two quarter-inch bolts hold the flange in place, though the hole for the one-inch pipe should first be bored, threaded and the pipe fitted. If the wood has been cut accurately and the fittings made tight, the cylinder should be perfectly parallel with the uprights and be reasonably solid.

A bar of steel one-quarter of an inch thick and three inches wide is drilled and set under the lower end of the piston. This is supported by four rather stiff coil-springs which raise the bar to a two and one-half or three inch clearance. Rods driven into the wood base will hold the springs where they belong, though the tops should be low enough so that the springs can be compressed without striking the tops in question. This feature comprises the mechanism which returns the die after pressure has been applied and released. The stationary die is a piece of steel milled out to fit every movable die. It is usually desirable to have a stationary die with every movable die. The lower ones are set in the notch cut for them in the base.

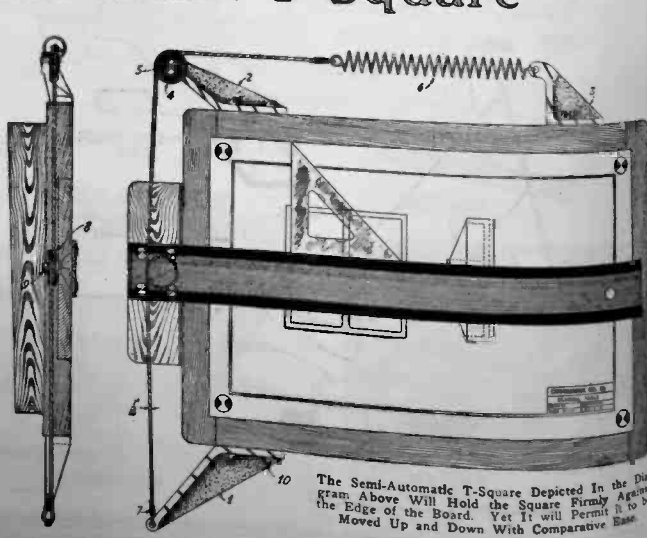
A pipe line runs from the upper half of the cylinder to a discharge tank as shown. A valve is included in the line.

(Continued on page 376)

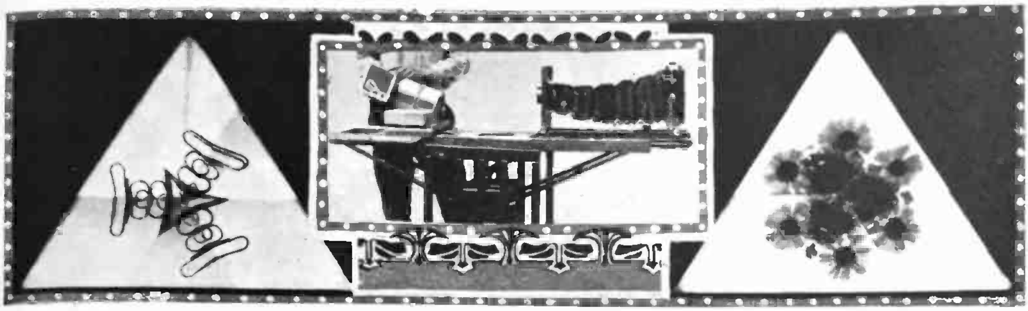
Semi-Automatic T-Square

THE drawing illustrates a semi-automatic T square attachment, that is to be used in connection with drawing boards under 30 inches, to take the place of the expensive complicated attachments now used, and yet answer their purpose. It will be seen that this device is very simple in construction, while of great value in connection with general drafting. The T square can be attached or released in a second, and will always come in line again, regardless of its position, as it is always held against the side of the board. The tension cord bracket No. 1, pulley bracket No. 2, and spring bracket No. 3, are made of bronze or aluminum castings. Tension cord pulley No. 4 is turned and grooved 1/16 inch wide and 1/16 inch deep for the cord, which is about 1/16 inch in diameter. The pulley is counterbored, so that the head of the screw No. 5 will set flush, and clear the head of the T square. The pulley should turn freely but without any play on the screw No. 5. No. 6 is the tension spring, 6 inches when compressed, and 8 to 9 inches when extended. This is made of music wire. No. 7 is the tension cord, one end is held in the eye of the tension cord bracket No. 1, and passes over the T square pulley, which is made like No. 4, but is held in position on the head of the T square with a 5/32 inch (No. 9) round head wood screw.

Contributed by B. R. WICKS.



The Semi-Automatic T-Square Depicted In the Diagram Above Will Hold the Square Firmly Against the Edge of the Board. Yet It will Permit It to be Moved Up and Down With Comparative Ease.



Many Beautiful Designs Undreamt of Before Can Be Automatically Formed With a Home-Made Kaleidoscope. The Method of Using the Kaleidoscope With a Camera is Shown in the Center Picture. The Design at the Left is Formed From Paper Clips, While That at Right is Formed of the Images of Small Flowers. Art Letters, Such as the "A" at the Beginning of the Article Below, can be Made of Actual Flowers and a Few Sticks of Wood With Very Attractive Results

How to Use Your Camera

By DR. ERNEST BADE

No. 7 Photography in the Decorative Arts

ALTHOUGH photography is quite universally employed as an illustrator of the written word, as it really is the most dependable reproducer of drawing and objects at our command, it is still but little used as a basis for the designing of artistic and decorative motives. Few, indeed, appreciate the results to be obtained through the camera with the aid of various everyday objects, if these objects are arranged in certain combinations. In the hands of a practical man much can be done, especially in the way of original and striking ornamental designs.

A letter cut from wood or cardboard, hung over a flower, and placed with light fingers in a more or less distinctive position, will produce initials of exceptional beauty and simplicity of design which can be used without the least touch of an artist's brush.

Far more manifold and practically unlimited in diversity of form are photographs taken from a kaleidoscope. This is a machine which will automatically produce the most artistic and unique designs, the most delicate of scroll work, and the most massive of decorations. All that is required for its construction are three large mirrors, two plates of glass, one of them ground, and a paper cylinder.

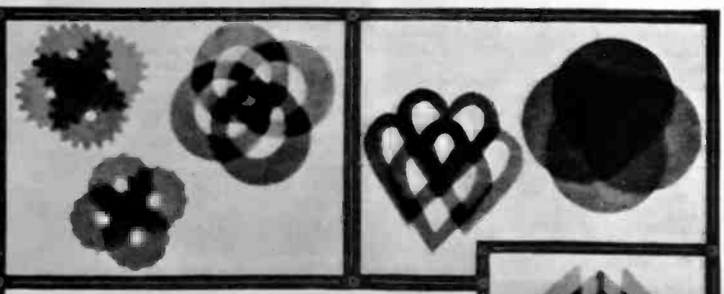
The paper cylinder should have a diameter of approximately 5 inches, although this is not necessary. It is probably best to take the three equal size mirrors and, with a piece of string, wrap it around them so that they form a hollow prism, whose cross-section is an equilateral triangle. About this prism wrap soft cardboard, so as to for an approximate cylinder, followed by glue and more cardboard. The space between mirror and cardboard is then filled with cotton or with paper.

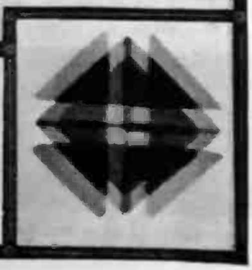
The two glass plates are next taken and cut into squares of such size that they will entirely cover the triangle of mirrors; if they are an inch or so larger, they will give better service than if they are cut to fit too closely. These two plates are fastened together to form a shallow box about ¼ of an inch in depth. This is accomplished by pasting a strip of cardboard of this width on three sides of the glass. This will leave one side open which is absolutely necessary.

The mirrors and the box are now assembled upon a table, and the camera is focused upon the lower corner of the mirror triangle farthest from the camera. Care must be taken in tilting the cylinder of mirrors so that a perfect triangular image consisting of six smaller triangles, is thrown upon the ground glass of the camera, and that the triangle fills the plate.

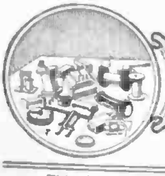
A dozen matches or so placed in the hollow glass box and the box placed immediately behind the mirrors, will form perfect symmetrical designs. But the ground glass of the box must be turned away from the camera and towards the source of light which is to illuminate the whole by direct artificial light, the light being at a little distance from the glass box. A slight movement of the box in either direction will produce an entirely different design, and in fact, such an amazing number of them can be obtained by even the slightest shock or disarrangement of the matches in the box, that it is impossible to follow the rapid shifting of one beautiful design to another still more wonderful.

(*Continued on page 375*)





A Simple, Cheap and Clever Electric Designing Machine is Shown at the Left, While the Other Photos Here Reproduced Show Some of the Work Accomplished With This Device. The Machine Itself Comprises Simply an Inverted Metal Reflector With Tungsten Lamp and Socket, to Which are Secured Four Small Mirrors Supported by Wire or Thin Metal Bands Riveted or Soldered to the Reflector. The Downward Rays of Light Cast from the Mirrors Cause Super-imposed Shadows to Appear on the Photographic Paper Placed Under the Glass Plate, the Different Designs Being Placed on Top of the Glass Plate, so as to Form the Multiplicity of Interlinking Shadows, as Shown. The Photos Above Show from Left to Right Respectively, Shadowgrams from a Gear, a Metal Washer, Paper Heart, a Paper Disk and a Cube.



HOW-TO-MAKE-IT

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

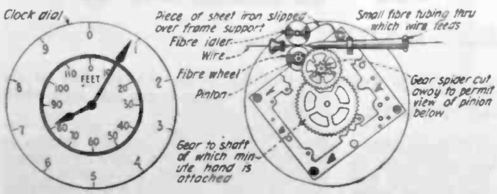
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize 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

WIRE MEASURING INSTRUMENT

In the illustration herewith is shown how to construct a wire meter from an old alarm clock. All the gears and springs are removed with the exception of the big gear which also carries the minute hand on the shaft, the gear and pinion meshing with the big gear, and the pinion meshing with the second gear. On the shaft of the last mentioned pinion, a small rubber or fibre wheel 21/32" in diameter, and ¼" thick, is attached. A small fibre tube is then fastened to the frame as shown. The same is done on the other side of the rubber wheel. A piece of sheet iron or tin is cut and bent to carry the idler, which is also made of rubber or fibre. A small spring or rubber band will produce sufficient pressure to hold the idler to the wheel. The reduction gears for the hour hand remain in the same position as before, and the dial is calibrated as shown. The hands are set to serve the purpose of reading the number of feet of wire drawn through the device.

Contributed by RICHARD PIETSCHMANN.

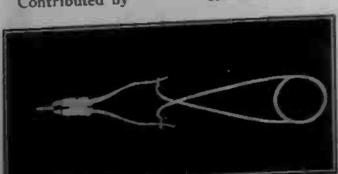


At the Left, An Instrument For Measuring the Number of Feet of Wire Which Passes Through Between the Two Rollers. It is Made From An Old Alarm Clock, and a Few Additional Parts.

SELF-GRIPPING PLIERS

Here is an original method for holding small parts, screws, nuts, cotter pins, etc., while inserting them in awkward places around the car. Ordinary pliers not long enough to be inserted into places which are not within easy reach, are nevertheless a most efficient tool when equipped with the spring handle shown. This device consists of a length of one-eighth inch wire coiled in the center, the ends being crossed over and looped around the plier handles. It will be found that this wire is sufficiently heavy to hold securely any small part placed between the plier jaws, and the system serves as an effective method of overcoming the tedious difficulty of inserting many parts.

Contributed by HARRY MOORE.



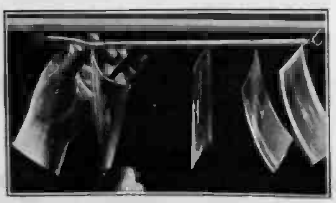
A Pair of Pliers Which Will Grip Small Parts Without Having to be Held by the Hands.

SECOND PRIZE $10.00

SPRING CLIP HOLDER FOR NEGATIVES

When drying negatives, the amateur or professional photographers generally use a separate spring clip for each negative. A clever Philadelphia photographer, Mr. George W. Stedman, uses a coiled spring to hold his negatives up to dry. It holds up a dozen negatives, while the old way requires a dozen spring clips, one clip to each negative. This method is not only cheaper, but it is quicker and easier to operate.

It is constructed by supporting the spring at each end by a cup hook screwed to a strip of wood. To hang up a negative, the spring is opened between the turns at the point where it is desired to hang the negative, the negative is inserted and then the spring automatically closes up and grasps the negative. A gentle pressure of the fingers, as shown in the accompanying photograph, is all that is required to operate this simple and useful spring clip holder.



An Extremely Simple Rack For Hanging Up Wet Photographic Negatives.

Contributed by JOHN B. FLOWERS.

WINDING COILS WITH BARE WIRE

I hereby submit a little scheme which I tried a few days ago.

It happened that when I tried to wind a tuning coil with bare wire I found it very difficult to prevent the adjacent turns from touching and thus decreasing the efficiency of the coil.

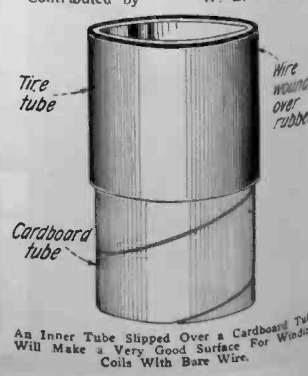
This I overcame by cutting from a discarded automobile tube, a section as long as the cardboard tube on which I wanted the coil wound. I then took the piece of tube and drew it carefully down over the cardboard form.

This not only held the wire very securely, but also made a wonderful insulator.

After this I tried the scheme on forms of larger and smaller denominations and found that a common Ford inner tube would fit forms from 3½" to 4½" inclusive.

If a transmitting inductance is wanted I would recommend that a larger inner tube be used.

Contributed by W. B. HINTON.

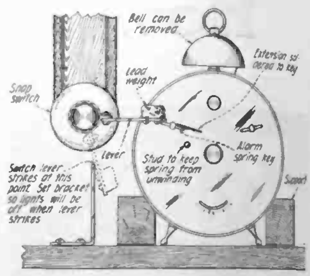


An Inner Tube Slipped Over a Cardboard Tube Will Make a Very Good Surface For Winding Coils With Bare Wire.

THIRD PRIZE $5.00

TIME SWITCH FOR LIGHTS

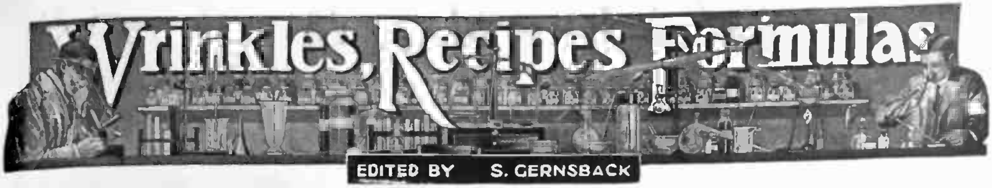
Here is an idea for turning off the lights at any desired hour in an electric light sign. I used the type of alarm clock, which when the alarm goes off, the spring key turns.



Another Time Switch Which is Actuated by Means of a Falling Weight, Released by the Alarm Key.

The lever is made of ¾" flat brass, and formed on one end to fit around the knob on the snap switch, with a machine screw and nut to hold it tight. This lever was weighted on the other end with enough scrap lead to make it turn the switch when the alarm goes off. I attached an extension to the clock key, mounted as shown, which strikes a stud fastened in back of the clock to keep the alarm spring from running down. This scheme is well adapted to any electric display sign when one doesn't wish to keep it lit all night.

Contributed by W. T. MARKOWSKI.



THIS MONTH'S $5.00 PRIZE WINNER

A BETTER WAY TO TAKE MEDICINE; THAT SAVES YOUR TEETH, ETC.

The common spoon methed of taking medicine has four serious objections, all of which are eliminated at once by the very simple method presented in this article.

The four distinct serious objections to the spoon method are as follows:

1. Strong medicines not only stain or corrode the enamel of the teeth but also thereby open the way for the decay of the teeth themselves. Yet as commonly administered with a spoon, contact with the teeth is almost unavoidable and there are many whose teeth have been permanently marred or injured in this way.

2. Strong or unpleasant-tasting medicines are not only revolting to adults but are extremely difficult to administer to children. By the spoon method it is almost impossible to avoid contact of the medicine with the sensitive tongue, walls or roof of the mouth and hence the unpleasant taste is felt not only before but also after swallowing.

3. Medicines with a strong acid content may undergo a chemical change while in contact with the metal spoon; such a change is contrary to the original composition of the medicine and may in some instances prove distinctly injurious to the patient.

4. At the same time some medicines may stain or corrode the spoon.

By pouring the required dose into a small glass receptacle and imbibing the medicine through a glass tube of small diameter (obtainable at small cost from druggist or chemist) or a "straw" (obtainable at soda fountains, etc.), all of the above stated objections of the spoon method can be eliminated without in the least way altering the effectiveness of the medicine taken.

Contributed by C. NYE.

FUEL INTENSIFIER FOR AUTOMOBILE ENGINES

There has been advertised in the past many fuel intensifiers for which extravagant claims were made. A test of many of these products showed them to be either tablets of napthalene or napthalene powdered or dissolved in some solvent, such as gasoline. The value of these is questionable, for the writer knows a concern that manufactures napthalene in all its forms, and still does not use it in their truck motors. Napthalene, by the way, is the substance from which the so-called Tar Camphor Balls are made. A mixture that will give pep, power and reduce carbon can be made as follows:

Ether	1 part
Acetone	1 part
Turpentine	1 part

One ounce of this solution is added for every five gallons of gasoline put in the tank. Do not use more than an ounce to two gallons of gasoline. This mixture will increase the power of the motor and reduce the carbon. Try it.

Contributed by THOMAS W. BENSON.

THE CHEMICAL FLAG

A very interesting chemical magical stunt can be produced by sketching an American flag lightly, on a large white sheet of paper. The stars should be outlined, and then the entire field, with the exception of the stars, should be painted with a solution of potassium ferrocyanide ($K_4Fe(CN)_6$). All of the portions of the flag which are to remain white, are not touched by any of the two preparatory solutions, and care must be exercised in the use of the potassium ferrocyanide, inasmuch as this is very poisonous. Now proceed to paint the stripes that are to be red with a solution of ammonium thiocyanate (NH_4CNS) and allow the two solutions to dry. When ready for exhibition of the trick, the plain sheet of white paper is tacked to a board and daubing a wad of cotton on the end of a stick, previously moistened with a solution of ferric chloride (Fe_2Cl_6), over the entire surface, the red, white and blue will appear in their proper places. The red coloring is due to the formation of ferric thiocyanate, and the blue to the formation of Prussian blue.

Contributed by R. L. POTTS.

TO REPAIR A CRACKED FOUNTAIN PEN BARREL

Secure a silk thread as nearly like the color of the pen to be repaired as possible. Then coat the section covering the crack with alcoholic solution of shellac. Before the shellac sets, wrap the section with the silk thread as uniformly as possible, and with all the tension that the thread will stand, making no provision for the ends of the thread except to smooth them down well in the setting shellac. After this shellac is dry, which will only require a few minutes, the job can be finished by covering the thread with another light coat of shellac. The part thus repaired will be the strongest point in the pen, and if it be the barrel of the pen, it will be absolutely leak proof. If the shellac used is too heavy, it will not make a neat job, whereas if it is too light, it will set before it can be wrapped. If too light give the place a second coat, when the first has half set.

Contributed by E. H. TAYLOR.

REPAIRING RUBBER STORAGE BATTERY JARS

A great many good storage batteries are junked because of leaks in the rubber jars thereof, and because it is not generally known how comparatively easy it is to remedy this trouble. Leaks, usually caused from freezing, when located on the sides or corners of storage battery cells, may frequently be repaired by vulcanizing. Remove the entire battery from the box and also remove the damaged plates from the jars. These operations are performed by chipping out most of the sealing composition, and then running a flat blade like a putty knife or a piece of old phonograph spring between the battery box and the battery, and between the inside of the jars and the plates respectively, to melt and detach the sealing compound. It is not necessary to remove the lead connecting bars. The blade used should be heated, or dipped in gasoline to facilitate this operation. If the plates are dry, it will be well to soak them in clean water or electrolyte before attempting to take them out of the jars.

The crack in the jar should now be thoroughly cleaned with gasoline or benzol, and a coating of auto-tube vulcanizing cement applied. When this is tacky apply some tube vulcanizing gum, packing it well into the crack. Cut some pieces of board to fill out the inside of the jar to prevent it from collapsing under pressure and vulcanize on a hot plate. If no regular vulcanizer is available, a sad iron, the laundry instrument, either electric or ordinary, may be used. When the rubber is cured remove the inside blocks and straighten the jar, which will be somewhat softened by the heat. Chill this immediately in cold water and replace all parts and reseal by pouring on hot sealing compound. The old compound may be remelted and used, and should be quite hot. I have lately reclaimed four or five "junk-heap" batteries by this method, which are doing good service.

Contributed by L. E. ANDERSON.

REMOVING TARNISH FROM HEADLIGHT REFLECTORS

Automobile and motorcycle headlight reflectors will become tarnished by use; the result being that the light given is dimmer and not as evenly distributed as should be, due to the absorption of some of the light rays by the film of tarnish. All reflectors should be cleaned frequently, to prevent such a deposit from permanently dulling their bright surfaces, as dampness seems to add thickness to the film and makes it more difficult to remove.

All headlight reflectors, whether used with electric or acetylene lamps tarnish sooner or later, but the products of combustion from acetylene gas causes a bright surface to stain far more quickly. The first thing to do is to remove the tarnish before repolishing. This is best accomplished by using a weak solution of acid in alcohol; the proportions are one pint of alcohol to a tablespoonful of pure sulphuric acid. Always pour the acid into the alcohol and not vice versa, as it is apt to spurt around. Dip a piece of soft linen into this mixture, squeezing out the surplus so as to leave the cloth fairly damp, then quickly rub the tarnished part until the film is removed. Now wash the surface with alcohol alone, using a clean rag for the purpose, and finish with clear water. Every trace of the sulphuric acid must be removed from all parts of the lamp in order to prevent corrosion. Procure from your druggist ten cents worth of precipitated chalk, dampen a soft clean cloth with water, and dip it into the chalk; then rub the reflector's surface briskly. Under this treatment it will acquire a fine polish of intense brilliancy, quite free from any scratches if carefully done.

Contributed by W. S. STANDIFORD.

WATERLESS FACE WASH

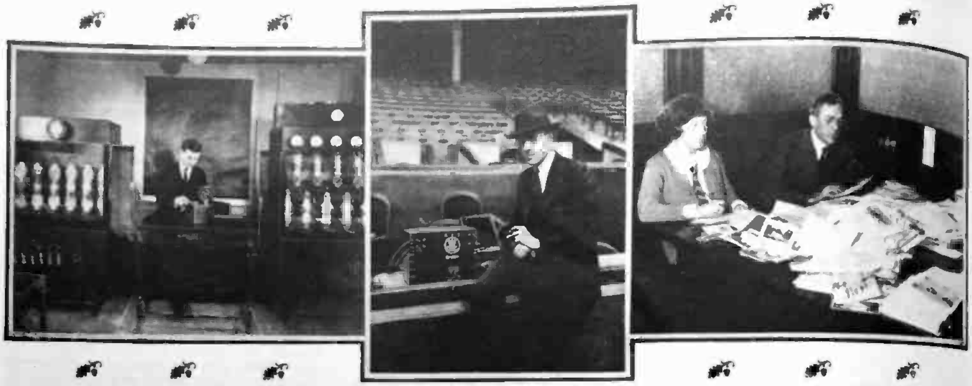
When motoring or traveling and it is impossible to get a wash in the ordinary way, carbonate of magnesium in powder form is useful for dry cleaning the face and hands. Scatter a little of the magnesium carbonate on a clean soft rag and rub well into the skin. The dirt comes away freely and a general feeling of refreshment is experienced.

Contributed by S. LEONARD BASTIN.

TO MAKE BENZINE SAFE

Add about 10 per cent carbon tetrachloride, CCl_4, to the benzine. This mixture will not catch fire. Since carbon tetrachloride is also a cleaning liquid, the product is as good as benzine alone and many times as safe.

Contributed by KENNETH H. SLAGLE.



Left: This Photo Shows the High Power Transmitting Vacuum Tubes at the Old WJZ Station in Newark. Some Idea of the Size of These Tubes and Their Arrangement Is Gleaned from This Interesting Photo. Center: The Author of the Present Article Shown With Radio Amplifier from Grandstand. Right: This Photo Shows the Daily Mail of WJZ, Which Requires a Corp of Two Men and Four Stenographers to Answer. The Day's Mail Received from Broadcast Listeners Averages Five Hundred Letters.

Radio Broadcasting Problems and Their Possible Solution

By C. W. HORN*

WHEN radio broadcasting first became popular the person "listening in" was thrilled when he recognized sounds as music or as someone speaking. This "listener in" was generally, at that time, an amateur radio telegraph operator, as no one yet had purchased apparatus to listen to the experiments being conducted by one or two prominent radio experts.

We all remember the individuals who predicted that radio broadcasting was but a fad. "There was nothing to it and it would die out in a very short time." But radio broadcasting did not accommodate these pessimists by dying out, but has developed into a lusty infant industry which some day will be compared with the automobile and motion picture industries in its rapid growth and development. There is a reason for this prediction and that reason is that it fills a long felt want. We needed the automobile and we needed the movie. Also, we needed something at home which would open the wide spaces and permit us to attend functions and affairs and be entertained without the necessity of putting on a stiff, starched shirt and enriching the ticket scalpers. It will be a part of every household for the same reason that the phonograph became successful. People wanted music and, instead of going to the music, had the music brought to them. But radio has none of the limitations of the phonograph or any device or mechanism developed in recent years. From my present viewpoint there is as yet no limit to what radio may be called upon to do, but it is not necessary here to repeat the many and varied activities to which radio can be applied.

As in the case of the phonograph, public enthusiasm ran away ahead of the practical development of the apparatus. This, of course, stimulated the engineers and those in charge of development work to greater effort and has been the cause of the great strides being made. One of the forms this enthusiasm has taken, and the one which has caused the greatest amount of embarrassment to the science itself, has been the desire of a large number of individuals and concerns "to entertain the people," in many cases merely to get publicity. It is of this latter phase of radio work that I am best qualified to speak and which I will discuss here. It is a very serious matter and will have much to do with the immediate future of radio and vitally concerns the public.

There were before the end of 1922 more than 600 radio broadcasting stations in existence. There were probably not more than 25 or 30 of these stations so situated in centers of population and so operated and maintained that they were giving unselfishly the best that could possibly be given at the present stage of development. This meant the outlay of enormous sums of money without any possible revenue accruing from this expenditure. The majority in this group of more than 600 licensed stations were in the game merely to spread their names over the map and to obtain for themselves all the publicity that they could. These stations may be classed as offensive billboards on the highway reserved for pleasure and education.

They obstruct the view of the person seeking to broaden himself by listening to the many fine speeches and talks given nightly over the radio and in place of these desirable talks and entertaining music which this poor listener could pick up he must listen to the "Blaa-Blaa Station of the Blaa-Blaa Company" blaaing. Generally this "blaa-blaa" station was built by some energetic amateur whose experience in radio telephony was obtained from having once seen a radio telegraph spark set on a ship.

Contrasted with these are the stations built by the large electric companies, each of which maintains a large and competent staff of engineers who have all the information there is available on the subject and the facilities and assistance of research laboratories, etc. Determine by means of an engineering commission the number of stations that can operate simultaneously on different wave-lengths without undue interference. Then very carefully allocate these stations throughout the country, paying particular attention to the large cities. The cities that are most favored with facilities for obtaining talent, such as New York and Chicago, should he permitted to have at least four stations, each operating on a separate wave-length. These stations should all be allowed to make use of considerable power and in fact should be required to use fairly high power in order that listeners at distant points can pick them up.

All the other broadcasting stations should be put on a number of fixed wave-lengths and permitted to go on 360 to 400 meters. In my estimation, the ideal condition would be one under which it would be possible for the average person to turn dis dial to a fixed point and know that he would be able to pick up a certain station without interference. Should he then find that the broadcasted material is such as to be uninteresting to him he could then turn to some other station and pick that one up again without interference

*Superintendent of Radio Operations, Westinghouse Electric & Manufacturing Company.

Miss Dorothy Benkeser With Her Home-Made Radio Set is Shown in the Left Hand Photograph, Operating the Same. The Set is of the Single Tube Type Using a Two Circuit Tuner and Gives Very Good Results. At the Right is Shown Miss Benkeser With the Antenna Which She Erected Herself. The Aerial Masts Are Attached to the Chimneys.

My First Radio Set

By MISS DOROTHY BENKESER

WHEN I decided to make a radio set, a friend of mine said, "Well, you go ahead and buy the things, and when you need my help, just call me up." I told him I would, but made a mental reservation never to let him hear from me if I couldn't get along without assistance.

You see, I am not in the radio business, and I have no technical training whatever. I am and have for some time been in life insurance business, so it was natural for my friend to think that I would send an S.O.S.

I went to a radio store and looked over the sets and they appeared simple enough, so I bought enough parts to work on for one evening. With the parts I received a book of directions with diagrams and a lot of, what seemed to me, very technical terms.

The panel was drilled and the coils were wound, so that helped. The "one evening" lengthened to three and at the end of the third, I had screwed on the parts to the panel and was ready to wire. When I realized how complicated this was I just wanted to give up, but I had the diagrams and I had seen the sets hooked up, so I stuck at it.

Everything went along beautifully until I was ready to solder. The soldering! I had never done anything like it in my life and in fact had never paid any attention to such things. I had taken our Victrola apart and fixed it, but I never had to solder any parts. Consequently I had strange misgivings when I realized there were so many parts.

I had no tools but the few my mother had for her sewing machine, and as I was very anxious to get things started and had no soldering iron, I searched for something "just as good." The only thing I could think of was an old fashioned curling iron—the kind you heat in a stove or with gas. This iron had a metal handle and while I did manage to solder some of the parts, when the iron got red hot the handle was also very hot and this was most uncomfortable.

So I waited another day and a friend sent around a soldering iron with a wooden handle which seemed like the trickiest thing I had ever seen. You put alcohol in the handle and its burns near the tip of the iron and keeps it hot.

This was an entirely new toy, and it interested me very much until I began to work with it—then the flame worried me and I had visions of burning all the tubing and insulated wire and just about everything in sight, but much to my relief, the flame would go out occasionally and it was at such times that I worked best.

When I had completed the set, I bought a lightning arrester.

The circuit is what is termed a loose coupled or two circuit hook-up employing no regeneration. I have a WD-11 vacuum tube operated with a single dry cell for the "A" battery. I find the Baldwin phones excellent and have two sets of them, so that in an emergency four people can listen.

I was very anxious to install the set, so one fine Sunday we climbed to the roof, laden with poles, insulators, wires, rope, cord, scissors, hooks and what not.

We had a dreadful time walking around the roof for the front of it (and the way to the roof is up the front of it) slopes considerably, and we are not good acrobats.

We tied poles to two of the chimneys and attached the copper wire to these poles. This gave us an aerial only about fifty feet long, but about ten feet from the tin roof and it has been very satisfactory.

Perhaps if you closely examined the aerial you would smile—in fact I'm sure you would. We used all the rope and cord we could find and I know it is a terribly amateurish job, but it serves the purpose. The knots are very poorly tied, and I know even a very young "Girl Scout" would never be proud of them, and I know some day we'll have to make another trip up there to tighten the poles.

In order to attach one of the poles, I tried to climb on a little ledge which is a good deal higher than the rest of the roof and quite near the edge. My friend told me it was very foolish to do this for the house was old and she thought any part of it might be very apt to become detached and besides, she didn't think the chimney was a safe thing to hold on. I asked her if she were making any reference to my weight and told her to "unhand me" for I was very confident the chimney was strong enough to hold me. This she refused to do and I was struggling to get away from her and to pull myself up when the piece of the chimney which I held gave way and had she not held me, I should most likely have landed on the cold and unsympathetic pavement three or four stories below.

We were a couple of very much unstrung and very tired persons when we finally gathered together our tools and went down to connect the set, but we felt it was worth it and besides there were no casualties, I having got away with a few scratches on my arms.

I shall never forget the thrill I experienced when I actually heard an announcement over this set.

The set has been quite a success so far (it is about two months old) and we pick up distant stations with very little difficulty, and it has given us no end of pleasure. Just the other night I got Springfield, Mass.

No, I did *not* wear overalls.

BROADCAST-STATIONS

The Photos Above and to the Right Show the Interior of the Studio of Station WEAN Operated by the Shepard Stores of Providence, R. I. The Orchestra Shown in the Above Photo is the Band of the 7th Coast Artillery of Newport as They Appeared When Broadcasting Selections From WEAN. The Photo at the Right Gives a More Comprehensive View of the Lay-Out of the Studio, Showing the Microphone and the Tasteful Arrangement of Furniture.

The Photo to the Left and Below Show, Respectively, the Transmitting Antenna and the Studio of Station WGI, Operated by the American Radio and Research Corp'n, of Medford Hillside, Mass., Better Known as Amrad. This Station Has an Enviable Record Which it Acquired in the Early Days of Broadcasting and Has Maintained Ever Since. Their Consistent range is Over 300 Miles and They Have Been Heard 1500 Miles.

Fig. 1. Using a Simple Portable Reflex Receiving Set. Fig. 2. Using a Kite to Support An Aerial. Fig. 3. Using Body of an Automobile as an Aerial. Fig. 4. a Wire Fence Doing Duty as an Aerial. Fig. 5. Using the Car Battery on the Radio Set, and an Aerial Suspended From a Tree. Fig. 6. Using a "Tree Aerial." Fig. 7. An Under-Water, Insulated Antenna. Fig. 8. a Spiral Aerial For Use Either Indoors or Out.

Vacation Time Radio

By A. P. PECK

WHEN you sit down in the evening and start to figure up expenses and other incidentals for your vacation trip, do you contemplate taking your radio set with you or are you going to store it away until you return? If you are considering the latter, just dismiss the thought at once, for your vacation will by no means be complete without the good old radio set. No matter how you are going to travel or where you are going, you can still take your set along and derive great enjoyment from it.

If you are going to tour in an automobile you will find that a set can be handled with the greatest ease. One of the prominent manufacturers has put on the market a set embodying the reflex principle which can be tucked away in one corner of the tonneau and used at any time desired. It is entirely self-contained and utilizes a loop aerial. One of its many uses is illustrated in Fig. 1.

KITE RAISES AERIAL

A cord is attached to the kite and the latter is raised to some distance; then an insulator is attached to the cord, to the other end of which insulator is attached a considerable length of No. 22 D. C. C. wire. The kite is then allowed to ascend higher, carrying the wire with it. When desired a loop may be made in the wire to which a second insulator is attached, the other end of the latter being connected by a cord to a stake driven in the ground. The wire running off from the insulator is then attached to the set as an aerial. This is illustrated in Fig. 2, in which we also indicate how a wire fence may be used as a counterpoise. Any of the other antennae mentioned below could also be used.

AUTO AS ANTENNA

If you are touring, it is possible to use the frame of your automobile as an antenna merely by connecting a wire to some part of the metallic frame. This may be used in connection with an iron pipe a foot or two long, driven in the ground. The latter will serve as a temporary ground connection and the complete installation is shown in Fig. 3.

A wire fence may be utilized as another form of substitute antenna in connection with a driven ground, such as described in the last paragraph, as is shown in Fig. 4. It will generally be found quite necessary to use a variable condenser with a large capacity in series with the aerial when using a fence for this purpose.

When touring in an automoile it is not necessary to carry a separate A battery with you, for, as shown in Fig. 5 it is possile to connect the battery used in the ignition and starting system of the car directly to the set. As is shown in this figure, an aerial may be erected by throwing a cord with a stone attached to one end over a limb of a tree and pulling up a wire to quite a height by means of this cord. A small insulator should be interposed between the cord and the wire.

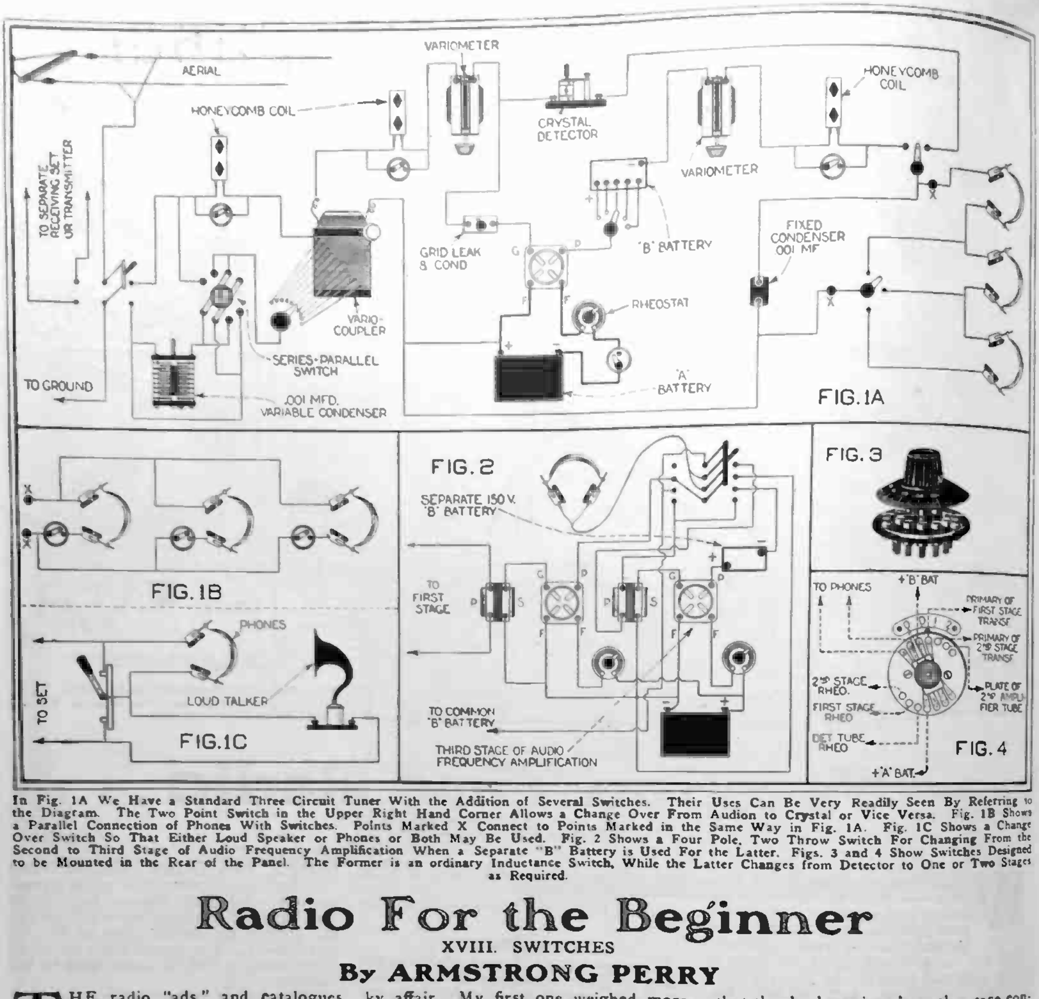
A TREE ANTENNA

Under some conditions it is possible to make use of a large tree as an antenna and the method for doing so is shown in Fig. 6. Two six inch spikes are driven into the tree, one very close to the ground and the other some distance up. Wires are connected to these spikes and lead to the ground and aerial posts of the set respectively. The use of such an aerial opens quite a field of experiment to the amateur.

When a camp is located along the shore of a lake or other body of water, it is possible to reduce static to a very great extent by submerging the aerial in the water. For this purpose a length of No. 14 rubber covered wire should be used, with the end which is to lie in the water securely covered with rubber tape in order to render it water proof. This type of aerial may be used in connection with a driven ground in the ordinary way as shown in Fig. 7.

SPIRAL ANTENNA ALSO GOOD

When it is desired to use the radio set in a summer bungalow on the shore or some other point, where it is impractical to erect an outside antenna, and where none of the other makeshifts given above will be found available, it is possible to make a very good antenna which is to be suspended between the walls of a room. This is shown in Fig. 8. It consists merely of a form made of a couple of barrel hoops and some lengths of heavy twine. Around this form are wound numerous convolutions of wire as shown. It is not necessary to use insulators with this installation when it is to be used indoors, but the same type of aerial is readily applicable to out-door use, whereupon it should be as well insulated as the usual types of aerials.



In Fig. 1A We Have a Standard Three Circuit Tuner With the Addition of Several Switches. Their Uses Can Be Very Readily Seen By Referring to the Diagram. The Two Point Switch in the Upper Right Hand Corner Allows a Change Over From Audion to Crystal or Vice Versa. Fig. 1B Shows a Parallel Connection of Phones With Switches. Points Marked X Connect to Points Marked in the Same Way in Fig. 1A. Fig. 1C Shows a Change Over Switch So That Either Loud Speaker or Phones or Both May Be Used. Fig. 2 Shows a Four Pole, Two Throw Switch For Changing From the Second to Third Stage of Audio Frequency Amplification When a Separate "B" Battery is Used For the Latter. Figs. 3 and 4 Show Switches Designed to be Mounted in the Rear of the Panel. The Former is an ordinary Inductance Switch, While the Latter Changes from Detector to One or Two Stages as Required.

Radio For the Beginner

XVIII. SWITCHES

By ARMSTRONG PERRY

THE radio "ads." and catalogues devote little space to switches. They seem to be considered as among the accessories that the radio fan will buy without urging if he needs or wants them, yet there are few home radio stations in which an additional switch or two would not add to the convenience of the operator, save time and annoyance, and possibly increase the element of safety.

LIGHTNING PROTECTION SWITCHES

No set used with an out-of-doors aerial can be operated without at least one switch or other approved safety device, if the house where it is installed is insured, unless the owner is willing to run the chance of losing the insurance as well as the house in case of fire. The National Board of Fire Underwriters requires a 100-ampere lightning switch which disconnects the receiving set from the aerial and connects the aerial with the ground, outside the house, when the station is not in operation. An approved lightning arrester may be accepted in place of the switch, but while that may draw off a portion of the surplus charge placed upon the aerial by a stroke of lightning, enough may still pass into the receiving outfit to damage or destroy it.

LARGE LIGHTNING SWITCH NECESSARY

The 100-amp. lightning switch is a bulky affair. My first one weighed more, cost more and took up more space than the receiving outfit I started with. Some beginners try to get by with a little knife switch that will carry 25 to 35 amperes but that is like trying to use a one-truck truck for a four-ton load; it is sure to break down when it is most needed. An amateur who wanted his lightning switch out-of-doors but did not want to go out-of-doors to operate it, put it on the outside of the house, bored a hole through the wall and installed a crank and shaft for turning the handle.

A switch in the ground wire is not often seen but it has advantages. If there are two receiving sets, for example a long-wave and a short-wave set, which are used with the same aerial and ground wire, a single-pole double-throw switch will connect one or the other with the ground. The usual practice is to wire both sets to a double-pole double-throw switch, so as to change both aerial and ground connections at the same time, but conditions may render it more convenient to have separate switches in the aerial and ground leads. The statement is sometimes made that two sets can be grounded with the same wire and that if one is disconnected from the aerial and the other connected, the dead one will not affect the tuning of the active one. It is a fact, however, that the dead receiver in such a case constitutes a "dead-end" of large proportions, and for psychological effect if nothing more it is better to cut it out entirely and thereby eliminate it from the consideration when difficulties are encountered.

EXPERIMENTS MADE POSSIBLE WITH SWITCHES

The lack of switches to change over from one set to another often robs the fan of interesting experiences. Many use a crystal detector set as a stand-by outfit to pick up local broadcasts, instead of a tube set for distant stations or for louder results with the local stations, because it seems wasteful to keep tubes burning all day when the crystal set will bring in local broadcasts loudly enough to be heard throughout a room where the listener is busy with quiet work. With properly installed switches it takes but a second or two to cut in the tube set when something comes across that needs to be brought out more distinctly, but if it is necessary to fumble with wires in making the change, the desired feature is often lost and the fingers may get a few punctures from copper wire that might have been avoided.

If there are two tube sets and but one aerial, ground connection, "A" battery and "B" battery, a change-over without

(Continued on page 376)

A Microphone Amplifier

By BERT T. BONAVENTURE

CONSIDERABLE interest has been involved to produce a device which will be able to satisfactorily amplify speech and music and which does not utilize a vacuum tube for its operation. However great this interest has been, a suitable amplifier is yet to be developed. The well known Brown microphone relay is perhaps the best known of these devices, but its excessive cost prohibits its use among the radio fraternity. In order to compete with the vacuum tube amplifier, for which there is no peer, the amplifying device must be easily constructed and low in cost. It must be able to faithfully reproduce the original sound waves that are desired to be amplified. The frying noises inherent in any loose contact device such as the microphone must be of such small magnitude as to be practically negligible when the instrument is in operation.

EQUAL TO 1 STAGE OF AMPLIFICATION

While the device herein described cannot be claimed to be equal to the Brown relay, it is nevertheless a satisfactory understudy of it, besides being very easy to construct. Actually, it took less than four hours to build the unit. It is equal to about one stage of tube amplification, using a tube detector, when the unit is properly adjusted. Unless the transmitting station is close by, a crystal receiving set will produce but mediocre results so that a bulb receiver is recommended if satisfactory operation is to be expected. In fact, the greater the energy input into the device, the better it will work.

BALDWIN PHONE AND MICROPHONE BUTTON NEEDED

To make this amplifier, a Baldwin type C receiver unit and a microphone button are required—and the junk box. In the junk box one should find about eight inches of ⅜" by 1/16" brass strip, a few 6-32 round head brass machine screws, a 10-32 flat-headed machine screw, 1¼" long and a length of phosphor bronze or other stiff wire. Steel piano wire will do very well.

In the accompanying sketch (Fig. 1) of the assembly of the unit are given the dimensions of the brass angle pieces that support the microphone button. The ⅜" by 1/16" stock should be bent according to those specifications. In the bottom support drill two holes in the feet to clear a 6-32 screw and tap a 6-32 thread in each leg ¼" from the top of the yoke. The top angle is for added rigidity for the microphone button and two holes are drilled in each leg ¼" from the ends as indicated. In the exact center of the top of each of these angles drill a hole that will just clear a 10-32 machine screw. These holes will be in alignment when the two brackets are assembled and serve to guide a 10-32 screw on the end of which the microphone button is mounted.

MOUNTING THE MICROPHONE BUTTON

As to this button, the writer used a Newman-Stern, which is very much the same as the well known Skinderviken. The entire button must be taken apart for the next operation, care being exercised that none of the carbon grains are lost and that the mica disc is not injured in any way. Through the center of the back support, which has a cup-shaped recess cut in it, drill and tap a hole with a 10-32 thread. Countersink this hole from the inside. Since there is not much thickness to the brass shell at this part, be careful not to countersink too far, otherwise the threads will be cut away entirely. The head of the 10-32 screw will have to be filed down until it becomes flush with the surface of the cup-shaped hollow, during which process the slot in the head will no doubt disappear. Only experiment can determine just how far to file the head so that repeated trial fittings are necessary. In case the microphone button does not permit any countersinking at all, use a round head screw with the head filed down quite flat. This projecting head of the screw will take up some of the space formerly occupied by the carbon granules so that some of these may be discarded in the microphone assembly.

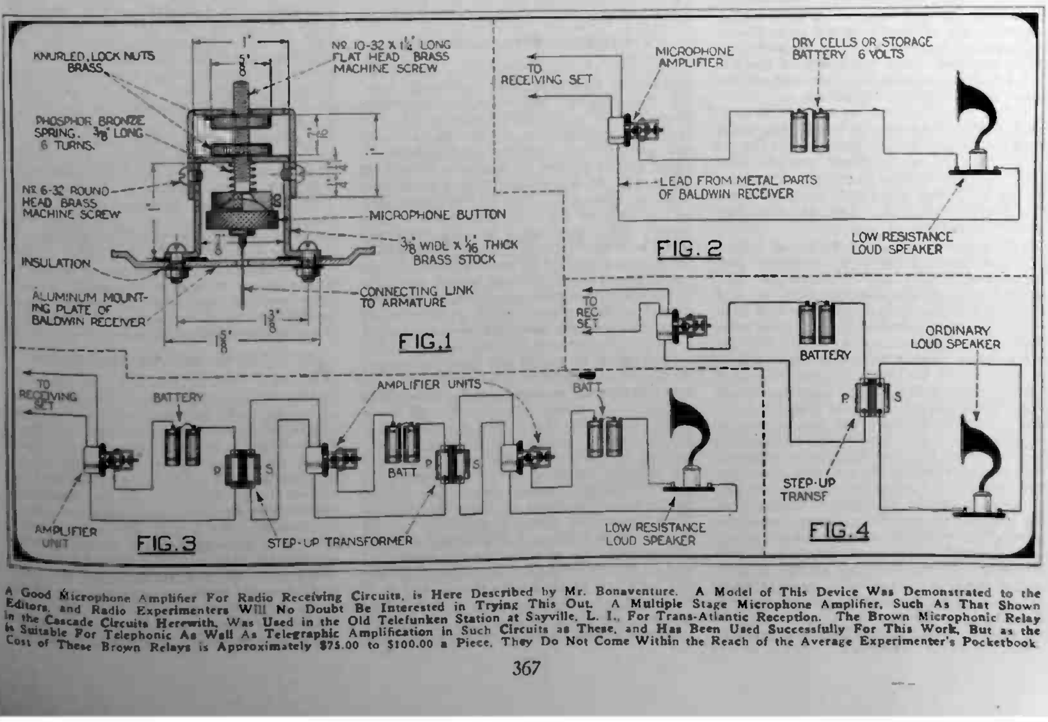
Thread the rear support of the button on the screw, replace the carbon grains and mica sheet, thus completing the job of attaching the button to the movable support. Before beginning with the complete assembly, sweat the brass tip of the front of the button with solder as this will facilitate the later attachment of the connecting link to the armature. Next assemble the complete amplifying unit before mounting on the Baldwin receiver. The stiff spring, made of phosphor-bronze or steel piano wire, is placed between the button and the bottom of the lower bracket. A locknut goes in between the two brackets. If no locknuts are handy, use ordinary large hexagonal nuts. A coating of black lacquer completes this part of the amplifier. All that remains now is to attach the exterior part to the actuating mechanism of the Baldwin phone.

ATTACHMENT TO BALDWIN PHONE

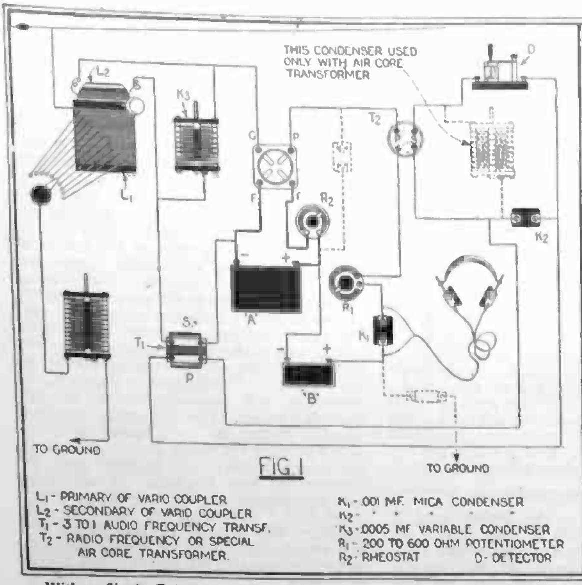
Unfortunately, to do this, the whole Baldwin unit must be dismantled. Do not be dismayed by this prospect for it is a very simple operation. First scrape off or heat the solder on the washer which holds down the mica diaphragm and unscrew the washer from the connecting link to the balanced armature. The mica diaphragm will now be free to be removed and put in the junk box. You may as well keep it, since you may wish to reconvert the Baldwin into its original form.

Next remove the two screws which hold the permanent magnet on the pole-pieces.

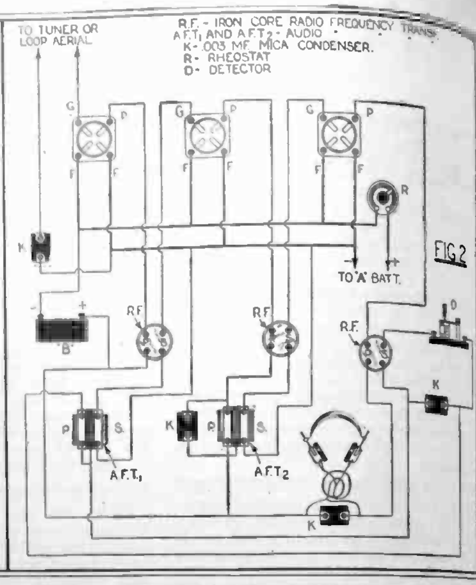
(Continued on page 375)



A Good Microphone Amplifier For Radio Receiving Circuits, is Here Described by Mr. Bonaventure. A Model of This Device Was Demonstrated to the Editors, and Radio Experimenters Will No Doubt Be Interested in Trying This Out. A Multiple Stage Microphone Amplifier, Such As That Shown in the Cascade Circuits Herewith, Was Used in the Old Telefunken Station at Sayville, L. I., For Trans-Atlantic Reception. The Brown Microphonic Relay is Suitable For Telephonic As Well As Telegraphic Amplification in Such Circuits as These, and Has Been Used Successfully For This Work, But as the Cost of These Brown Relays is Approximately $75.00 to $100.00 a Piece, They Do Not Come Within the Reach of the Average Experimenter's Pocketbook.



With a Single Tube and a Crystal Detector, It Is Possible To Obtain the Effect of One Stage of Audio Frequency Amplification and One Stage of Radio Frequency Amplification Using the Circuit Shown Above.



The Above Circuit Diagram Illustrates the Use of Three Vacuum Tubes and a Crystal Detector In a Reflex Amplifier, Which May Very Easily Be Used In Connection With a Loop Aerial.

Practical Notes On Reflex Amplifier Construction

By ROBERT E. LACAULT

THE reflex amplifiers have recently come to the fore for several reasons, the main one being that with a minimum number of tubes greater amplification may be had since each tube does double duty. On account of their price and cost of operation this performance of double duty is quite an appreciable feature for the majority of radio amateurs, and has made of the reflex amplifier a very popular type of receiver for broadcast reception.

Reflex amplifiers are by no means new, as in 1916 the writer, then with the radio research laboratory of the French Signal Corps, worked on the development of the first reflex amplifiers, which were designed for use in the French army during the war by Mr. M. Latour, the well known engineer.

The construction of a reflex amplifier is not an easy problem if it is to give maximum results, and the experimenter contemplating the construction of one should remember that patience and care are necessary to make it work properly. One of the greatest drawbacks is that the circuits have a tendency to oscillate on account of feed-back effects occurring through the grid-to-plate capacity inside of the vacuum tubes. This may be overcome, but necessitates the use of special ransformers. Another defect which must be avoided is the rectification of the signals before they reach the detector. By referring to the diagram, Fig. 2, it may be seen that the secondary winding of the audio frequency transformer which is generally shunted by a by-pass condenser, acts somewhat as a grid leak and grid condenser making the tube to the grid of which they are connected, operate as a detector partially rectifying the oscillations, thus destroying the benefits of radio frequency amplification. The best method to reduce this is to omit the by-pass condensers across the secondaries of the audio frequency transformers. The distributed capacity of the winding is sufficient in this case to allow the high frequency currents to flow in the grid-filament circuit.

A ONE-TUBE REFLEX CIRCUIT

The use of a potentiometer should be avoided, as this instrument, although helpful for tuning, introduces undesirable losses, as it is generally connected. In order to further reduce the resistance of the grid circuit, connections should be short and of course all contacts should be soldered. In a one-tube reflex amplifier, such as shown in Fig. 1, the secondary of the coupler L2 should be wound with heavy wire and have a comparatively small number of turns. In order to stabilize such a circuit, and prevent undesirable oscillations, a resistance, which may be a standard potentiometer, may be connected in the plate circuit as shown at R1. The transformer T2 may be either a radio frequency transformer of the proper type to cover the band of wavelengths which it is desired to receive, or another coupler consisting of a tube three inches in diameter wound with 60 turns of No. 22 or No. 24 wire for the secondary and about 20 turns wound directly over and in the center of the secondary for the primary winding. If such a coupler is used a .0005 M F variable condenser should shunt the secondary to tune the circuit. This provides greater selectivity and higher amplification, but generally necessitates the use of either a resistance, as shown at R1 or a fixed condenser of .002 MF or more as shown by the dotted lines in Fig. 1. In some cases it is helpful to ground the positive of the B battery through a high non-inductive resistance.

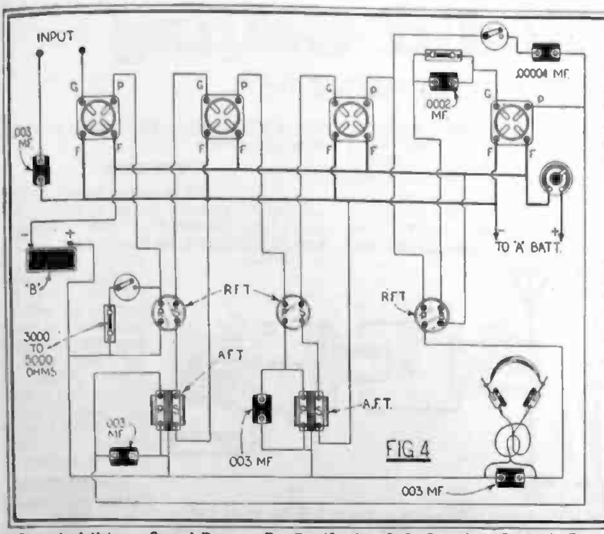
TUBES FOR REFLEX SETS SHOULD HAVE LOW INTERNAL CAPACITY.

It is very difficult to lay down hard and fast rules for the design of this type of amplifier as the conditions are different in every case and with every make of tube. However, it is desirable to use vacuum tubes having as low an internal capacity as possible. There are on the market at the present time several tubes fulfilling this condition. It is the case with the UV199, the Myers audions, the Western Electric "N" Tubes, the French tubes, and others of similar construction. It has been said that such tubes as the UV199 or the UV201A and C301A were not suitable for radio frequency amplification. This is erroneous, as these tubes are on the contrary very good amplifiers, but perform as such only when the grid is at a negative potential. Since in most of the radio frequency amplifiers now in use, it is necessary to make the grids of the tubes positive in order to prevent self-oscillations, poor results are obtained, but the tubes are not to blame.

MULTI-TUBE REFLEX AMPLIFIERS

When a loop or small indoor aerial is to be used it is necessary, in order to receive distant stations, to use several stages of amplification. In this case it is more difficult to make a reflex amplifier work properly, unless one experiments before making the complete set. The best method is to hook up all the apparatus temporarily on a board, keeping the transformers at least a few inches from each other and making the wiring as straight as possible. It is important to keep the leads from the transformers to the grid and plate of each tube short and apart from each other.

In order to determine if a reflex amplifier works properly it is best to hook up



Instead of Using a Crystal Detector For Rectification, It Is Sometimes Desirable To Use a Vacuum Tube Detector. This May Be Connected As Illustrated Above and the Two Switches Inserted In the Circuit Allow Variations Not To Be Obtained Otherwise. The Use of a Vacuum Tube Detector Gives Greater Volume Than Would Be Obtained When Using a Crystal Detector.

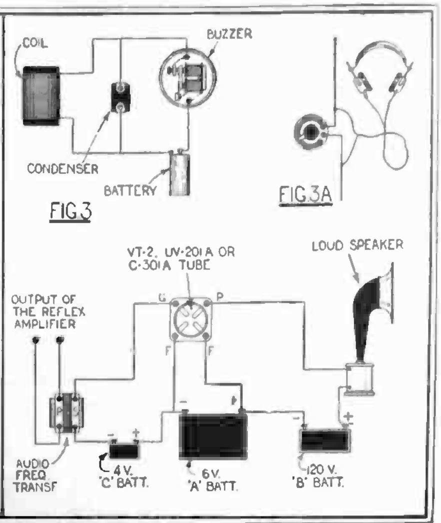


Fig. 3 Shows a Buzzer Transmitter For Testing a Reflex Set. A Potentiometer Connected As Shown In Fig. 3A Acts As An Audibility Meter. If Greater Volume Is Desired It May Be Obtained With An Additional Stage of Audio Frequency Amplification As Shown In Fig. 5 Below.

all the apparatus at hand in a straight circuit using separate tubes for the radio and audio frequency amplifier. An audibility meter may then be used to determine the intensity of some standard signals, which should, of course, be the same when the same transformers and tubes are hooked up in a reflex circuit. A standard signal should be available to determine the efficiency of the amplifier. This may be either a near-by broadcasting station which is always received with the same intensity, or a small driving circuit which may be composed of a coil, condenser and buzzer with battery as shown in Fig. 3. With the coil 3" in diameter and wound with about 32 turns of insulated wire, shunted by a .0005 MF condenser, the circuit radiates a wave of about 360 meters which may be used as the source of constant intensity signals, the buzzer being kept always at the same distance from the loop-aerial connected to the amplifier. An easily constructed home-made audibility meter may consist of a potentiometer shunted across the phones as shown in Fig. 3A. By noting the readings on a scale a comparison may be made between the standard circuit efficiency and that of the reflex.

TESTING THE REFLEX SET WITH BUZZER TRANSMITTER.

Once the standard circuit composed say of three stages of radio frequency, a vacuum tube or crystal detector, and two stages of audio frequency, is hooked up, the buzzer of the driving circuit is started and the audibility of the signal is reduced to a minimum by carrying the buzzer away from the loop. This should be made with the potentiometer at maximum, that is with all the resistance in circuit. One listens carefully and adjusts the potentiometer until the signals become inaudible in the telephones. The setting of the potentiometer should be carefully noted, and should be about the same when connected to the reflex amplifier, which may then be hooked up according to the circuit of Fig. 2.

Before connecting the second audio frequency transformer the telephone should be introduced in the plate circuit of the second tube instead of the primary of the transformer AFT2. All the tubes being lit up and the detector adjusted, no signals should be heard while the buzzer or the station tuned in is being received; if the signals are audible before they reach the detector, this shows that they are being rectified by the first tube. In this experiment the phones should be used alone, without the potentiometer shunted across. After this is verified the second audio-frequency transformer may be connected as shown and the telephone introduced in the plate circuit of the third tube.

THREE STAGE RADIO AND TWO STAGE AUDIO REFLEX SET

Fig. 4 is the circuit of a French Army amplifier which was extensively used during the war in direction finding work. This type of amplifier is provided with four tubes, three stages of radio-frequency and two stages of audio-frequency amplification, the second and third tubes being used to amplify both frequencies and the last one being the detector. These amplifiers were generally connected to a one-turn loop about six to eight feet square to locate short wave transmitters used by the enemies.

Very great distances were covered, thanks to these amplifiers, which are very stable in operation over the whole range of wave-lengths extending from 200 to 1,200 meters. As may be noted in the diagram, Fig. 4, some condensers and resistances may be used in the circuit. These are for the purpose of stabilizing and are shown here as suggestions for the building of such amplifiers. It has been found that the best results are obtained with low ratio audio-frequency transformers not exceeding 3 to 1, and iron core radio-frequency transformers, some of those on the market today being very suitable for the purpose.

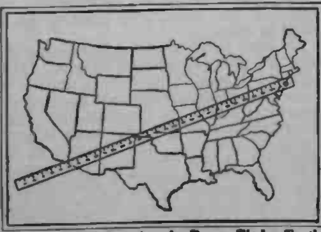
In general it is not advisable to use high plate voltage on a reflex amplifier and if a loud speaker is to be used it is best to connect to the output, an extra stage of audio-frequency amplification using an extra tube and separate batteries as shown in the diagram Fig. 5.

It is not absolutely necessary that a separate storage battery to supply the current for the filament be used. This separate battery is, however, an advisable addition as it will lessen the squeal which may otherwise be developed.

A Simple Range Finder

The first requisite is a strip of celluloid about half an inch wide and long enough to reach from the point on the map indicating the owners location to the most distant part of the chart. If it is impossible to obtain celluloid, a strip of thin wood or bristol board may be used.

Consider for a moment the use of celluloid. The scale of the map is determined and laid off on the strip starting half an inch from one end. With a scriber, sharp scratches should be made in the material at every division point, which in the case of a large scale map need not be closer than the distance representing 25 miles. The short scratches can then be filled in with black India ink, and in order to make a neater job as well as a clearer reading scale, every long division indicating 100 miles should be marked in red. The figures representing distances may be marked in as desired. This same scheme may be carried out on either a wood or cardboard strip.



The Method of Securing the Range Finder To the Map and Using the Same Is Illustrated Above.

Next the city in which the amateur is located is accurately found on the map and a pin placed through the first division on the scale is affixed thereto. It is now very easy by swinging this indicator around its pivot to determine with a very fair degree of accuracy the distance of any point on the map. When not in use the indicator will fall to a perpendicular position.

Selective Radio Calling

By FREDERICK V. HUNT

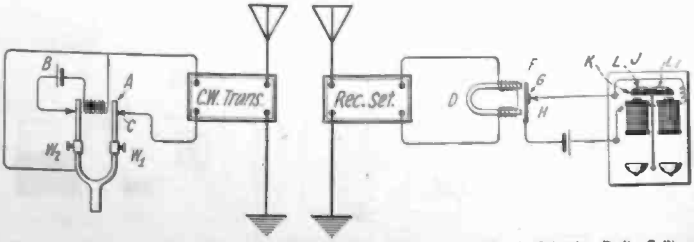
THE ideas about to be described are amply illustrated in the accompanying schematic diagram. Referring to the diagram by letters the explanation follows:

TRANSMITTING

The continuous wave transmitter is modulated by tuning fork A, which is electrically driven by circuit B, thus interrupting contact C, at the frequency of the fork. Adjustable weights W_1 and W_2 allow this frequency to be varied. This transmits a wave strongly modulated at the frequency of the fork.

RECEIVING

The receiving set is tuned to the wave-length of the transmitter. Any audio frequency tone received will be transferred through a telephonic or frequency relay to the external circuit J, in which is placed a harmonic bell ringer, which, if resonant to the received frequency, will ring loudly. Frequency relay D is of quite simple construction, consisting of an ordinary low resistance telephone receiver (75 or 80 ohms) to the diaphragm F, of which is soldered the silver contact G. Contact H being adjustable, it is normally in contact with that on the diaphragm. The received frequency causes the diaphragm to vibrate, breaking the external circuit at that frequency. Harmonic ringer J, is of orthodox construction, but had best be bought, as it will be rather difficult to make. Its construction is here briefly described that its operation may be better understood. A polarized bell ringer, such as is found in the ordinary wall telephone, has bearing on its magnetized armature K, two springs L and L_1, which after the nature of a reed, cause the bell to be resonant to one frequency only. These may be purchased in several standard frequencies, as 16, 33, 50, 66 cycles per second, etc.



A Schematic Diagram of the Connections of the Apparatus Necessary to Use in Selective Radio Calling Is Shown Above. The Action of the Tuning Fork "A", Controls This System as is Fully Explained in the Text. This System is Applicable Only to C. W. Transmission and Reception.

OPERATION

Transmitting station, having previously determined the frequencies produced by different positions of the adjustable weights, places these weights on the frequency assigned to the receiving station he wishes to call. Upon starting the transmitter the modulated wave is emitted. This is of course received by all stations within range which are tuned to that wave-length, but it affects only the receiver whose harmonic ringer is resonant to that frequency. The operator or attendant then plugs in and resumes telegraphic or telephonic communication, as is usual.

VARIATIONS

A hand operated magneto, buzzer, oscillating vacuum tube, or any other electrical or mechanical producer of tone frequencies may be substituted for tuning fork A. If a limited number of stations are to experiment with the system, an ordinary polarized bell ringer may be substituted for the harmonic ringer shown, the system then depending upon the use of different wave-lengths for selectivity in calling.

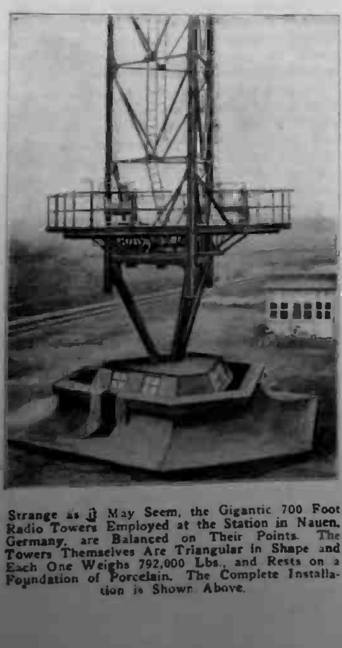
APPLICATIONS AND POSSIBILITIES

A complete radio telephone system may be set up offering the flexibility of the present land practice, utilizing wave-length selection as well as different harmonic ringer frequencies. Ships at sea may agree on a definite frequency for a distress signal avoiding the necessity of keeping a radio operator on constant watch to listen for SOS signals. In time of national crisis the President may call the nation to their receiving sets for the dispensing of important information.

PRACTICABILITY

This complete system has been experimentally put into operation and proved to be an actuality by the author at the Signal Corps Research Laboratory, Ohio State University.

How a 700-Foot Radio Tower is Balanced on a Point



Strange as it May Seem, the Gigantic 700 Foot Radio Towers Employed at the Station in Nauen, Germany, are Balanced on Their Points. The Towers Themselves Are Triangular in Shape and Each One Weighs 792,000 Lbs., and Rests on a Foundation of Porcelain. The Complete Installation is Shown Above.

ONE of the most curious things which the radio-technique has created are the great towers of Nauen, which bear the antennae. Are you able to balance a pencil on its point? You certainly will have the opinion, that such a thing is absolutely impossible. However, the great towers of the radio station at Nauen near Berlin, the greatest one of which has a height of 700 feet, are balanced on a point. They resemble indeed gigantic pencils of triangular sections, which are put on their sharpened conical point. Each one of the two great towers has a weight of 360,000 kilograms, that is 1.4 kilogram for each millimeter of height. The total pressure on its foundation is 792 pounds for each tower. The foundation consists of 72 plates of porcelain, which are arranged in such a manner as to form small pillars. Each pillar contains six round plates of porcelain. The pillars are standing on a block of concrete.

On these plates of porcelain balances the high and heavy tower with its point. This balancing is made possible by a number of guys which go from different parts of the tower to points in all directions, and which are fastened with anchoring irons in great blocks of concrete. The tightness of the guys is such that the tower can move a little under the pressure of the wind. If that precaution were not taken, and if it were stiff and unmovable, it would break down at the first strong blast of wind.

A View of the Tower Base is Shown Above, with the Outside Casing Removed. The Extreme Point of the Tower is movable Upon Its Foundations so That It Can Sway Slightly When Affected by High Winds. This is Necessary to Eliminate the Possibility of Breakage in a High Wind. A Complete Description of This Base is Given in the Text.

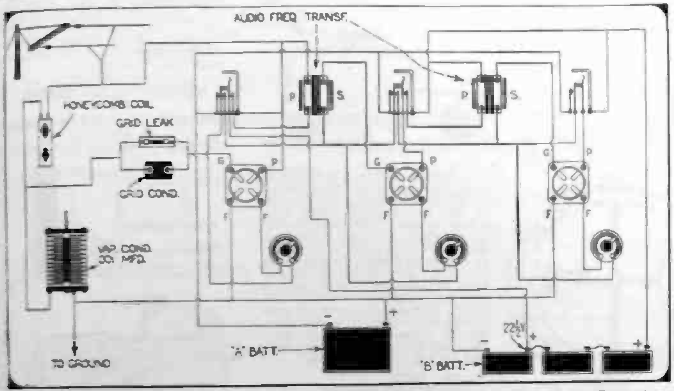
Radio Oracle

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.

A TWO STAGE AMPLIFIER

(163) Mr. George Bunker, Toronto, Ont., Canada, requests:

Q. 1. Can you furnish me with a circuit diagram showing the connections of a two stage audio frequency amplifier employing a honey comb coil and variable condenser for tuning and using filament control jacks between the tubes?



The Connections for a Radio Set Employing Two Stages of Amplification and a Very Simple Tuner Are Shown in the Above Diagram. Filament Control Jacks Are Used to Cut Out the Tubes Which the Operator Does Not Desire to Use.

A. 1. We are giving herewith a circuit diagram as requested.

RECEIVING SET QUERIES

(164) Mr. Lot Dennis, Jr., Melvin Village, N. H., submits a circuit diagram of a single circuit tuner and asks:

Q. 1. What should be the capacity of the variable condenser connected in series with the primary of the vario-coupler?

A. 1. The variable condenser in the antenna lead of the circuit diagram you sent us, should have a capacity of .001 M. F.

Q. 2. I have a 4 inch stator and a 3½ inch rotor for a vario-coupler. How should these two tubes be wound?

A. 2. We would advise you to use about 55 turns of No. 22 wire on the primary of your vario-coupler, and wind each side of the rotor with as much No. 22 wire as it will hold. Of course, this rotor winding should be split in the middle to make room for the shaft.

Q. 3. Will you kindly look over the enclosed diagram and tell me why I cannot make my set work?

A. 3. The hook-up you submitted is correct, but we would advise you to experiment a little with your A battery connections; that is, reversing them, so as to present a different pole to the negative pole of the B battery. This may have some effect on the working of your set.

You should go over all the connections on your set very carefully and be sure that they are all correct and soldered. This is important, because of the fact that such a small current is present. A "leaky" connection will result in greatly reduced efficiency.

BATTERIES

(165) Mr. Carl Akerfeldt, East Toronto, Canada, requests:

Q. 1. What kind of battery must be used on a radio set employing a U.V.-200 tube?

A. 1. You can use any standard make of six volt storage battery, for the "A" battery of a radio set. For the "B" battery you can purchase block batteries made especially for this purpose.

LOADING A CIRCUIT

(166) Mr. A. O. Bottorf, Louisville, Ky., says:

My radio set will only tune to 360 meters. He asks:

Q. 1. How can I increase the wave-length of this set so that I can receive from commercial stations operating on 600 and 800 meters?

A. 1. You would have to load your circuit in four different places in order to obtain efficient results. In the first place, you would need a loading coil in the antenna circuit, as well as one in series with the primary of the vario-coupler, one in series with the grid of the detector tube, and one in series with the plate variometer. This is necessary in order to balance the circuits.

VARIO-COUPLER VERSUS LOOSE COUPLER

(167) Mr. Milton Beck, Buffalo Lake, Minn., asks:

Q. 1. Will a loose coupler give better results than a vario-coupler in receiving radio messages?

A. 1. For short waves the vario-coupler is undoubtedly better than a large loose coupler, but for long waves it will be found necessary to employ the latter. In such a case, it would be connected the same as the vario-coupler, and a variable condenser should be shunted across the secondary.

ANTENNA QUERIES

(168) Mr. M. L. Bender, Spring Valley, Minnesota, wants to know:

Q. 1. Does it make any difference where the lead-in is connected to an aerial?

A. 1. If you make the inverted L type of aerial, bring your lead-in wire off the exact end of the flat top. If you make it a "T" type, connect the lead-in exactly in the middle. Otherwise you have an unbalanced condition, with currents bucking each other at one or more places as they oscillate. Solder all the joints. Use stranded wire. Surface is what you want in wire used for radio currents and there is more surface in a stranded wire than in a solid wire of the same size. One hundred feet ought to be a good length for your purpose. If you can point the elbow formed by the flat top and the lead-in of an L type aerial directly at the transmitting station your chances will be increased. If it is a "T" aerial, point either end at the transmitting station you want to get.

INDOOR AERIAL

(169) Mr. Berget Blockson, Michigan City, Ind., asks:

Q. 1. When using an indoor aerial which is hung from the moulding around the walls of a room should the wire be suspended on insulators from this moulding or may it be fastened thereto with nails?

A. 1. It would be much better under all conditions to suspend your aerial wire from insulators rather than to allow it to touch the molding. This will give much more efficient results in damp weather.

Q. 2. Can a crystal set be used with such an aerial?

A. 2. It is possible to use a crystal set with an indoor aerial if it is desired to receive over comparatively short distances only. However, for best results you should use an audion detector and preferably two stages of audio frequency amplification. If greater distances are desired, you should use one stage of radio frequency amplification.

STORAGE BATTERY TROUBLE

(170) Mr. J. P. Brumfield, Galena, Kansas, writes:

When I listen in on my set and turn on the detector rheostat, the signals come in loud but gradually fade out and do not return till I turn out the tube, and leave it out for some time. This happens even after the A battery has been fully charged. He asks:

Q. 1. Can you tell me what can possibly be the trouble?

A. 1. A poor "A" battery is the only possible solution to your trouble. When your battery is fully charged, the hydrometer should read from 1300 to 1350. It may be that your "A" battery does not keep its charge, and that is the reason for your signals going down in volume after the tube has been used for some time.

RADIO FREQUENCY SET

(171) Mr. F. Buffehr, Cheyenne, Wyoming, refers to the circuit diagram published on page 156 of the June, 1922, issue of SCIENCE AND INVENTION, and asks:

Q. 1. How may I use this circuit without the two stages of audio frequency amplification?

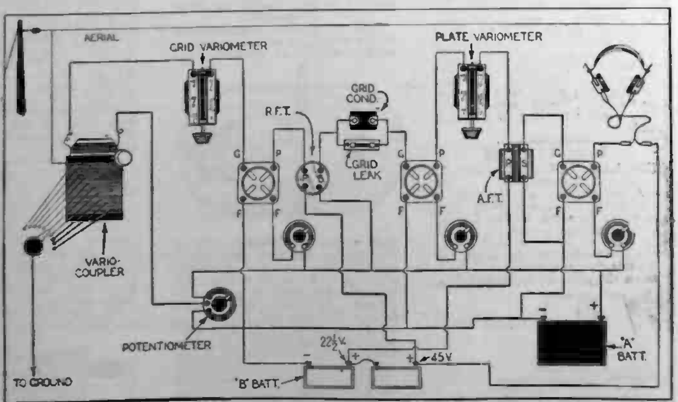
A. 1. To use this circuit without the two stages of audio frequency amplification, all that is necessary is to leave them out and connect your phones in the plate circuit of the detector tube in place of the primary of the first audio frequency transformer.

RADIO AND AUDIO FREQUENCY CIRCUIT

(172) Mr. C. P. Allen, Bartlesville, Okla., requests:

Q. 1. Can you give me a circuit diagram showing one stage of radio frequency amplification, a detector and one stage of audio frequency amplification using a vario-coupler and two variometers for tuning?

A. 1. You will find the circuit diagram you desire below.



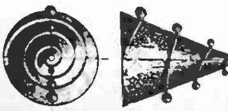
A Standard Three Circuit Tuner Used in Conjunction With One Stage of Radio Frequency Amplification and One Stage of Audio Frequency Amplification is Shown Above. More than 45 Volts May Be Applied to the Plates of the Amplifying Tubes if Desired.

LATEST PATENTS

SOUND AMPLIFIER

(No. 1,449,530, issued to Frank E. Miller.)

The sound amplifier designed by the famous surgeon, Dr. Frank E. Miller, possesses many unusual



features. It is made in the form of a conical horn having a ridge projecting inside and outside of the wall of its main portion. Along the path and beginning at one-quarter sector of a spiral from the center orifice, and thereafter located at every half turn of a spiral, are resonators made of brass or other substance. These are spherical in shape.

ELECTRIC MASSAGE APPARATUS

(No. 1,433,184, issued to Henry Csanyi.)

The most distinctive features of this novel massage apparatus are the method of locating the same within the case, as illustrated herewith, and the system of mounting the high tension coil and massaging electrodes in the ordi-

nary flashlight case, making a very compact unit. The massaging elements may be detached in the same manner as a flashlight bulb is removed from the case, namely, by removing it and its fixtures. The high tension coil is placed within the case and makes contact with the positive pole of the upper flashlight cell. Leads pass to the electrodes across which the circuit is completed when they are laid on the skin. Being close together, they cause the effect to be localized.

DISPLAY RACK

(No. 1,445,123, issued to Lewis L. Zimmerman.)

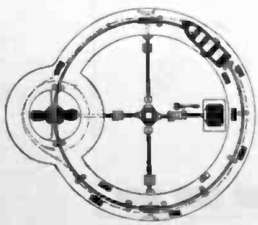
A very clever display rack is that depicted in the diagram. This is driven by a belt and an air turbine resembling a small wind vane. In view of the fact that nearly every storekeeper possesses an electric fan, the inventor has cut down the price of the installation,

so that one need only operate his rather efficient fan, directing the stream of air against the wind vanes of the turbine in order to obtain the desired motion. By changing the relative size of the pulleys, the speed of the rack may be decreased or increased. Of course, the amount of air which the fan develops will determine the speed at which the rack rotates.

AMUSEMENT DEVICE

(No. 1,448,306, issued to Erastus A. Lezert.)

This is a very beautiful amusement device and if installed at some of the summer resorts should

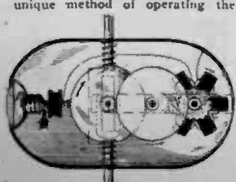


attract great attention. An endless chain on the bottom of the runway is rotated constantly by an electric motor, which motor also turns a large propeller at the bottom of a circular tank through which the ships must pass. Secured to the runway are also a series of spring bumpers either staggered or lying side by side. Rollers on the bottom of the ship come in contact with these guides. Supposing now we have these vessels loaded with passengers and the clutch mechanism which drives the sprocket chain is thrown in. The movement of the chain carries the boats with it, because they are coupled to the chain by means of a very flexible coupling, and the bumpers serve to lift the boat and give it a longitudinal rocking motion, where they are paired, or produce a lateral rocking motion where the single bumpers are encountered. When the vessel reaches the whirlpool, the boat being free to move on its coupling, is given a whirling twisting motion, after which it continues on its original course.

FLASHLIGHT

(No. 1,436,798, issued to Fred Evans.)

This is another hand-operated pocket flashlight which employs a unique method of operating the

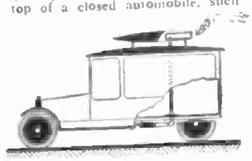


train of gears. As will be seen in the diagram, this gear train is contained within the casing of the lamp. A rod extends through the casing and projects on either side thereof. By pushing this rod first in one direction and then in the other, the rack causes a toothed wheel operating within it to rotate continuously. The motion is imparted to a gear wheel, for the purpose of increasing the speed of the permanently magnetized armature, which gear meshes with the other gear above alluded to, by means of a third cog wheel mounted upon its axle.

ADVERTISING DEVICE

(No. 1,447,749, issued to Raymond L. Beselin.)

This unique advertising device is very simply constructed. On top of a closed automobile, such

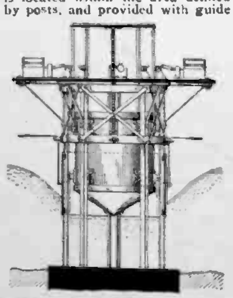


as a delivery wagon, a model of a large cigar, pipe or cigarette is mounted. This has an opening in its rear end, communicating with a pipe passing down through the automobile, and thence coupled to the muffler of the engine by means of a piece of flexible tubing. The top of the pipe or the end of the cigar or cigarette is closed with a disk perforated by numerous small holes. The exhaust gases are now caused to pass up into the pipe, making it appear that a lit monster pipe or cigarette is being carried on top of the machine.

WAVE MOTOR

(No. 1,444,693, issued to Joseph A. Lymburner.)

A float of suitable construction is located within the area defined by posts, and provided with guide

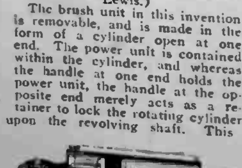


rollers operating in channels of the posts as shown. By this means it can move vertically. Attached to the float and extending above the same are gear-rack bars, and mounted upon the platform adjacent to each of the rack bars, is a standard which carries a shaft, upon which is a gear wheel which in turn engages in the gear racks. A crank arm coupled to the gear-wheel shaft connects with piston rods of the numerous pump devices. As the float slides up and down due to the action of the waves, the pumps are operated.

ROTARY BRUSH

(No. 1,448,630, issued to Charles Lewis.)

The brush unit in this invention is removable, and is made in the form of a cylinder open at one end. The power unit is contained within the cylinder, and whereas the handle at one end holds the power unit, the handle at the opposite end merely acts as a retainer to lock the rotating cylinder upon the revolving shaft. This

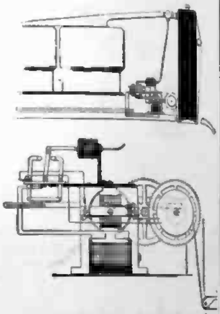


brush is adaptable for many purposes. It may be employed for brushing the hair, removing paint from furniture, and doing all sorts of light or heavy work. It may be interesting to note that the idea here given was developed largely, and the original model was made by the patent and research department of the Electro Importing Company.

AUTOMATIC RADIATOR CURTAIN

(No. 1,443,465, issued to Weston M. Fulton.)

If this invention is placed upon

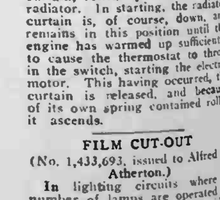


the market before the forthcoming winter, it should prove a boon to autoists. As will be seen in the diagrams, a thermostat containing an expansible fluid has its upper extremity located in the return pipe from the auto engine to the radiator. This thermostat controls a switch for reversing or starting an electric motor, which in turn is connected by a train of gears to a cable attached to a curtain, rolled up in front of the radiator. In starting, the radiator curtain is, of course, down, and remains in this position until the engine has warmed up sufficiently to cause the thermostat to throw in the switch, starting the electric motor. This having occurred, the curtain is released, and because of its own spring contained roller it ascends.

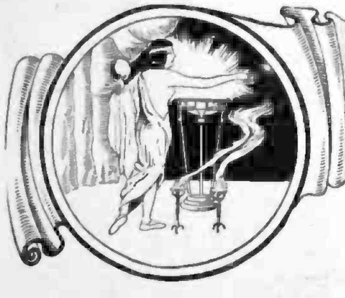
FILM CUT-OUT

(No. 1,433,693, issued to Alfred L. Atherton.)

In lighting circuits where a number of lamps are operated in series, a means must be provided to automatically short-circuit a lamp when it burns out; otherwise all the lamps on the entire series circuit would go out, and it



becomes a difficult matter to find the lamp causing the trouble. Although film cut-outs are not new, this one, employed with an ordinary base receptacle, is so arranged that either the cut-out or the lamp may be removed without noticeably affecting the other lamps in the circuit. In the base of the lamp socket a spring may be found which is pushed down when the lamp has been screwed into the socket, but which short circuits the socket when the lamp is withdrawn, thus preventing the film cut-out from being damaged every time the lamp is removed.



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 the 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 PROBLEM IN HEAT

(1506) Raymond Coup, McKeesport, Pa., gives the following problem. In order to find the temperature of a stove fire, a piece of cast iron weighing 1 pound is placed in it. A copper vessel weighing 1½ pounds is partly filled with 3¼ pounds of water, the temperature of both being 85°. After the cast iron piece has been placed in the vessel of water, the temperature of the mixture is found to be 128°. What was the temperature of the fire? He asks:

Q. 1. Can you give me the answer to this problem and show all the work done?

A. 1. In order to solve this problem it is necessary to consider several factors. These are all given below. The weights in pounds that you give are changed to grams. The calculations are approximate, not being carried out as far as possible.

The specific heat of copper = .0951.

The specific heat of cast iron = .1298.

1 pound of iron = 453.44 grams. 1.5 pound vessel = 680.16 grams. 3¼ pounds of water = 1473.68 grams.

The thermal capacity of the vessel = weight in grams × specific heat = 680.16 × .0951 = 64.6832.

The heat lost by the iron = weight in grams × specific heat × (Temperature of iron (unknown and represented below by T) — resultant temperature = 453.44 × .1298 × (T — 128°) = 58.85 T — 7532.8.

The heat gained by the water and vessel = (weight of water in grams + thermal capacity of vessel) × (resultant temperature — temperature of water at start) = (1473.68 + 64.68) × (128 — 85) = 1538.36 × 43 = 66149.48.

The heat gained by water and vessel = heat lost by cast iron. Therefore:

58.85 T — 7532.8 = 66149.48.
58.85 T = 66149.48 + 7532.8 by transposing.
58.85 T = 73682.28.
T = 73682.28 divided by 58.85 = 1252° plus.

A FREAK PHOTOGRAPH

Mr. Roy McIntyre of Akron, Ohio, one of our readers has pointed out to us a freak photograph which appeared in our magazine. He refers to page 948 of the February issue, the top photograph. It will be noted that if one looks at this picture and concentrates his gaze just above and to the left of the white dot he will see an almost perfect human face outlined.

Upon receipt of this information from our reader we looked this up and were able to find several other faces outlined by the peculiar formation of the rock on the mountain side. It might be of interest to others to look this up.

INSULATING COMPOUND

(1507) Mr. Joe A. Martin, Hopkinsville, Ky., asks:

Q. 1. Will you give me a formula for making a good, black insulating composition similar to hard rubber or bakelite which can be used for switch knobs and other parts of electrical apparatus?

A. 1. It is beyond the scope of the average amateur mechanic to make a composition similar to hard rubber or bakelite which can be used for panels and switch knobs, and other parts of radio apparatus.

Switch knobs, however, may be cast, after a little experimenting from the following compound: One part of Stockholm tar, one part of resin, and three parts Gutta Percha. Plaster of Paris molds may be used, and when the melted compound is poured into the moulds, a machine screw is inserted into it in the position that it is desired to occupy in the finished knob. This must be put in while the compound is still in a molten state and held in position until it hardens. After the compound has hardened it may be removed from the mold and polished. The best way to polish such knobs is by using fine emery or rotten stone and oil.

TESLA GASOLINE TURBINE

(1508) Mr. Frank F. Michel, Oakland, Calif., requests:

Q. 1. Can you tell me where to obtain some information on the operation of the Tesla gasoline turbine?

A. 1. The Tesla gasoline turbine was fully described in an article under that title, which appeared in the July, 1920, issue of SCIENCE AND INVENTION.

PRODUCTION OF HYDROGEN GAS

(1509) Mr. John H. McMillen, Dewey, Okla., says:

Some time ago I had the opportunity to examine a device which was supposed to be operated on hydrogen gas drawn from the air, he asks:

Q. 1. Can you tell me anything of such a device and whether or not it is practical?

A. 1. The invention you described in your recent communication is absolutely impossible. Hydrogen gas does not exist in the air, and therefore, the motor you describe could not possible have worked on the principle of extracting hydrogen from the air.

There are two or three ways of making hydrogen gas; the first, is the electrolytic decomposition of water, separating the water into two volumes of hydrogen and one volume of oxygen gas. The second, is by mean of the action of sulphuric hydrochloric or various other acids on zinc or iron, thus evolving hydrogen gas. Commercially, it is prepared by the dissociation of water, electrically.

Therefore, we would advise you not to invest in such speculative scheme, because hydrogen cannot be extracted from the air.

REMOVING WALL PAPER

(1510) Mr. W. H. Hunt, Somerset, Neb., wants to know:

Q. 1. Can you tell me the best method for removing wall paper from ordinary walls?

A. 1. We know of no better method of removing wall paper from the walls than by soaking the same with water. Some wall paper removers use a mixture of water, starch, or other substance, which prevents the water from evaporating too rapidly.

We consider ordinary warm water to be as good as any of the other methods.

COUNTERACTING MAGNETISM

(1511) Mr. Van Haynes, Tennessee, asks:

Q. 1. Is there any metal or other substance that magnetic lines of force will not penetrate?

A. 1. There is no metallic substance, any substance of any kind which magnetic lines of force will not penetrate.

The only ways to counteract magnetic attraction is by another equal magnetic force. In other words, if you place the north and south poles of two magnets together, that is north to north and south to south, there will be repulsion instead of attraction between the same, and if of equal strength they will not attract iron.

AN AIR COOLED RESISTANCE

(1512) Mr. W. D. Croy, Henryetta, Okla., asks:

Q. 1. What resistance should be used in series with an electric arc furnace for experimental use when used on 110 volts A. C.?

A. 1. A suitable resistance for a 110 volt arc furnace will be about 8 ohms. This should be wound with either some grade of resistance wire or iron wire upon two uprights, preferably made of porcelain and so arranged that there is plenty of space between the windings. This resistance is air cooled.

MAGNET QUERIES

(1513) Mr. G. W. Daniels, New York City, wants to know:

Q. 1. Must a permanent magnet be made in the shape of a horse shoe or can it be made in the form of a disc which will attract an armature or steel objects to its flat sides?

A. 1. A permanent magnet could very well be made from a solid disc as you suggest, in which case it would attract a steel or iron armature to either one or the other of its flat side.

Q. 2. Of what material should such a magnet be made?

A. 2. This disc should be made of tungsten steel to secure the best results and most permanent magnetism. This disc may be magnetized by placing between the pole pieces of a powerful electro-magnet. The current supplied to the electro-magnets should be interrupted several times a second.

GUN POWDER

(1514) Mr. Fletcher Douthitt, Chicago, Ill., asks:

Q. 1. Why cannot sodium nitrate be used in place of potassium nitrate in the manufacture of flat gun powder?

A. 1. The reason sodium nitrate is not employed in gun powder, is because of its hygroscopic properties. It absorbs moisture to such an extent, that when used in making gun powder, the resultant becomes unfit for use soon after being made.

Q. 2. Would not the products of combustion of a mixture composed of ammonium nitrate, carbon, and sulphur be entirely gaseous?

A. 2. Yes.

Q. 3. In what order do the following chemicals stand as to the readiness in which they give up their oxygen? Potassium permanganate, potassium chlorate, sodium chlorate, and ammonium chlorate.

A. 3. The following is the order in which the various chemicals stand ready to give off their oxygen. Potassium permanganate, ammonium chlorate, potassium chlorate, and sodium chlorate. The last two are about on a par with each other in this respect.

IMPEDANCE COIL

(1515) Mr. R. J. Coombs, Hagerstown, Md., wants to know:

Q. 1. Can you give me the data on an impedance coil that will draw one ampere on 110 volts, 60 cycle current? I want to use this in place of a lamp bank.

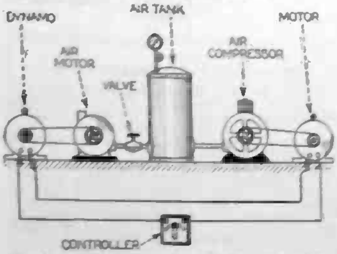
A. 1. For your impedance coil, we would suggest that you wind 666 turns of No. 15 wire on a soft iron core 1 inch in diameter and 10 inches long.

ONCE MORE—PERPETUAL MOTION

(1516) Fenton Connor, Philadelphia, Penna., sends a diagram of a machine by means of which he intends to get perpetual motion. The apparatus consists of a motor which drives an air compressor; this compresses air in a tank, which compressed air in turn drives an air motor, which in turn drives a generator, which generator is supposed to drive the motor and operate perpetually. He asks:

Q. 1. Will such a machine work and if not, can you tell me why?

A. 1. The best way that we can disprove your perpetual motion machine is by giving you the percentage of efficiency developed by each of the various machines used. An electric motor is about 82 per cent efficient, an air compressor about 50 per cent, a compressed-air motor about 48 per cent, and a dynamo about 82 per cent. Therefore, disregarding losses in the air compression tank, rheostat, and other places, your machine will only be approximately 16 per cent efficient. Obviously it is impossible for the same to operate, with such a loss in the apparatus.



Another Variation of An Old Perpetual Motion Scheme. The Original Was a Motor and Generator Belted and Connected Together. They Were to Run Each Other.

A MAGNETIC WINDOW DISPLAY

(1517) Mr. Jos. F. Heredia, Santiago de Cuba, Cuba, says:

I am planning a window display in which I desire to have placed several hidden electro-magnets. These magnets are to attract metallic chairs covered with cloth. The floor of the room represented in the show window will be perfectly smooth and made slippery by some method and the chairs will be mounted on wheels. The magnet should be able to attract the chairs over a distance of about six feet. He asks:

Q. 1. Can you give me any data on the construction of an electro-magnet such as I will need?

A. 1. In order to have the pulling power that you desire, a magnet would have to be of prohibitive size and power. If such a magnet were constructed, the pull would be so great, that the chair, if allowed to come in contact with the core of the magnet would hit the same with such a smash that it would in all probability be destroyed. It would magnetize watches in the whole neighborhood.

MILK OF LIME

(1518) Mr. J. B. Holland, Kamloops, B. C., Canada, asks:

Q. 1. What is milk of lime made of and how can I make it at home?

A. 1. Milk of lime is made by mixing slaked lime with water to slightly thinner than a creamy consistency.

IODINE TESTING SOLUTION

(1519) Mr. J. B. Holland, Kamloops, B. C., Canada, wants to know:

Q. 1. What is the iodine solution composed of which is used for determining the presence of starch in any solution?

A. 1. Ordinary tincture of iodine, which may be purchased at any drug store, is used for testing the presence of starch in any solution.

CIGARETTE HOLDERS

(1520) Mr. G. Otto Hielscher, Seattle, Wash., wants to know:

Q. 1. Can you tell me how corn cobs are made into a mixture which is to be used for making cigar and cigarette holders?

A. 1. The method of using corn cobs for making cigar and cigarette holders, based on the production of furfural is too complicated for one to use who does not have at his command very expensive and up-to-date machinery.

This work is accomplished by macerating the cobs thoroughly, which requires quite a large and strong machine, after which they are treated with certain chemicals to extract the cellulose. This cellulose is then made into an imitation amber, which is formed into cigar or cigarette holders by means of hydraulic presses.

REPAIRING MARBLE

(1521) Mr. Nafty Hage, Franklin, La., requests:

Q. 1. Can you give me the formula for making a composition that will repair broken marble objects?

A. 1. We are giving you herewith formula for the repairing of marble. Mix together four parts of gypsum and one part of finely powdered gum arabic. Then with a cold solution of borax make this into a mortar-like mass. Apply this to the parts to be joined, and fasten together. Leave the mended objects for several days.

A cement which dries instantaneously may be made as follows: In a metal vessel or large spoon, melt 4 parts of rosin, and 1 part of beeswax. This mixture must be applied rapidly, it being advantageous to slightly heat the surfaces to be united, which naturally must have been previously well cleaned.

Another good cement consists of 10 parts of slaked lime, 15 parts of chalk, 5 parts of kaolin mixed together. Immediately before using, stir in an equal amount of potassium silicate, or potash water glass.

INVISIBLE WRITING

(1522) Mr. C. B. Hansen, Coronado, Calif., asks:

Q. 1. Can you tell me of any method whereby I can write upon a prepared piece of paper with a steel point or stylus so that it will be invisible, but will become legible by treating with some solution or some other method?

A. 1. Unless you wish to resort to photographic methods, the only way to obtain the results you desire, is to use two sheets of paper with carbon paper between them. By writing on the top sheet with a steel stylus, the writing will be practically invisible on that sheet, but on the bottom sheet will be clearly legible.

PURIFYING THE MOTOR EXHAUST

(1523) Mr. Harry Gessler, New York City, asks:

Q. 1. Is there any known way of purifying, or in other words extracting the carbon monoxide from the exhaust of a gasoline engine?

A. 1. The only way to purify the exhaust from a gasoline motor would be to pass it through a solution of cuprous chloride. This should absorb the carbon monoxide present in the exhaust.

ELECTRICITY THROUGH THE AIR

(1524) Mr. Frank Falusi, Peterbazy, Sask., Canada, asks:

Q. 1. Is it possible to send an electric current through the air so that it will do some work such as propelling an automobile?

A. 1. Electricity can undoubtedly be sent through the air and Dr. Tesla has proven this, but the cost of this is so great that it would be impractical to employ this method for ordinary use. Dr. Tesla is now working on developments in this direction.

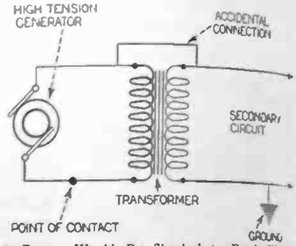
Whenever a wireless sending station is operating a certain amount of electricity is passed into the air, but the current is so slight that it takes a very delicate receiver to detect it.

A HIGH TENSION LINE PROBLEM

(1525) Jos. Eggert, Sandusky, Ohio, asks:

Q. 1. How is it possible for a person standing on the ground to be killed by touching one side of a high-tension primary circuit even though the other side is free from the ground, in case the secondary has accidentally become connected with the primary?

A. 1. The Underwriters' rules covering high-tension installation require that one side of the secondary circuit in high-tension work be grounded. Therefore, an accidental connection between the primary and secondary of the transformer would result in a current passing through the body of any person touching one side of the primary circuit, inasmuch as the person is grounded and completes a circuit. This can be easily seen from the diagram given herewith. It is sometimes the case, in certain installations, that the primary circuit is also grounded, which would also explain at once why a person would be killed when touching one side of the circuit, although, if the connections were made in a certain way, such an accidental connection would result in a burned-out generator.



A Person Would Be Shocked to Death When Touching the Point of Contact, Due to the Accidental Connection.

THE COLOR OF THE SUN

(1526) Mr. Alfred Fierro, New York City, asks:

Q. 1. Would not the color of the sun be a bright blue if viewed from outside our atmosphere?

A. 1. There is no reason to suppose that when one reaches the limits of the atmosphere the sun appears blue.

Sunlight is composed of all the prismatic colors, and if one reached the limit of the atmosphere it would appear a dazzling white, and of a dazzling brilliancy.

When the rays of the sun reach the atmosphere, due to refraction, and due to water vapor in the atmosphere, a blue color is obtained. This color is not entirely due to dust, but somewhat to the intensity of our atmospheric veil.

The blue sky is found in practically dustless places, as for instance, on the top of very high mountainous peaks.

THE STRENGTH OF A SPRING

(1527) Mr. Royal Daggert, Staten Island, N. Y., asks:

Q. 1. How long would a spiral spring made from very best hardened steel retain its elasticity and original shape when placed under pressure sufficient to reduce its length to one-half the original?

A. 1. It will be impossible to state just how long a spiral spring will retain its shape and elasticity when used as you suggest. Many factors will enter into this, such as the quality of steel used in the spring, the place in which the spring is used, that is, the atmospheric conditions around the same, and the amount of pressure used.

AUTOMATIC COIN CONTROL MACHINES

(1528) Martin G. Hoddinot, Toledo, Ohio, asks:

Q. 1. Can you tell me where I can purchase a book dealing with automatic coin control machines or where I can get any information on the subject?

A. 1. We do not believe that there is any book on automatic coin control machines. We would suggest that you secure copies of all patents upon the subject. You may obtain these at a cost of 10c. each. Simply write to the Commissioner of Patents, Washington, D. C., and request the numbers of the patents dealing with coin controlling devices.

ELECTRO-MAGNETIC AUTOMOBILE SIGNAL

(1529) M. A. Gysel, Rochester, N. Y., says that he is working on an automatic semaphore signal for automobiles which he desires to work with an electro-magnet. He sends a diagram showing a lazy tong arrangement, which is to be opened by an electro-magnet and closed by a spring. The electro-magnet will require a pull of about one-half pound. He asks:

Q. 1. Can you give data on suitable magnet?

A. 1. Advise that you use a solenoid and that you place the core in such a position that it will be at least ½ inch within the coil. Rewind coil with No. 14 wire, instead of No. 18. Placing an iron yoke around the coil will help matters.

A Microphone Amplifier

By BERT T. BONAVENTURE

(*Continued from page 367*)

This permits the magnet to be removed and also the top pole-piece. Now pull out the wire saddle in the other pole-piece on which the rear of the armature rides. The armature now being perfectly free, the magnet coil can be removed after unsoldering the leads to the phone terminals. This leaves the bare aluminum mounting plate on which we fasten the part previously made. The holes are already drilled for this purpose, there being six large holes punched in the mounting plate. Of these six, only the two center ones are used for our requirements. Two 6-32 machine screws hold the microphone support to the aluminum plate. Some thin sheet bakelite, mica, hard rubber or other insulating material is placed both above and below the aluminum so as to insulate the brass framework from the aluminum plate. If a suitable washer is at hand, the screw should also be insulated where it goes through the mounting plate. This insulation may be omitted if the unit is carefully assembled so that the screw does not touch the aluminum anywhere.

After the bracket support has been mounted on the aluminum plate, the receiver parts may be replaced as they were, reversing the procedure previously cited. Now free the tension on the spring by entirely loosening both locknuts, so that the tip of the microphone button comes to rest on the tip of the connecting link to the armature, on which the threaded washer has been replaced. Now the trick is to solder this washer to the front contact of the microphone button. It will take patience but it can be done. Then draw up the locknuts somewhat and proceed to test out the amplifier.

TESTING THE AMPLIFIER

Using a low resistance loud-speaker of about 35-75 ohms in series with six volts, attach one wire under one of the screws that hold the permanent magnet in position. This makes connection to the front contact of the button through the armature of the Baldwin receiver. The other wire is connected under a screw provided for that purpose on the back part of the button. Lay the unit on its side as it operates best in that position.

Every time the circuit is closed, a loud click should be heard in the loud speaker and upon tapping the entire unit, these vibrations should be considerably amplified. See Fig. 2 for the hook-up of connections. Upon connecting the Baldwin to a tube set, the amplifier will faithfully reproduce the signals that are coming in, the tension on the locknuts being adjusted for best operation.

Especially good results have been obtained by using a Bristol loud speaker, with the transformer in the base left out of the circuit entirely. A Magnavox should be very satisfactory, only be careful to regulate the voltage on the button so as not to burn out the moving coil of the Magnavox. In this case also, the transformer of the loud speaker is not used.

On a crystal set the functioning of the amplifier leaves something to be desired and it is suggested that cascade arrangements of these amplifier units would provide fruitful results, besides affording interesting experimentation. If a low resistance loud speaker is not procurable, a step-up transformer will come in handy. This may be a modulation transformer or an ordinary telephone induction coil. Fig. 4 shows the circuit by which this may be done. For the cascade arrangement, Fig. 3 gives the hook-up.

An Unusual Meteorite

(*Continued from page 344*)

gauged from the fact that it penetrated twenty-three layers of tightly packed straw.

The incandescent mass set fire to the center of the stack, but owing to the absence of sufficient air, the straw did not break into a blaze until combustion had progressed slowly outwards to the surface. *The hole made by the meteorite in entering thus remained clearly observable for some hours.*

Examination of the cooled and solidified substance of the meteorite, supplemented by observations of the stack prior to its burning out, lead one to believe that it had a definite shape, with a distinct head and tail. The meteoric material collected weighed some six tons, with a total volume of some five hundred cubic feet (approximately 8 x 8 x 8 feet). These data, and the small size of the hole originally made by it in the stack, appear to warrant the supposition that when travelling through the air, its shape must have been that of a small and elongated comet, of molten and vaporous consistency.

The substance of the meteorite, of which samples have been sent for expert analysis, appears to an unskilled observer to include three fairly distinct classes of material. Firstly, at the point where the head of the meteorite presumably reached, it consisted mainly of a dull slate-grey igneous rock, fairly heavy, and marked with spots and veins of dark turquoise blue. Secondly, there was a certain quantity of jet black highly glazed slag resembling black volcanic lava, with numerous air pockets and similar turquoise veins. Lastly, and roughly where the tail would have ended up, were quantities of material resembling grey coke in appearance and weight.

All the material is very friable, most of it being comparatively light.

A curious feature is that, at any rate to an untrained eye, there are no traces of the pure iron which is commonly seen in small meteorites.

Contributed by MAJOR COL. BRONLOW,
Staff College, Quetta, Baluchistan, India.

Man-Made Lightning

(*Continued from page 323*)

far made in the high tension laboratory at Pittsfield shows that the disruptive strength of water is much greater than that of air. Between 1" spheres and with a gap of 1.5 centimeters or about ⅝", the impulse kilovolts to break down this gap in a globe filled with water was 165 K. V., while for the same spark gap in air but 46 K. V. were required. With a six centimeter or 2⅜" gap between 60 degree points on ½ inch rods the impulse kilovolts required to disrupt this gap in water was 156 K. V., while the same gap in air was disrupted by 56.5 K. V.

The impulse generator circuit employed by Mr. Peek comprised a high tension 60 cycle step-up transformer, with protective resistances connected to the secondary terminals, across which was connected the sphere or other spark gap. One side of this gap was grounded and across the gap was connected an inductance, resistance and capacity of known electrical dimensions. In this way all of the electrical phenomena taking place could be checked up mathematically.

The photographs herewith show the huge condenser built up of glass plates supported on rib post insulators. There are ten glass plates in each series of the frame. These plates are made of glass coated on both sides with tin-foil. The insulated stands as shown will hold forty-eight frames or cells, or a total of four hundred and eight condenser plates. The capacity per plate is .0112 microfarad, and per cell .00112 microfarad. The cells are readily arranged in multiple and series combinations as required. Three cells in series on each side operate satisfactorily at a million and a half volts maximum to ground. The resistance used in the shunt oscillatory circuit was a water tube having a value of 5,000 ohms.

How to Use Your Camera

(*Continued from page 359*)

This is also the place to mention the photography of the shadow produced by an artificial light. Around a metal shade, which has been inverted so that it points upward, four mirrors are attached with a thin band of iron or brass, that they are opposite each other, the light, reflected from the mirrors, being concentrated on the table below the lamp at one point. This then throws four shadows, one for each mirror. Now a clear piece of glass is taken, and placed upon four blocks so that it rests about an inch above the table. If a white piece of paper is placed under the glass upon the table, and if an object, such as a cube or a disk is placed upon the glass, four shadows will be thrown upon the paper, one partly overlapping the other, while another part is lighted by the reflected light of an opposite or adjacent mirror. In this way shadows of different intensity and tone value are thrown upon the paper.

To obtain these shadow pictures in their full tone value, is very easy, for a piece of printing paper need only be placed under the glass where the shadows are found. Before this is done, the source of light is covered with a piece of yellowish red envelope paper, which, of course, passes only non-actinic light, and the printing paper is placed under the glass, slightly weighting the edges so that it cannot curl. Then the yellow paper covering the light is removed, so that the paper can be exposed. An exposure of one minute will generally be sufficient when using a 50-watt tungsten lamp. The lighted paper is then developed as described under printing, it is fixed, washed and dried.

New X-Ray Plates

By DR. H. BECHER

(*Continued from page 344*)

part to yellow light. The photographs of the hand will demonstrate this point. In both cases half the plate was exposed to the action of yellow light before the X-ray pictures had been taken. Note that in one of them the effect of the exposure to yellow light has completely obliterated the details of the X-ray photograph, and, in fact, has almost totally destroyed the effect of the X-ray on that half of the plate. This is the ordinary photographic plate. With the Neo-Röntgen plate, however, the effect of the yellow light was almost nil. For this reason, developing the plate is considerably facilitated, as the plate can be exposed to yellow light and the attendant, who need not be a skilled operator, can examine the plate in a rather brilliant light without necessarily guessing at possible results. The examination of the plate under a ruby light is, therefore, completely done away with. It follows that if the new X-ray plate would come into general use, much clearer X-ray photographs would be possible; the time of exposure could be decreased; an unskilled operator could develop the plate in a room flooded with yellow light.

A Small Hydraulic Die and Punch Press

(*Continued from page 358*)

A valve is also included in the line from the top of the cylinder to the supply tank, and this continues to near the bottom of the tank.

A short pipe line is run from the upper portion of this supply tank, this, too, with a valve, and the end is upturned to take a small funnel. The grease is poured into the tank through the funnel until the lower end of the supply pipe is covered for a foot or more. The valve is then closed.

Next the air pump is started, with the valve in the outlet pipe closed, until the dial registers one hundred and fifty pounds. The die is now ready for use. When the discharge pipe valve is closed and the supply pipe opened, admitting the grease under pressure to the cylinder, the piston is forced down. When the metal has been formed, the supply pipe valve is closed, and the discharge pipe valve opened, freeing the grease as the coil springs force the piston back to its place. The process is then repeated.

Since grease cannot be compressed, the amount used each time is less than a half pint which accumulates in the discharge pipe. After the grease in the supply tank runs low, the air is released and the grease again transferred to the supply tank.

Since heavy grease is used, there will be no leakage past the rings, if they have been made accurately.

Assuming a working pressure of one hundred and fifty pounds then the formula would be πR^2 to find the total pressure.

2×2 equals four $\times$ 3.1416 equals 12.5664, and 12.5664 $\times$ 150 equals 1884.96 lbs. or the total pressure, discounting no loss by friction. Assuming that this loss is 8% or 150.77 lbs. then the total pressure will be 1728.18 lbs.

Practical Chemical Experiments

By RAYMOND B. WAILES

(*Continued from page 355*)

absorption of oxygen in the air surrounding the funnel by the alkaline pyrogallate solution in the funnel. Gently pinch the rubber tube. A bubble of air will rise through the liquid in the funnel and the liquid will enter the test tube. Keep the funnel almost full of the liquid and when the level ceases to sink, invert the test tube and clamp it in the position shown in the photograph. Keep the level of the liquid in the funnel and in the test tube on the same horizontal line as shown, and tie a string or spring a rubber band around the test tube at the level of the surface of the liquid. Also secure a string or rubber band around the tube at the level of the inner end of the stopper in the test tube. Unclamp the whole set-up and rinse with water. Now pour water into the tube until it comes to the mark marking the inner end of the stopper, and measure in cc, the amount of water. Call this number "Y." Measure the water contained in the test tube up to the other string, and call this number of cc "O." Multiply this last number in cc ("O") by 100 and divide by the number of cc "Y." This will give the per cent of oxygen in the air in the tube, or, in the atmosphere. For instance: Y is found to be 30.5 cc; X, 6.4 cc. Then:

30.5 : 6.4 :: 100 : B

or, when this is calculated, B, or the per cent oxygen is found to be 21.

The alkaline pyrogallate combines chemically with the oxygen, and causes a vacuum in the test tube, this sucking more of the liquid in until the pressure inside equals that of the outside air. Rotating the test tube serves to faciliate the absorption of the oxygen. The test tube should be handled as little as possible for the heat of the hand will temporarily expand the remaining nitrogen in the tube and lower the result.

(*Concluded in next issue.*)

Uncle Sam "Keeps Tab" on Fliers

(*Continued from page 343*)

bulletin board. Chairs, tables and lockers in which to deposit equipment are among the facilities at the disposal of aviators visiting Bolling Field.

Wireless telegraphy, quite obviously, is the supporting vehicle whereby the War Department keeps momentary track of the progress of its aircraft in flight. Not only is the operations office at Washington equipped with complete radio apparatus, but wireless facilities are in service at the other important points along the airway.

Radio for the Beginner

(*Continued from page 366*)

switches takes a lot of time and sometimes inspires cuss words. When the operator at last gets wise and wires the outfits to convenient switches so that the change can be made in an instant, he always wonders why he did not have sense enough to do it at the start.

Some of the switches common on radio receivers seem to puzzle beginners. A ten-point switch, or a seven-point switch, or one in which a lever or tongue makes contact with any number of points as it moves through the arc of a circle, merely cuts in one or more inductance coils or more or fewer turns of the same coil. The beginner may understand it better if he imagines himself an incoming electron on an antenna. He presents himself at Gate No. 1 of a big railroad station, the radio receiver, because he wants to go out on Track No. 1. For reasons best known to the station master, all the gates are barred except No. 9, so the electron has to make the long circuit up through Gate No. 9 and come back to Track No. 1. Each switch point represents a certain distance that the current must travel in going from the antenna to the ground. The shorter the wave-length, the shorter the distance. This switch sometimes has two arms, making two contacts at the same time. This is because of the design of the windings and connections inside. The leading arm usually governs the amount of inductance in the circuit at any given setting.

Switch parts can be purchased and assembled by beginners. Even the multi-point switch is easy to put together after the purchaser has the necessary knob, lever, points and stops.

One of the most ingenious switches ever developed is the series-parallel switches. The function which gave it its name is to change a condenser (for example one used to lengthen or shorten the fundamental wave-length of an antenna circuit), from a series connection, which shortens the wave-length, to a parallel connection, which lengthens the wave. It has many other uses, including: connecting an instrument, such as a meter, to either of four circuits; changing aerial and ground connections from one set to another; changing connection from loud speaker to phone; cutting batteries in and out; connecting batteries so that they can be used with two or more sets, one at a time; reversing polarity at the terminals of the set; connecting phones with either of two or more sets; putting a battery on charge or discharge, etc.

Advanced Chemistry

By JACK G. HUEKELS

(Continued from page 332)

Up and down spasmodically on the laboratory floor came the two hundred and ninety pounds with the professor thrown in.

Bottles tumbled from the shelves. Furniture was upset. Precious liquids flowed unrestrained and unnoticed. Finally the professor dropped with exhaustion and the rat and Mag Nesia made a dash for freedom.

Early in the morning pedestrians on Arlington Avenue were attracted by a sign in brilliant letters.

DEATH IS ONLY A DISEASE.
IT CAN BE CURED BY
PROFESSOR PAUL CARBONIC

Professor Carbonic in the morning betook himself to the nearest hardware store and purchased the tools necessary for his new profession. He was an M.D. and his recently acquired knowledge put him in a position to startle the world. Having procured what he needed he returned home.

Things were developing fast. Mag Nesia met him at the door and told him that Sally Soda, who was known to the neighborhood as Sal or Sal Soda generally, had fallen down two flights of stairs, and to use her own words was "Putty bad." Sal Soda's mother, in sending for a doctor, had read the elaborate sign of the new enemy of death, and begged that he come to see Sal as soon as he returned.

Bidding Mag Nesia to accompany him, he went to the laboratory and secured his precious preparation. Professor Carbonic and the unwilling Mag Nesia started out to put new life into a little Sal Soda who lived in the same block.

Reaching the house they met the family physician then attendant on little Sal. Doctor X. Ray had also read the sign of the professor and his greeting was very chilly.

"How is the child?" asked the professor.

"Fatally hurt and can live but an hour." Then he added, "I have done all that can be done."

"All that *you* could do," corrected the professor.

With a withering glance, Doctor X. Ray left the room and the house. His reputation was such as to warrant no intrusion.

—AND THE CHILD LIVES

"I am sorry she is not dead, it would be easier to work, and also a more reasonable charge." Giving Mag Nesia his instruments he administered a local anesthetic; this done he selected a brace and bit that he had procured that morning. With these instruments he bored a small hole into the child's head. Inserting his hypodermic needle, he injected the immortal fluid, then cutting the end off a dowel, which he had also procured that morning; he hammered it into the hole until it wedged itself tight.

Professor Carbonic seated himself comfortably and awaited the action of his injection, while the plump Mag Nesia paced or rather waddled the floor with a bag of carpenter's tools under her arm.

The fluid worked. The child came to and sat up. Sal Soda had regained her pep.

"It will be one dollar and twenty-five cents, Mrs. Soda," apologized the professor. "I have to make that charge as it is so inconvenient to work on them when they are still alive."

Having collected his fee, the professor and Mag Nesia departed, amid the ever-rising blessings of the Soda family.

At 3:30 P. M. Mag Nesia sought her employer, who was asleep in the sitting room.

"Marse Paul, a gentleman to see you."

The professor awoke and had her send the man in.

The man entered hurriedly, hat in hand. "Are you Professor Carbonic?"

"I am. what can I do for you?"

"Can you——?" the man hesitated. "My friend has just been killed in an accident. You couldn't——" he hesitated again.

"I know that it is unbelievable," answered the professor, "But I can."

A TOUGH CASE

Professor Carbonic for some years had suffered from the effects of a weak heart. His fears on this score had recently been entirely relieved. He now had the prescription—Death no more! The startling discovery, and the happenings of the last twenty-four hours had begun to take effect on him, and he did not wish to make another call until he was feeling better.

"I'll go," said the professor after a period of musing. "My discoveries are for the benefit of the human race, I must not consider myself."

He satisfied himself that he had all his tools. He had just sufficient of the preparation for one injection; this, he thought, would be enough; however, he placed in his case, two vials of different solutions which were the basis of his discovery. These fluids had but to be mixed, and after the chemical reaction had taken place the preparation was ready for use.

He searched the house for Mag Nesia, but the old servant had made it certain that she did not intend to act as nurse to dead men, on their journey back to life. Reluctantly he decided to go without her.

"How is it possible!" exclaimed the stranger, as they climbed into the waiting machine.

"I have worked for fifteen years before I found the solution," answered the professor slowly.

"I cannot understand on what you could have based a theory for experimenting on something that has been universally accepted as impossible of solution."

"With electricity, all is possible; as I have proven." Seeing the skeptical look his companion assumed, he continued. "Electricity is the basis of every motive power we have; it is the base of every formation that we know." The professor was warming to the subject.

"Go on," said the stranger, "I am very interested."

"Every sort of heat that is known, whether dormant or active, is only one arm of the gigantic force electricity. The most of our knowledge of electricity has been gained through its offspring, magnetism. A body entirely devoid of electricity, is a body dead. Magnetism is apparent in many things including the human race, and its presence in many people is prominent."

"But how did this lead to your experiments?"

"If magnetism or motive force, is the offspring of electricity, the human body must and does contain electricity. That we use more electricity than the human body will induce is a fact; it is apparent therefore that a certain amount of electricity must be generated within the human body, and without aid of any outside forces. Science has known for years that the body's power is brought into action through the brain. The brain is our generator. The little cells and the fluid that separate them, have the same action as the liquid of a wet battery; like a wet battery this fluid wears out and

(Continued on page 380)

Advanced Chemistry

(*Continued from Page 378*)

we must replace the fluid or the sal ammoniac or we lose the use of the battery or body. I have discovered what fluid to use that will with the brain cells produce the electricity which the human body is unable to induce."

"We are here," said the stranger as he brought the car to a stop at the curb.

"You are still a skeptic," noting the voice of the man. "But you shall see shortly."

The man led him into the house and introduced him to Mrs. Murray Attic, who conducted him to the room where the deceased Murray Attic was laid.

Without a word the professor began his preparations. He was ill, and would have preferred to have been at rest in his own comfortable house. He would do the work quickly and get away.

THE PROFESSOR OPERATES ON A DEAD ONE

Selecting a gimlet, he bored a hole through the skull of the dead man; inserting his hypodermic he injected all of the fluid he had mixed. He had not calculated on the size of the gimlet and the dowels he carried would not fit the hole. As a last resource he drove in his lead pencil, broke it off close, and carefully cut the splinters smooth with the head.

"It will be seventy-five cents, madam," said the professor as he finished the work.

Mrs. Murray Attic paid the money unconsciously; she did not realize, whether he was embalming her husband or just trying the keenness of his new tools. The death had been too much for her.

THE DEAD COME TO LIFE

The minutes passed and the dead man showed no signs of reviving. Professor Carbonic paced the floor in an agitated manner. He began to be doubtful of his ability to bring the man back. Worried he continued his tramp up and down the room. His heart was affecting him. He was tempted to return the seventy-five cents to the prostrate wife when—THE DEAD MAN MOVED!

The professor clasped his hands to his throat, with his head thrown back dropped to the floor. A fatal attack of the heart.

He became conscious quickly. "The bottles there," he whispered, "Mix—, make injection." He became unconscious again.

The stranger found the gimlet and bored a hole in the professor's head, hastily seizing one of the vials, he poured the contents into the deeply made hole. He then realized that there was another bottle.

"Mix them!" shrieked the almost hysterical woman.

It was too late, the one vial was empty, and the professor's body lay lifeless.

In mental agony the stranger grasped the second vial and emptied its contents also into the professor's head, and stopped the hole with the cork.

Miraculously professor Carbonic opened his eyes, and rose to his feet. His eyes were like balls of fire; his lips moved inaudibly, and as they moved little blue sparks were seen to pass from one to another. His hair stood out from his head. The chemical reaction was going on in the professor's brain, with a dose powerful enough to restore ten men. He tottered slightly.

Murray Attic, now thoroughly alive sat up straight in bed. He grasped the brass bed post with one hand and stretched out the other to aid the staggering man.

He caught his hand; both bodies stiffened; a slight crackling sound was audible; a blue flash shot from where Attic's hand made contact with the bed post; then a dull thud as both bodies struck the floor. Both electrocuted, and the formula still a secret.

Speed

By HAROLD F. RICHARDS, Ph.D.

(*Continued from page 337*)

logarithm of 2, which is 0.69315; multiply the latter by the product of the resistance and the capacity, which are, say, 1200 ohms and 0.0000002 farad (0.2 m.f.), respectively, and we have as a result the time, which is 0.000167 second. Dividing this number into the distance between the two contacts, one-half foot, say, we find the speed of the bullet to have been 3,000 feet per second, or 2,040 miles per hour.

CHECKING THE ERROR IN MEASUREMENTS

By adding one resistance and two switches to the apparatus shown in Fig. 2, we can easily detect any error that may have resulted from inaccuracy of the galvanometer. The modified instrument is shown in Fig. 3. Here, when the battery switch is closed on side 1, the current flows through C_1, R_2, R_1, and back to the battery; but the condenser is charged only to the voltage-drop across the terminals of R_1. When the bullet breaks contact C_1, the condenser discharges through R, until C_2 is broken, and then remains insulated with its residual charge as before. The next step brings the check on the accuracy of the previous determination. Switch S is now closed, and the battery switch is reversed, so that current again flows through the battery circuit; and then key K is depressed, automatically connecting the condenser across the terminals of R_1. The height h, the battery voltage, and the resistances R_1 and R_2 have been so chosen that, *if the previous determination of the speed of the bullet was correct*, the voltage of the condenser, after the bullet has been fired, will be exactly equal to the voltage-drop across R_1. *That any deflection whatsoever of the sensitive galvanometer is due entirely to the error of the previous determination*, provided, of course, that the two bullets traveled at the same speed. In practice, the speed of a given projectile is usually known approximately before the measurement, so that the investigator can use the more refined instrument at the beginning, setting it at the expected speed and then correcting that speed, in the manner described, to one part in one million.

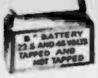
HOW MAGNETIC INDUCTION MEASURES SPEED OF SHELLS

The foregoing method is not well adapted for making several determinations of the speed of the same projectile at different points of its path, owing to the fact that the shell must necessarily touch solid objects and may therefore be deflected or slightly slowed. Measurements of such a nature are necessary, however, in order to test the effect of air-resistance, and accordingly the ballisticians of the U. S. Ordnance Division, notably Dr. G. F. Hull have recently perfected a device which does not require the shell to touch anything but air. This apparatus, entirely electrical in nature, is shown in Fig. 4. The large steel

(*Continued on page 385*)

BUILD YOUR SET WITH BARAWIK STANDARD RADIO GOODS

PLATE CIRCUIT "B" BATTERIES



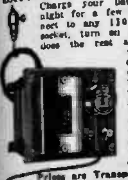
You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

X190 Signal Corps Type. Small size. 15 cells. 22½ volts. Each....95c

X184 Variable Large Navy size, 6⅝x4x3 inches. 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each....$1.80

X180 Combination Tapped 45 volts 30 cell, 13x4x3 battery. Tapped to give 45, 22½, 21, 19½, 18 and 16½ volts. Handles both detector and amplifier tubes. Each......$3.55

HOMECHARGER BATTERY CHARGING RECTIFIER

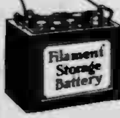


Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

Prices are Transportation Paid.

X201 For 6 volt battery....................$12.05
X203 For 12 volt battery....................12.95

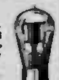
STORAGE "A" BATTERY



A ... battery made especially for radio service. Guaranteed for three years. Properly cared for will give many more years of service for filament lighting. Made of best raw materials. Full capacity. The best battery buy on the market. Try one of these batteries on your set for 10 days. If at the end of that time you are not fully satisfied with the battery return it and we will refund the purchase price.

X194 6 volt, 40 ampere size. Each...$10.00
X196 6 volt, 80 ampere size. Each... 12.50

VACUUM TUBES



Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

X105 Detector. UV200 C300 Ea. $4.30
X112 Amplifier, UV201A C301A 5.95
X110 5 Watt Transmitter...... 7.70
X107 WD11 1½ v. Fil. Each.............$5.95
X101 WD12. Each.............5.95
X102 UV199. Each.............5.95
X103 UV199 Socket.............49c
X104 UV199 Adapter.............49c
X108 WD12 Socket Each.............49c
X109 WD11 Adapter. Each.............49c

FILAMENT CONTROL RHEOSTATS

Best grade. High heat resisting base. Diam. 2½ in. cap. 1½ amp. Resist. 6 ohms. 1½ in. knob with pointer, 75c value.

X132 Each....................45c

X131—25 Ohm Rheostat for 201A 201A tubes....................65c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 200 ohms.

X133 Each....................90c

VERNIER RHEOSTAT

Gives exceedingly fine control of "A" battery current. A necessity for best receiving results.

X135 Each....................89c

VACUUM TUBE SOCKETS

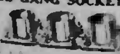
Our Special Socket. A wonderful value. Moulded entirely of brown bakelite. Four binding post connections. Right angled contact springs.

X140 Each....................39c

High Grade combination type for panel or table mounting. Metal tube. High insulation base. One of the best sockets made.

X144 Each....................45c

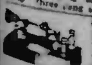
TWO AND THREE GANG SOCKETS



These sockets make it easy to build detector and amplifier units and make a neat, compact workmanlike job. Perfectly made of high grade materials. Quickly mounted on panel or base.

X147 Two gang socket....................$1.05
X148 Three gang socket....................1.45

GALENA DETECTOR



Easy fine adjustment. Crystal mounted in cup. Moulded base and knob. Brass parts polished nickel finish. An unequaled value.

X732 Each....................50c

DETECTOR CRYSTALS CARE-FULLY TESTED

X736 Galena, Arlington tested, per piece 10c
X736 Silicon, Arlington tested, per piece 10c
X736 Tested Galena, per piece.......... 8c
X737 Tested Silicon, per piece.......... 8c

WE PAY TRANSPORTATION CHARGES EAST OF THE ROCKIES

THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

FAST SERVICE—TRY US AND BE CONVINCED

THIS GUARANTEE PROTECTS YOU—Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

"HONEYCOMB" COILS

Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art No.	Not Mntd.	Art No.	Price Mntd.
25	120- 250	X301	$0.39	X320	$0.89
35	175- 450	X302	.42	X322	.96
50	240- 720	X303	.49	X323	1.04
75	390- 910	X304	.54	X324	1.08
100	500- 1450	X305	.58	X325	1.13
150	600- 2000	X306	.63	X326	1.17
200	900- 2500	X307	.72	X327	1.26
250	1200- 3500	X308	.78	X328	1.35
300	1500- 4500	X309	.82	X329	1.36
400	2000- 5000	X310	.97	X330	1.57
500	2800- 6100	X311	1.12	X331	1.63
600	4000-10000	X312	1.27	X332	1.78
750	5000-12000	X313	1.43	X333	1.93
1000	7900-15000	X314	1.70	X334	2.28
1250	9750-19500	X315	1.92	X335	2.49
1500	14500-26500	X316	2.18	X336	2.65

COIL MOUNTINGS

X340 Three-coil mounting.............$3.95
X341 Two-coil mounting.............$2.95

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

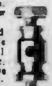
RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks Only:
X390 Open circuit. Each.........43c
X391 Closed circuit. Each.........49c
X392 Two circuit. Each.........60c
X393 Single circuit filament cont. 69c
X394 Two circuit filament cont. 85c

X395 Plug. Large space with set screws for attaching cord. Each....................35c

BINDING POSTS

Brass, polished nickel finish. Washer and 6-32 in. screw extending ⅜ in.

X370 Large size—barrel and knob ⅜ in. long, dozen...85c
X372 Smaller size — barrel and knob 9-16 in. long, dozen....................70c
X374 Large size with composition knob, dozen.........50c
X376 Large size with hole for phone tip or wire, dozen....................60c
X378 Small size with hole for phone tip or wire, dozen....................35c

SWITCH CONTACT POINTS

Brass polished nickel finish. All have ⅛ in. long also 6-32 screws and two nuts. All prices the same. Dozen 18c. Hundred $1.05. Order by Article Number.

X360 Head, ¼ in.; Diam. ¼ in. High
X362 Head, 3-16 in.; Diam. ¼ in. High
X363 Head, 3-16 in.; Diam. 1-16 in. High

SWITCH LEVERS

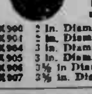
Moulded composition knob. Exposed metal parts polished nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

X382 1½ in. Radius }
X381 1¼ in. Radius } 45c. Ea.
X380 1 in. Radius }

SWITCH LEVER STOP

Brass, polished nickel finish.
X386—Dozen 18c. Hundred $1.05

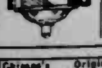
ONE-PIECE DIAL AND KNOB



Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

X900 2 in. Diam. for 3-16 in. shaft. Ea.......19c
X901 2 in. Diam. for ¼ in. shaft. Ea.......19c
X904 3 in. Diam. for 3-16 in. shaft. Ea.......25c
X905 3 in. Diam. for ¼ in. shaft. Ea.......25c
X906 3½ in. Diam. for 3-16 in. shaft. Ea.......35c
X907 3½ in. Diam. for ¼ in. shaft. Ea.......35c

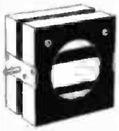
OUTDOOR LIGHTNING ARRESTER



X000 Price....................$1.50

Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

VARIOMETER

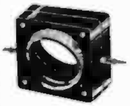


X410—Completely assembled, price $2.69

Perfect in design and construction. Accurate wood forms of genuine solid mahogany. Correct inductive ratios. Solid baked windings. Positive contacts. Highest efficiency. A real bargain.

X411—Not assembled nor wound but all parts complete except wire, including winding form, $1.48

MOULDED VARIOMETER



Polished black moulded rotor and stator forms. Maximum inductance with greatest efficiency and minimum distributed capacity. A high grade durable instrument that will make up into a set you will be proud of and will get the best results. Wave length 180 to 600 meters. 4¾ in. square, 1⅞ in. thick.

X412 Price including mounting brackets $3.45

IMPROVED 180° VARIO-COUPLER

X418 Price.........$2.89

Our price gives you a big saving. An instrument of highest quality. The most efficient type of coupler. Insures sharper tuning and louder signals. Primary and secondary wound on genuine bakelite tubes. Secondary connections through soldered flexible cables eliminates contact noises. Primary has 7 taps. Can be panel or table mounted. Range 180 to 650 meters.

MAGNET WIRE

Insulated copper wire. Best quality even drawn wire, one piece to a spool. Prices quoted are for 8 oz. spools.

Double Cotton Covered		Enameled Insulation		Green Silk Covered	
Number X990		Number X992		Number X991	
Gauge	Price	Gauge	Price	Gauge	Price
18	50c	20	45c	20	$0.78
20	60c	22	55c	22	.90
22	75c	24	61c	24	1.05
24	85c	26	65c	28	1.10
26	95c	30	70c	30	1.70
28	$1.15	32	79c	32	2.05
30	1.65	36	98c	36	2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for aerials.

X248—100 ft. coil 72c X249—500 ft. coil $3.20

SOLID BARE COPPER WIRE

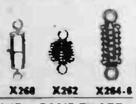
Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
X240—100 ft. coil 49c X242—500 ft. coil $2.35

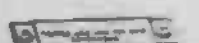
Solid Bare Copper Wire, size 12
X244—100 ft. coil 67c X245—500 ft. coil $3.05

ANTENNA INSULATORS

X260 Size 1x3¼. Two for.........17c
X262 Size 2¼x3¼. Two for.........33c
X264 Size 1⅜x4. Two for.........60c
X266 Size 1⅜x10¼. Two for.........$1.23



PHONE AND GRID CONDENSERS



A compact style of condenser that is very satisfactory. Conducting sheets and dielectric are wound on fiber strip with eyelets for mounting and connections. Each 12c

X170 Phone Condenser .001 Mfd.
X172 Phone Bridging Condenser .0005 Mfd.
X174 Grid Condenser .00025 Mfd.
X175 Condenser .006 Each....................28c
X176 Grid Condenser .00025 with pencil mark leak. Each....................24c

TUBULAR GRID LEAKS AND CONDENSERS—MOUNTED STYLE

Very convenient. Permits quick change of leaks or condensers of varying capacities.

Grid Leaks Price Each....................26c

Resistance		Resistance	
X850	.5 Meg.	X855	2. Meg.
X851	1 Meg.	X857	3. Meg.
X853	1.5 Meg.	X858	5. Meg.

GRID AND PLATE CONDENSERS

Price, each....................55c

X852 .0001 Mfd. For special circuits.
X434 .00025 Mfd. For U.V.201 and Cun. 301
X436 .0005 Mfd. For U.V.200 and Cun. 300

MOUNTINGS

Bakelite base. Spring clip contact.

X840 Single mounting. Each.............32c
X842 Double mounting. Each.............57c
X844 Triple mounting. Each.............78c

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

X234 10 to 1 Mounted. Each.............$3.46
X235 10 to 1 Unmounted. Each.............2.85
X236 3 to 1 Mounted. Each.............3.40
X237 3 to 1 Unmounted. Each.............2.85

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

X812 43 plate .001 Mfd. $1.73
X813 21 plate .0005 Mfd. 1.43
X814 11 plate .00025 Mfd. 1.32
X815 3 plate Vernier.... .98

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Fine polished end plates of heavy bakelite. Shafts ¼ inch diameter. Sturdy, heavy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS

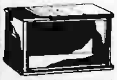
X824 23 plate .0005 Mfd. with dial and knobs. Price....$2.89
X826 43 plate .001 Mfd. with dial and knobs. Price....$3.45

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial mounted with a three plate vernier condenser, which is controlled by separate knob mounted above knob on dial. This arrangement permits of very fine tuning. Compact convenient mounting on panel. High grade design and construction. Finely finished.

STANDARD BRAND HEADSETS

X754 Baldwin Type C with universal jack plug.........$11.75
X755 Baldwin Type C unit with cord $5.50
X756 Red-Head, 3000 ohm.........5.76
X768 Brandes, 2000 ohm.........5.90
X770—2000 ohm Rarawik.........3.75
X751 Murdock 56, 2000 ohm.........4.20
X752 Murdock 56, 3000 ohm.........4.95
X764 Frost, 2000 ohm.........4.20
X766 Frost, 3000 ohm.........$4.85
X758 Western Electric, 2200 ohm.........9.50

CABINETS



Fine looking cabinets solidly built. Elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions			Art. No.	Price Each
	High	Wide	Deep		
6x 7"	5½"	6½"	7"	X420	$2.48
6x10½"	5½"	10"	7"	X422	2.75
6x14"	5½"	13½"	7"	X424	3.30
7x14"	6½"	13½"	7"	X423	3.60
7x18"	6½"	17½"	7"	X426	3.90
7x21"	6½"	20½"	7"	X425	4.20
9x14"	8½"	13½"	10"	X428	3.70
12x14"	11½"	13½"	10"	X430	4.40
12x21"	11½"	20½"	10"	X432	5.25

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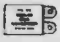
Notice our very low prices on this fine quality material. We supply genuine Bakelite, Condensite Celeron or Formica, all of which are materials with practically identical mechanical, chemical and electrical properties. Machines well without chipping. Won't warp. Waterproof. Highest mechanical and dielectric strength. Attractive natural polished black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick		3-16" thick		¼" thick	
	Art No.	Price	Art No.	Price	Art No.	Price
6x7	X450	$0.50	X460	$0.75	X470	$0.98
6x10½	X451	.75	X461	1.11	X470	1.47
6x14	X452	1.05	X462	1.55	X472	2.05
7x14	X458	1.20	X468	1.80	X478	2.40
7x18	X453	1.55	X463	2.30	X473	3.10
7x21	X457	1.70	X467	2.65	X477	3.60
9x14	X454	1.60	X464	2.30	X474	3.10
12x14	X455	2.10	X465	3.10	X475	4.15
12x21	X456	3.15	X466	4.65	X476	6.20

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed. X160 Each.........10c

GRID CONDENSER



X162 Mounting holes spaced to fit lugs of above leak. Cap. .00025 MF..........10c

X163 Same as 162 but higher grade. Enclosed in metal case..........39c

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3. Loose Coupler with Crystal Detector.
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5. Plain Audion Detector Circuit.
6. Feed-back Circuit with a loose Coupler.
7. Armstrong Feed-back Circuit.
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10. Short Wave Regenerative set, with 2 step amplifier.
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16. Radio and Audion frequency amplifier.
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Including Two Interchangeable Inductance Coils

NATIONAL MONODYNE TUBE SET

PAT. TRADE MARK

MODEL GT-1

THE IDEAL VACATION SET

CLARITY *VOLUME* *DISTANCE* *SIMPLICITY* *ECONOMY*

For many months our radio engineers have been exerting their efforts toward developing the ideal tube set. They knew that millions of homes would welcome the low priced instrument that embodied simplicity of operation with a minimum cost of up-keep. They wanted an instrument that would bring in volume and distance, clear and loud, **with a single control**, an instrument that would be classed as a work of art, the possession of which anyone would be proud. That their untiring efforts have been crowned with success is now certain.

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The tube socket is of a new design and most practical because it holds the tube with a positive grip on all four prongs for a depth of more than one-quarter of an inch.

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In our New York laboratory tests, we repeatedly heard stations ... Chicago, WOC at Davenport, Iowa, and many others, quite loud and ... This without resorting to any mode of amplification.

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With the outfit are furnished two interchangeable ... ed double inductance coils, ranging from 200 to 600 meters.

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Gentlemen:
Please send me prepaid One (1) NATIONAL MONODYNE tube set, Model GT-1, for which I will pay the postman $10.00.
If within five days I do not find the apparatus all you claim for it, I may return same to you in good condition and you will refund the full purchase price.

NAME ....

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NATIONAL AIRPHONE CORPORATION

20 HUDSON ST. NEW YORK

Speed

(Continued from page 380)

shell, 3 or 6 inches in diameter, for example, is first magnetized and then projected so as to pass successively through the centers of two solenoids. The momentary change of magnetic induction through these coils of wire, due to the magnetic field which the shell carries with it, produces two instantaneous surges of current in the primary circuit, separated in time by the period required for the shell to pass from the center of one coil to the center of the other. These two currents induce corresponding surges in the secondary, and are recorded photographically as a result of including the element of an oscillograph in the secondary circuit. The oscillograph resembles a string galvanometer, having a wire or a particle of iron suspended under stress in a magnetic field, so that the passage of a momentary surge of electricity causes the element to be deflected. A very small mirror is attached to the sensitive element of the oscillograph, and a narrow beam of light is reflected from the mirror to the moving film. When the mirror is at rest, the resulting photographic trace is a straight line; but when the mirror is deflected by the electro-magnetic force, there is a corresponding deflection of the photographic trace. Thus the passage of the magnetized shell through the two coils of wire produces two sharp peaks on the film, and as soon as we know the speed of the moving film we can determine the time interval corresponding to the distance between the peaks.

The ordinary means of measuring speeds of rotation are not sufficiently accurate to be relied upon for a measure of the excessively short period of time required for the shell to travel two or three feet, and so a time calibration is placed on the film simultaneously with the oscillograph record. For this purpose a fine slit is attached to one prong of a tuning fork vibrating at a constant rate of one or two thousand times per second, and a part of the beam of light from the arc is reflected by a series of prisms so that it can pass through the slit, and thus reach the moving film, only once during each vibration of the fork. By this means the ballistician is enabled to translate the distance between the two peaks into the corresponding time interval; and it is then a simple matter to divide this time into the distance between the two coils and so obtain the speed of the shell.

The great advantage of this magnetic chronograph over the condenser-discharge apparatus is that during a measurement the projectile touches no material substance other than air, so that by setting up similar coils at different points of the path of the shell a number of records of the same flight can be secured automatically. These successive records tell at once the falling off of speed per forward foot, due to air resistance, and can also be used to find what shape of shell is least affected by air-resistance. Furthermore, by enclosing the whole primary circuit in a huge pipe of great length, and using merely an inductive linkage with the measuring apparatus, the effect of varying the pressure and temperature of the air can be studied at will, on the ground. Such measurements permit military engineers to calculate exactly the advantage of firing long-range shells through the rarer air of the upper atmosphere—an advantage which the Germans seem only to have guessed at in bombarding Paris with their Big Berthas—and accordingly this new use of electricity removes any need of trying to manipulate the yardstick and the stopwatch in an airplane without getting hit.

The Man from the Atom

By G. PEYTON WERTENBAKER

(Continued from page 329)

With this little object in my lap, you could grow forever, until there was nothing left in the universe to surpass. Or you could shrink so as to observe the minutest of atoms, standing upon it as you now stand upon the earth. It is an invention that will make scientific knowledge perfect!" He halted with flushed face and gleaming eyes. I could find nothing to say, for the thing was collossal, magnificent in its possibilities. If it worked. But I could not resist a suspicion of so tiny a machine.

"Professor, are you in absolute earnest?" I cried.

"Have I ever jested about so wonderful a thing?" he retorted quietly. I knew he had not.

"But surely that is merely a model?"

"It is the machine itself!"

II

I was too astounded to speak at first. But finally, "Tell me about it," I gasped. "This is certainly the most fantastic invention you have made yet! How does it work?"

"I am afraid," suggested Professor Martyn, "that you could not understand all the technical details. It is horribly complicated. And besides, I am anxious to try it out. But I will give you an idea of it.

"Of course, you know that an object may be divided in half forever, as you have learned in high school, without being entirely exhausted. It is this principle that is used in shrinking. I hardly understand the thing's mechanism myself—it was the result of an accident—but I know that the machine not only divides every atom, every molecule, every electron of the body into two exactly equal parts, but it accomplishes the same feat in itself, thus keeping pace with its manipulator. The matter it removes from the body is reduced to a gaseous form, and left in the air. There are six wires that you do not see, which connect with the body, while the machine itself is placed on the chest, held by a small belt that carries wires to the front of the body where the two controlling buttons are placed.

"When the user wishes to grow, he presses the upper button, and the machine then extracts atoms from the air which it converts, by a reverse method from the first, into atoms identical to certain others in the body, the two atoms thus formed joining into one large particle of twice the original size.

"As I said, I have little idea of my invention except that it works by means of atomic energy. I was intending to make an atomic energy motor, when I observed certain parts to increase and diminish strangely in size. It was practically by blind instinct that I have worked the thing up. And now I fear I shall not be able to discover the source of my atomic energy until I can put together, with great care, another such machine, for I am afraid to risk taking this apart for analysis."

"And I," I said suddenly, with the awe I felt for such a discovery quite perceptible, I fear, in my tone, "I am to try out this machine?"

"If you are willing," he said simply. "You must realize, of course, that there are a multitude of unknown dangers. I know nothing of the complete effects of the machine. But my experiments on inanimate objects have seemed satisfactory."

"I am willing to take any risks," I said enthusiastically, "if you are willing to risk your great machine. Why, don't you realize, Professor, that this will revolutionize Science? There is nothing, hardly, that will be unknown. Astronomy will be complete, for there will be nothing to do but to increase in size enough to observe beyond our atmosphere, or one could stand upon worlds like rocks to examine others."

"Exactly. I have calculated that the effect of a huge foot covering whole countries would be slight, so equally distributed would the weights be. Probably it would rest upon tall buildings and trees with ease. But in space, of course, no support should be necessary.

"And then, as you said, one could shrink until the mysteries of electrons would be revealed. Of course, there would be danger in descending into apparent nothingness, not knowing where a new world-atom could be found upon which to stand. But dangers must be risked."

"But now, Kirby," remarked the Professor officially, "time passes, and I should like you to make your little journey soon that I may quickly know its results. Have you any affairs you would like to put in order, in case——"

"None," I said. I was always ready for these experiments. And though this promised to be magnificently momentous, I was all ready. "No, if I return in a few hours, I shall find everything all right. If not, I am still prepared." He beamed in approval.

"Fine. Of course you understand that our experiment must take place at some secluded spot. If you are ready, we can proceed at once to a country laboratory of mine that will, I think, be safe."

I assented, and we hastily donned our overcoats, the Professor spending a moment or two collecting a few necessary apparata. Then we packed the machine in a safe box, and left his home.

"Are you all ready, Kirby?" The Professor's voice was firm, but my practiced ear could detect the slightest vibrations that indicated to me his intense inner feelings. I hesitated a moment. I was not afraid of going. Never that. But there seemed something partaking almost of finality about this departure. It was different from anything I had ever felt before.

"All ready, Professor," I said cheerfully after a brief moment.

"Are you going to magnify or minimize yourself?"

"It shall be growth," I answered, without a moment's hesitation there. The stars, and what lay beyond. . . . It was that I cared for. The Professor looked at me earnestly, deeply engrossed in thought. Finally he said, "Kirby, if you are to make an excursion into interstellar space, you realize that not only would you freeze to death, but also die from lack of air."

Walking to a cabinet in the rear of the room, he opened it and withdrew from it some strange looking paraphernalia. "This," he said, holding up a queer looking suit, "is made of a great quantity of interlocking metal cells, hermetically sealed, from which the air has been completely exhausted so as to give the cells a high vacuum. These separate cells are then woven into the fabric. When you wear this suit, you will, in fact, be enclosed in a sort of thermos bottle. No heat can leave this suit, and the most intensive cold cannot penetrate through it."

I quickly got into the suit, which was not as heavy as one might imagine. It covered not only the entire body, but the feet and hands as well, the hand part being a sort of mitten.

After I had gotten into the suit, the Professor placed over my head a sort of transparent dome which he explained was made of strong unbreakable bakelite. The globe itself really was made of several globes, one within the other. The globes only touched at the lower rim. The interstices where the globes did not touch formed a vacuum, the air having been drawn from the spaces. Consequently heat could not escape from the transparent head piece nor could the cold come in. From the back of this head gear, a flexible tube led into the interior; this tube being connected to a small compressed oxygen tank, which the Professor strapped to my back.

He then placed the wonder machine with its row of buttons on my chest, and connected the six wires to the arm bands and other parts of my body.

Professor Martyn grasped my hand then, and said in his firm, quiet voice:

"Then goodbye, Kirby, for awhile. Press the first button when you are ready to go. May the Fates be with you!"

The Professor next placed the transparent head gear over my head and secured it with attachments to my vacuum suit. A strange feeling of quietness and solitude came over me. While I could still see the Professor, I could hear him talk no longer as sounds cannot pierce a vacuum. Once more the Professor shook my hand warmly.

Then, somehow, I found myself pressing down the uppermost of three buttons. Instantly there was a tingling, electric flash all through my body. Martyn, trees, distant buildings, all seemed to shoot away into nothingness. Almost in panic, I pushed the middle button. I stopped. I could not help it, for this disappearing of all my world acted upon my consciousness. I had a strange feeling that I was leaving forever.

I looked down, and Professor Martyn, a tiny speck in an automobile far below, waved up to me cheerfully as he started his car and began to speed away. He was fleeing the immediate danger of my growth, when my feet would begin to cover an immense area, until I could be almost entirely in space. I gathered my courage quickly, fiercely, and pressed the top button again. Once more the earth began to get smaller, little by little, but faster. A tingling sensation was all over me, exhilarating if almost painful where the wires were connected upon my forearms, my legs, about the forehead, and upon my chest.

It did never seem as though I was changing, but rather that the world was shrinking away, faster and faster. The clouds were falling upon me with threatening swiftness, until my head broke suddenly through them, and my body was obscured, and the earth below, save tiny glimpses, as though of a distant landscape through a fog. Far away I could see a few tall crags that broke through even as had I, scorning from their majestic height the world below. Now indeed, if never before, was my head "among the clouds!"

But even the clouds were going. I began to get an idea of the earth as a great ball of thick cloud. There was a pricking sensation beneath my feet, as though I stood upon pine needles. It gave me a feeling of power to know that these were trees and hills.

I began to feel insecure, as though my support were doing something stealthy beneath me. Have you ever seen an elephant perform upon a little rolling ball? Well that is how I felt. The earth was rotating, while I no longer could move upon it. While I pondered, watching in some alarm as it became more and more like a little ball, a few feet thick, it took matters in its own hand. My feet slipped suddenly off, and I was lying, absolutely motionless, powerless to move, in space!

I watched the earth awhile as it shrunk, and even observed it now as it moved about the sun. I could see other planets that had grown at first a trifle larger and were now getting smaller, about the same size as the earth, a tiny ball of some two inches thickness.

It was getting much darker. The sun no longer gave much light, for there was no atmosphere to diffuse it. It was a great blinding ball of fire near my feet now, and the planets were traveling about it swiftly. I could see the light reflected on one side, dark on the other, on each planet. The sun could be seen to move perceptibly too, though very slightly. As my feet grew larger, threatening to touch it, I hastily drew them up with ease and hung suspended in the sky in a half-sitting position as I grew.

Turning my head away all at once, I observed in some surprise that some of the stars were growing larger, coming nearer and nearer. For a time I watched their swift approach, but they gradually seemed to be getting smaller rather than larger. I looked again at my own system. To my amazement, it had moved what seemed about a yard from its former position, and was much smaller. The planets I saw no longer, but there were faint streaks of light in circles about the sun, and I understood that these were the tracks of the worlds that now moved about their parent too swiftly to be followed with the eye.

I could see all the stars moving hither and yon now, although they still continued to appear closer and closer together. I found a number lying practically on the plane of my chest, but above that they seemed to cease. I could now see no planets, only the tiny sun moving farther and farther, faster and faster along its path. I could discern, it seemed to me, a trend in its and its companions' paths. For on one side they seemed to be going one way, and the opposite way on the other. In front, they seemed to move across my vision. Gradually I came to understand that this was a great circle swinging vastly about me, faster and faster.

I had grown until the stars were circling now about my legs. I seemed to be the center of a huge vortex. And they were coming closer and closer together, as though to hem me about. Yet I could not move all of me away. I could only move my limbs and head in relation to my stationary body. The nearest star, a tiny bright speck, was a few yards away. My own sun was like a bright period upon a blackboard. But the stars were coming nearer and nearer. It seemed necessary for me to move somehow, so I drew my legs up and shot them out with all my force. I began to move slowly away, having acted upon what little material substance there was in the ether.

The stars were soon only a few feet apart below me, then a few inches, and suddenly, looking out beyond them, I was struck with the fact that they seemed to be a great group, isolated from a number of far distant blotches that were apart from these. The stars were moving with incredible swiftness now about a center near which was what I imagined to be the sun, though I had lost track of it somehow. They merged closer and closer together, the vast group shrunk more and more, until finally they had become indistinguishable as entities. They were all part of a huge cloud now, that seemed somehow familiar. What did it suggest? It was pale, diffused at the ends, but thick and white in the center, like a nebul—a nebula! That was it! A great light broke over me. All these stars were part of a great system that formed a nebula. It explained the mystery of the nebulae.

And there were now other nebulae approaching, as this grew smaller. They took on the resemblance of stars, and they began to repeat the process of closing in as the stars had done. The stars, universes within universes! And those universes but nebulae in another great universe! Suddenly I began to wonder. Could there be nothing more in infinity than universe after universe, each a part of another greater one? So it would seem. Yet the spell was upon me and I was not ready to admit such simplicity yet. I must go on. And my earth! It could not even be found, this sphere that had itself seemed almost the universe.

But my growth was terribly fast now. The other nebulae were merging, it would seem at first, upon me. But my slow progress through space became faster as I grew larger, and even as they came upon me like flying arrows now, I shot above them. Then they, too, merged. The result was a vast nucleus of glowing material.

A great light began to grow all above me. Above I suddenly observed, far away, a huge brightness that seemed to extend all over the universe. But it began definitely. It was as though one were in a great ball, and the nebulae, a sunlike body now, were in the center. But as I became larger with every instant, the roof-like thing diffused even as before things had converged, and formed into separate bodies, like stars. I passed through them finally, and they came together again behind me as I shot away, another great body.

A coincidence suddenly struck me. Was not this system of a great ball effect with a nucleus within similar to what the electron was said to be? Could the nucleus and its great shell be opposite poles of electrical energy, then? In other words, was this an electron—a huge electron composed of universes? The idea was terrible in its magnitude, something too huge for comprehension.

And so I grew on. Many more of these electrons, if such they were, gathered together, but my luck held and I passed beyond this new body thus formed—a molecule, I wondered? Suddenly I tired of the endless procession of stars coming together, forming ever into new stars that came together too. I was getting homesick. I wanted to see human faces about me again, to be rid of this fantastic nightmare. It was unreal. It was impossible. It must stop.

A sudden impulse of fear took hold upon me. This should not go on forever. I had to see my earth again. All at once, I reached down, and pressed the central button to stop.

But just as a swiftly moving vehicle may not stop at once, so could not I. The terrific momentum of my growth carried me on, and the machine moved still, though slower. The stars seemed shooting upon me, closing about me. I could see no end of them before me. I must stop or they would be about me.

Closer in they came, but smaller and smaller. They became a thousand pinpoints shooting about me. They merged into a thick, tenuous cloud about me, thicker and thicker. I was shooting up now, but my growth had stopped. The cloud became a cold, clammy thing that yielded to the touch, and—and it was water! Yes, pure water! And I was floating in it. . . .

Years. . . .

Suddenly I shot up, out of the water, and fell back. Strength returned to me, and warmth, and love of life. It was water, something I knew, something familiar, a friend. And so I swam, swam on and on until my feet touched bottom, and I was leaping forth out of the water, on to the sand. . . .

IV

There is no need to drag the tale out. I awoke finally from an exhausted sleep and found myself in a world that was strange, yet familiar. It might have been a lonely part of the earth, except for an atmosphere of strangeness that told me subconsciously it was another world. There was a sun, but it was far distant, no larger than my moon. And vast clouds of steam hung over the jungles beyond the sand, obscuring them in a shimmering fog, obscuring the sun so that it danced and glimmered hazily through the curtain. And a perpetual twilight thus reigned.

I tried to tell myself I was in some strange manner home. But I new I was not. At last, breaking beneath the weight of homesickness and regret, I surrendered to a fit of weeping that shamed my manhood even as I wept. Then a mood of terrible, unreasoning anger against Fate enveloped me, and I stormed here and there about the beach.

And so, all through the night, I alternately wept and raged, and when the dawn came I sank again in peaceful slumber. . . .

When I awoke, I was calm. Obviously, in stopping I told myself I had been left in a cloud of atoms that proved to be part of another group of matter, another earth or atom, as you will. The particular atoms I was in were part of the ocean.

The only thing to do was to return. I was ashamed of my madness now, for I had the means of return. In the third button . . . the bottom button. I saw no reason for delay. I splashed back into the water, and swam hastily out to the point where it seemed I had risen. I pushed the lowest button. Slowly I felt myself grow smaller and smaller, the sense of suffocation returned, only to pass away as the pinpoints shot about me again, but away this time. The whole nightmare was repeated now, reversed, for everything seemed to be opening up before me. I thrilled with joy as I thought of my return to my home, and the Professor again. All the world was friend to me now, in my thoughts, a friend I could not bear to lose.

And then all my hopes were dashed. How, I thought, could I strike my own earth again? For even if I had come to the right spot in the water to a certainty, how could I be sure I would pass between just the right cloud of molecules? And what would lead me to the very electron I had left? And, after the nucleus, why should I not enter the wrong nebula? And even if I should hit the right nebula, how should I find my own star, my own earth? It was hopeless, impossible! . . . And yet, so constituted is human nature that I could hope nevertheless!

My God! Impossible as it is, I did it! I am certain that it was my own nebula I entered, and I was in the center, where the sun should be. It sounds fantastic, it *is* fantastic. The luck of a lifetime, an infinity, for me. Or so it should have been. But I looked where the sun ought to be found, in the central cluster. I halted early, and watched long with a sinking heart. But the sun—was gone!

I lay motionless in the depths of space and I watched idly the stars that roamed here and there. Black despair was in my heart, but it was a despair so terrible that I could not comprehend its awfulness. It was beyond human emotion. And I was dazed, perhaps even a little mad.

The stars were tiny pinpoints of light, and they shot back and forth and all around like purposeless nothings. And ever would they collide, and a greater pinpoint would be born, or a thousand pieces of fragments would result. Or the two might start off on new tracks, only to collide again. Seconds it took them to cover what I knew to be billions of trillions of light-years.

And gradually the truth dawned upon me, the awful truth. These stars were suns, even as mine had been, and they grew and died and were reborn, it seemed now, in a second, all in a second. Yet fair races bloomed and died, and worlds lived and died, races of intelligent beings strove, only to die. All in a second. But it was not a second to them. My immense size was to blame on my part.

For time is relative, and depends upon size. The smaller a creature, the shorter its life. And yet, to itself, the fly that lives but a day has passed a lifetime of years. So it was here. Because I had grown large, centuries had become but moments to me. And the faster, the larger I grew, the swifter the years, the millions of years had rolled away. I remembered how I had seen the streaks that meant the planets going about the sun. So fast had they revolved that I could not see the circuit that meant but a second, to me. And yet each incredibly swift revolution had been a year! A year on earth, a second to me! And so, on an immensely greater scale, had it been as I grew. The few minutes that meant to me the sun's movement through the ether of what seemed a yard had been centuries to the earth. Before I had lived ten minutes of my strange existence, Professor Martyn had vainly hoped away a lifetime, and died in bitter despair. Men had come and died, races had flourished and fallen. Perhaps all mankind had died away from a world stripped of air and water. In ten minutes of my life. . . .

And so I sit here now, pining hopelessly for my Mother Earth. This strange planet of a strange star is all beyond my ken. The men are strange and their customs curious. Their language is beyond my every effort to comprehend, yet mine they know like a book. I find myself a savage, a creature to be treated with pity and contempt in a world too advanced even for his comprehension. Nothing here means anything to me.

I live here on sufferance, as an ignorant African might have lived in an incomprehensible, to him, London. A strange creature, to play with and to be played with by children. A clown . . . a savage . . .! And yearn as I will for my earth, I know I may never know it again, for it was gone, forgotten, unexistent a trillion centuries ago. . . . .!

Vanishing Movies

By TEDDY J. HOLMAN

(*Continued from page 335*)

visible. A beam might be said to be somewhat similar since there is a surrounding envelope of weaker light *in most cases.* Several things operate to cause this. The diffusion of the reflector and the lenses is one of the principal reasons. Of course such diffusion is very slight compared to the strength of the beam. Thus the problem would be to form a shield that would allow the beam to pass through but stop the glow. This might be done by encasing the light source and passing the beam through a tube the inside of which is *non-reflective;* that is, painted with lampblack so that the glow would be absorbed and not reflected. We must also remember that the reflection and the refraction from the screen and projector would serve to nullify any appreciable glow and that such lights would be located to take full advantage of this. This merely shows that it would be possible to construct lights that would conceal the beam; therefore we will have to seek other proof to disprove or prove our hypothesis."

THE TROUBLE MUST BE IN FRONT OF THE SCREEN

Jackson thought a moment and then said, "You may be right; still, remember that a thorough examination of the room revealed nothing, and that when I passed a shield in front of the projector the shadow progressed across the screen."

"Do you think anyone would set up such apparatus without feeling certain it could not easily be found?"

"You've got the trump on that. I move, though, that we adjourn until tomorrow. We shall then examine the room again and, this failing to produce anything, work out some other way of locating the light, if there is such a thing."

The following day they conducted their search systematically, canvassing the floor, ceiling, and walls thoroughly. It was as unsuccessful as the others had been.

"I believe that light stuff is all bull," grumbled Jackson, lighting a cigar and puffing out great clouds of smoke.

Frank watched Jackson closely for a moment and then dashed out of the room, exclaiming, "I have it!"

"Now what are you after?" yelled Fred. "I think we have a sufficient supply of mysteries as it is." However, Frank had already disappeared. Nothing was heard of him until nearly night.

"Now if everything goes off right," Frank explained that night, "we cannot fail. "Everyone must be alert and ready for instant action."

The crowd was very small for, as Jackson had said, the incidents of the previous night had driven them away. In spite of this, the show started as usual and the pictures went on the screen for fifteen minutes without interruption; they then began to behave as on the previous night.

THE SOLUTION IS APPROACHED

Frank, who was standing near the wall, decided, after the pictures had been vanishing at short intervals for several minutes, that it was time to spring his surprise, so as the picture faded, he pressed a button. BANG! The few who were still present were greatly astonished by an explosion near the screen. Great clouds of dense smoke were thrown in all directions. Evidently it was a smoke bomb. The picture suddenly reappeared.

"We have it," cried Jackson as Frank joined him. "My men saw several beams and got the location of two. It should be child's playing finding the others by tracing the wiring."

A commotion near the door attracted their attention in that direction. "We've got the man!" cried Fred. "He has been acting suspiciously all night and just now tried to escape, but one of Jackson's men intercepted him."

Jackson bent over and looked closely at the prisoner. "Dandly," he gasped. "Call an officer!"

"What kind of outrage is this?" demanded Dandly angrily.

"Tell it to the judge," Jackson admonished.

"Here is where one of the lights should be," called Frank, indicating a place on the sheet metal ceiling, "but I certainly cannot see anything wrong. Move the ladder a little to you, Jackson, so I can get nearer. Ah! Here is a little circle cut in the metal

That may have some significance. Suppose we go upstairs and see what we can find."

"Nothing wrong here," Jackson declared.

"Nothing, eh!" exclaimed Frank as he jerked a board off the floor. "Look at this!"

"Thunder!" Jackson roared. "The cleverest thing you ever saw!"

"See," explained Fred, "he has a nitrogen filled incandescent light with a reflector behind it. This is all encased in a shield with a tube projecting from it in such a way that it directs the light on a second reflector, which, in turn, focuses it through another tube acting as a shield onto the screen. This last tube has several electrically operated shutters in it to cut off the beam. The inside is blackened to prevent it from reflecting any light. A hole has been cut in the ceiling for the beam to pass through and a metal disc matching the ceiling is held in the hole by a spring when the shutters are closed."

"I understand that, but how did he manage to work the shutter so effectively when I shielded the light from the screen?"

"From his connections here I judge that he has a whole bunch of sensitive selenium or photo-electric cells concealed in the beam from the projector and so connected with these shutters that they are open only when the light shines on the cells. There are eight shutters here and they probably form a selective combination so that a shadow starting from a particular side would operate a certain shutter whose shadow could be seen rapidly crossing the screen; so rapidly, in fact, that you would be unable to distinguish its shadow from the one formed at the machine. If you tried to move the shield slowly the operator would have time to open the main switch turning off the lights. This particular light is so small that he would need at least ten to produce the desired effect on the screen. What a tale for the *Star* tomorrow! But here comes the officer after Dandly."

A STRANGE FINISH

"We have a clear case against him, officer," declared Jackson. "These boys know all the facts, how he has been threatening me, and how we caught him with the goods on tonight."

"Yes, Jackson had a strong case against Dandly," Frank explained, "but we now have a still stronger case against the perpetrator of this crime for I myself saw the criminal press the button controlling the concealed lights; but for that he would have succeeded with his plans. Officer, arrest Jackson!"

Scientific Paradoxes

By EDWARD M. WEYER, JR.

(*Continued from page 352*)

she can, and bring the next toss tails? In other words, after you have won on heads for nine successive times, isn't it easy to think that the chances for heads appearing next are very small and that the safer bet is on tails; because in the long run the number of each will be even, and at present the number of tails is far behind the number of heads? What if you wait a day or a month to toss the coin the tenth time, or use a different coin? In flipping a coin, the thing which is always true is that the chances are alway equal for heads and tails, regardless of what the order has been preceeding or what order will follow.

"Who thinks that fortune cannot change her mind,
Prepares a dreadful jest for all mankind!"
—*Pope.*

In all gambling institutions are seen those who endeavor to win by system. I will describe the "one-one-two-one" system, and ask you to take it for what you think it to be worth.

1. Before you start betting, write down

1
1
2
1

leaving plenty of room below the figures.

2. Bet the sum of the extreme figures, which in the beginning is 1 + 1, or 2.

3. If you should lose, write below your column the amount of your loss, which happens to be 2.

1
1
2
1
2

4. If you should win, cross off the extreme figures, leaving

1
2

5. Continue, *always* betting the sum of the two extreme figures, and writing below the column the amount of the bet, when you lose, and crossing off the two extreme figures when you win, until all the figures are crossed off. *You will always find yourself 5 ahead when all the figures are crossed off.* This system is applicable to most gambling games. The question is: Does the system win for you 5, or does it merely tell you when you have won 5?

ZIGZAG DIAGONAL PATH ACROSS SQUARE NOT THE SHORTEST

Who of us, in walking from point A to point B in Fig. 4, would not take the zigzag route indicated by the heavy line and think that it were shorter than the path around dotted line? It looks shorter and first thought would tell us that it were shorter, but a little reasoning will show that it is not. If you add up all the horizontal components of the zigzag journey you will get a line equal in length to the line CB, and if you add all the vertical components of the zigzag line you will get a line the same length as AC. This proves that both routes are exactly equal.

Fig. 5 displays the same phenomenon more strikingly. The diagonal journey from A to B is still the same length as the seemingly longer path around by way of C. In fact, the zigzag route might be made up of such small horizontal and vertical lines that it would be impossible to detect that it was anything but a straight line. The small straight lines which make it up might be only 1/1,000,000,000 of an inch in length, and still it would be the same length. But as soon as the zigzag line becomes a straight line, the path *instantly* becomes $1/\sqrt{2}$ as long.

It is somewhat of a paradox in itself that, although man has probably been present on the earth for 500,000 years, until only 200 generations ago the world was practically a wilderness. Only 200 generations ago the earliest civilization had not yet begun. Only 70 generations ago the Roman civilization was at its height. Fifteen generations ago white man had not set foot on America, and two generations ago none of the present-day conveniences such as the telephone, electric light, typewriter, wireless and automobile had appeared.

How To Build A Swimmer's Sail-Board

By LAWRENCE B. ROBBINS

(*Continued from page 357*)

on the pontoons so that the latter are 4 ft. 3 in. apart from their centers. Then across the center of the base timbers should be bolted a piece of 12-in. plank with a round hole in the center for the mast. A block with a smaller square hole should be screwed to the plank directly below this round hole.

The third point of buoyancy is obtained by fastening a solid barrel hoop to the plank 6 in. from the stern end. A block of wood fastened to the plank at the end serves as one point of attachment as well as a solid point through which to bore a hole for the rudder post. The front edge of the hoop can be fastened to the plank by angle irons. Cut a large inner tube in two the same as before and close the ends by vulcanizing. Then curl the tube up in a spiral and fill in the space inside the hoop and lash the tube in place with wide tape. Then inflate the tube until it fills the space completely.

Make a rudder of some hardwood or sheet metal and provide a rudder post with a squared end. The tiller can also be cut out of hardwood and a square hole cut in the center to fit down over the rudder post. Drill a small hole in the post above the tiller and keep the latter on by a pin.

WORKING THE KEEL

Drifting or "side-slipping" when the board is tacking along a course must be eliminated and this is done by fastening a keel of metal or hardwood to the center of the bottom of the plank at a point about midway between bow and stern. It should extend down at as nearly right angles as possible and several long angle irons on each side will hold it solidly.

Now that the hull is completed give it at least one coat of linseed oil followed by two coats of good paint. Of course, when possible, galvanized fastenings should be used rather than black iron—especially if the board is to be used in salt water.

MAST AND SPARS

For the mast and spars use a good clear spruce. The mast should be about 6 ft. long and 2 in. in diameter at the butt, tapering to not more than an inch in diameter at the top.

Make both the boom and the gaff 8 ft. long and 1½ in. thick in the middle and tapering *slightly* toward each end. Sandpaper each spar smooth after rounding off with a plane. Then give all three spars two thin coats of spar varnish.

HOW TO MAKE THE SAIL

The sail should be made of light weight ducking in the shape of an equilateral triangle—about 7 ft. 6 in. long on a side. Use cloth not over 30 in. wide and start with the longest piece, placing the selvege edge of the cloth on the outside edge of the sail called the leech. Double seam the strips together and the cut ends should be double hemmed. Then a shipshape job can be accomplished by strengthening each corner with triangular pieces of cloth sewed on each side and by making eyelets or placing grommets along the edges which come next to the gaff and boom. The sail can then be lashed to these spars with stout cord. Pull the sail fairly taught on the spars but not enough to stretch it. Lash the gaff to the mast head and attach the boom loosely about the mast with a leather strap. When in the right position the sail should sit with the after end of the boom somewhat higher than the front. Tie a light rope to the boom for a "sheet" as shown.

NAVIGATING THE CRAFT

To navigate this sail-board—sit on the plank and use the after inner tube as a rest for the shoulders or arms. Grasp the sheet and tiller and then guide the craft with the wind exactly as you would sail a boat.

Dr. Hackensaw's Secrets

By CLEMENT FEZANDIE

(*Continued from page 330*)

ror. The enlarged image was thus as well illuminated as the first one. In the same way I was able to select a portion of this second image and throw it, enlarged, upon a third mirror, and so on, the illumination always remaining the same, or even being increased if I wished. That settled the light problem. In order to avoid distortion and chromatic aberration as much as possible, I made use of only the very center of each image. The center of the image is always very much less distorted than the edges. I am thus able to receive very clear images, even though highly magnified. As to troubles due to imperfection in the lenses, I have reduced these to a minimum; and, to avoid those caused by impurities in the atmosphere, I have installed the telescope on the top of a high mountain. The results exceeded my wildest hopes, but the distance of the telescope from my laboratory here, rendered it inconvenient of access. So I tried another tack, and improved my television apparatus. You have seen the instrument. As I explained to you, every object in the universe is radio-active, that is to say, it is continually emitting ether waves. Now my television apparatus is so constructed that I can tune it to receive any of these waves that I wish. I cannot only tune the instrument to receive waves of any given length, but I can direct it so as to receive only waves coming from an object in a certain direction and a certain distance away. By means of amplifiers I can then increase the intensity of these waves, and by means of special audions I can transform these radio waves back into light-waves again, and so obtain an image of the object.

"Up to this time I had been content to use my television apparatus to view objects on the earth, gradually increasing the power until I could see objects across the Atlantic and even as far as China—twelve thousand miles away. Now the moon is only some 240,000 miles from the earth. Many men have traveled that distance, and it occurred to me, that with some improvements, my television apparatus could be used for viewing objects on the moon. If so, I could set at rest, once for all, many problems that puzzle our astronomers."

"It's a pity," remarked Silas, "that you couldn't make your instrument powerful enough to show us the surface of Venus and Mars, so that we could see whether human beings exist there, or only animals and plants. The moon is certainly a cold, dead body without either air or water. I have looked at it through a telescope. The surface is only a series of extinct volcanoes, and no life of any kind could exist there!"

Doctor Hackensaw chuckled. "Don't be too cock-sure of that, Silas," said he. "In the first place the so-called volcanoes are not extinct craters as is popularly believed. Of course it is natural to imagine that, as conditions on Venus and Mars closely approximate those on the earth, the life there must be somewhat like our own. On the other hand, as we can perceive little or no air or water on the moon, it seems to us that no life can exist there. So, to a savage, living in the tropics, it would seem impossible that men could live in the polar regions. And yet the Esquimeaux manage to live there. And remember, the Esquimeaux adaptation to his surroundings is what you might call artificial. In the moon the adaptation may be due to a natural evolution that has lasted hundreds of thousands of years."

"At any rate," said Silas, "even admitting that life exists on the moon, it must be a very low form, because the moon is much newer than the earth."

MOON'S LIFE OLDER THAN OURS

"I don't know how it is that people get that idea," replied Doctor Hackensaw. "The converse is the case. The moon is older than the earth, using the phrase in the popular sense, for of course both moon and earth are of the same age, since they both originally formed part of the sun. According to the Nebular Hypothesis, the sun with its planets (including the earth), was formerly one immense body of incandescent matter extending far beyond the present orbit of Neptune. As this fiery mass cooled and contracted, Neptune was first formed, and so is the oldest of the planets, then Uranus, Saturn, Jupiter and Mars and then came the earth. The earth and moon were then combined in one mass, but as the earth cooled, its outer portion was thrown off and formed the moon. And the moon, being already the coldest portion, and cooling more rapidly than the earth, owing to its smaller size, must have been cool enough to support life hundreds of thousands of years before the earth was in a condition to do so. Hence we may truly say that the moon is older than the earth. Life has had a start there of perhaps countless thousands of years, and evolution was probably more rapid there than with us, since the moon is already cold. If intelligent beings were born on the moon, they have had time and opportunity to obtain knowledge and wisdom undreamt of on earth!"

"Doctor," asked Silas eagerly, "Do you believe that there are living men and women like us on the moon?"

Doctor Hackensaw shook his head. "No, Silas," he replied. "The chances are as infinity to one against it. I spoke of *intelligent* beings—not *human beings*."

"What are your reasons for believing there are no human beings on the moon?" asked the reporter.

HOW PLANET LIFE ORIGINATED

"To understand that, Silas, you must understand how life originated on the earth. Evidently there was no life of any kind present while the earth was in its incandescent state—at least we have no reason for believing so. But as the surface became cold, minerals formed, either crystals or amorphous masses. Chemical changes occurred, and, as a result of these, the first specks of live matter must have appeared, probably in the form of one-celled plants like the amoeba or slime that is found in our kitchen sinks. These amoeba are mere specks of protoplasm and their life consists simply of the power to feel and to contrast. Touch a bit of protoplasm with a pin. It feels the touch and it contracts. That is life in its simplest form. The amoeba also possesses the power of absorbing food and of growing and splitting up into two or more specks of protoplasm each with a life of its own.

"That is the way life must have originated on this earth. Whether all living beings have descended from one single speck of protoplasm, or whether a number of these specks were formed at the same time, is an open question. It is even possible that the process of spontaneous generation is going on at the present day. To me, however, the probabilities seem to be that all our animals and plants have descended from one original species of plant cell. There is too much unity in animals and plants to allow of a different belief."

"In that case," cried Silas triumphantly, "the chances are that life in the moon must have started from the same kind of cell, and consequently must have followed the same road and culminated by evolving into man, as it did on the earth."

"I am willing to admit your premise, Silas, but not your conclusions. I believe, as you say, that life on the moon probably began, if it ever began at all, by evolution from the same amoeba-like form from which it originated on the earth. Of course, other origins of life are possible, and we may even imagine living beings unlike either animals or plants, but the probabilities are that the start of life was the same on our satellite as here. The moon and the earth were similar in composition, and conditions were not very much unlike."

"Then," cried Silas triumphantly, "if the start were the same, and conditions were alike, the results should be the same!"

"You forget, Silas," retorted the doctor, "that even here on the earth where conditions are approximately the same, the original forms have branched out into endless species of animals and plants—millions of different forms from one original plant, forms as diverse as the elephant, the oyster, and the oak-tree. On the moon, even if conditions were almost identical with those here, millions of other forms must have existed, and yet the chances are great that, among the millions, except in the very earliest forms, no two should be alike, save superficially, as the moth resembles the humming bird or the bat resembles the sparrow. Hence the chances are infinitesimal that anything that we should call a human being, exists upon the moon. You must remember, too, that the lunar day consists of fourteen of our days, and as there is little or no atmosphere to temper the rays of the sun, the temperature must be blistering hot. Then follows a night of fourteen days. With no atmosphere to hold it, the heat is radiated off into space, and a cold we can scarcely dream of, follows. Conditions so different as these must have produced an entirely different kind of life on the moon.

MOON'S GRAVITATION ONE-SIXTH THAT OF EARTH'S

"Another thing that has probably exerted some influence is the difference in gravitation. The moon is smaller than the earth and its attraction therefore less. Gravity on the moon is measured by an acceleration of 2.65 feet per second instead of 16.09 feet per second as on the earth, in other words the attraction is one-sixth that of the earth. A hundred and fifty pound man would weigh only twenty-five pounds on the moon. If animals or plants live on the moon at the present day, they must certainly be far different from ours. I am convinced that the lowest forms, like our own, have no skeleton, but that the higher forms have some kind of skeleton or frame-work, either a shell like the clam, or an external or internal frame-work somewhat like the skeleton of an animal. I think it more likely, however, that this skeleton should radiate in different directions, as in a star-fish for example, than extend in a single line. Some of these animals and plants, like ours, must be rooted to one spot, others probably possess powers of locomotion. As to their organs, they must possess means of capturing and assimilating their food. Whether they breathe or not depends on the kind of life they possess. Our plants take carbon dioxide from the air and split it up into carbon and oxygen. Our animals take oxygen from the air and breathe it out combined with carbon as carbon dioxide. On the moon a fourth kingdom of matter may exist which depends for its energy on a different chemical combination."

"How about sex on the moon?"

"To understand that, you must first understand the evolution of sex on the earth. The lowest forms of animals and plants are asexual—that is they have no sex. They reproduce by growing larger and splitting up into two or more living cells. At the next stage, two living one-celled animals unite to form a single one-celled individual. At a still higher stage two distinct animals each throw off one cell and the two cells unite into one. There is still no such thing as sex—the two parents are alike and the two cells that join together are alike. But now sex begins to appear—the parent forms begin to differ and evolve into male and female, and the cells thrown off likewise differ and become sperm-cells and egg cells respectively. The male and female parent may be separate individuals, or both may form that part of the same individual as in most of our flowering plants. As it is an advantage for the sperm-cells and egg cells of different individuals to unite, cross-fertilization is evolved—the wind or the insects carrying the pollen from one flower to another. In animals the same result is obtained by the evolution of the act of pairing.

"At first sight it would seem impossible that the union of the two sexes could have resulted by slow steps. Either the egg-cell must be completely fertilized or it will not grow at all. No partial step seems possible. But the intermediate links still exist at the present day, as we can see in the fish. In certain species of fish the female lays the eggs, and the male fertilizes them after they are laid. Gradually the males learned to follow the females and finally attached themselves to the females and fertilized the eggs as they were laid. From this it was but a step to fertilize the eggs before they were laid, and by slow stages the act of pairing as it exists in our mammals was evolved, the eggs being fertilized several months before the young are hatched.

"Now, how about sex on the moon? Evidently the lowest forms of life, like ours, are asexual. But cross-fertilization is such a great advantage that some form of sex has probably been evolved. But I think it extremely probable that on the moon more than two sexes may have been evolved. I think it likely that three or more different parents may be necessary for each birth, or that the egg must pass from the body of one parent into the body of several other parents at different stages of its growth. This, however, is all mere hypothesis. Reproduction on the moon may be entirely different from anything we know of on earth. The new generation may even be produced synthetically from chemicals for aught we know!

SILAS LOOKS INTO THE SUPER-TELESCOPE

"But I am wandering off into flight of fancy. If you will just step into my laboratory here for a few minutes, you will have some *facts*. I want you to take a look at the moon through my instrument, and then I will tell you of a plan I have formed—a plan which, if successful, will throw all my other achievements into the shade."

Silas somewhat skeptically took a seat before the television screen and waited while Doctor Hackensaw adjusted his instruments. And then the reporter gave a cry of surprise, for there appeared on the screen a picture unlike anything he had ever imagined.

"That," explained the doctor, "is a small portion of the moon's surface. It is somewhat hazy and distorted, due to the tremendous magnifying power used, but it is sufficient to give you a tolerably clear idea of conditions on the moon."

LIFE ON THE MOON

"What funny plants!" cried Silas, in amazement. "And how is it they are not green. They appear to be all the colors of the rainbow; and as for shape, we have no plants at all like them, unless perhaps some of our marine growths. There's a golden plant that looks a little like a bunch of coral. And there are some that look more like roots than plants. And what are those things that are moving about and those others that are jumping so high? Are they animals?"

"They are either animals or else plants that possess the power of locomotion."

"How queer they all look, and all the queerer because they are upside down. Everything looks as if it were hanging from the moon and would soon drop off!"

"What puzzles me," said Doctor Hackensaw, "is whether these creatures possess intelligence or not. Of course it is difficult to conceive of *intelligent* plants, but the thing is not impossible. I am convinced that the fixed forms we see possess life. I have watched some of them grow from small seedlings into very large plants. It is not a mere crystallization such as we see in minerals, but a real growth. Some, however, are puzzling. They move about freely when young, but become fixed at a later stage of growth. But on earth some species of Medusae, or jelly-fish, do the same thing. In the jelly-fish stage they swim about, but their eggs take root and grow into a fixed stalk, which, at maturity, breaks up into a number of new and free jelly-fish."

"The commonest creature up there," remarked Silas, "looks just like the jack-stones that children play with. Surely those things cannot have intelligence. And notice how they roll about from place to place. Instead of walking, they roll around on four of their six spokes."

SILAS SEES STRANGE MACHINE ON MOON

Doctor Hackensaw now turned the instrument in a new direction, and the screen showed, in natural colors, as before, a large and most peculiar metal structure on the moon. It was evidently not a house, but some kind of machine, for portions of it were in motion.

"Well, Silas," he cried, triumphantly, "What do you think of that? If that isn't a machine of some kind I'll eat my hat! And if the selenites are able to construct machinery, they must surely possess intelligence, no matter how peculiar their shape."

"But what is the use of that machine? It doesn't look like anything we have here on earth. I'm not even sure it's made of metal."

"Probably it is made of some composition we know nothing of. Remember, the Selenites' machines must be at least as far advanced as those man will possess several hundred thousand years from now. He would be a rash man who would venture to prophesy what they would be. Think of the possible inventions during the next thousand years, and then try to imagine those of the next hundred thousand years! At any rate, one thing is certain. There are intelligent living beings on the moon, and I should not be surprised if this machine were designed to store up the heat during the lunar days, and give it forth at night, thus making the moon more comfortable to live on. But what its object is, I hope to find out."

"How so?"

THE DOCTOR TO COMMUNICATE WITH MOON

"I am going to attempt to communicate with these intelligent creatures in the moon."

"By wireless?"

"Possibly later. At present, however, my purpose is to send a car to the moon, with a message for the Selenites."

"Send a car with a message?" echoed Silas. "Do you happen to know their language, or do you expect them to understand English?" he added sarcastically.

"Neither!" replied the doctor, tranquilly. "I shall use a more universal language. To begin with, I shall send paintings of objects in their natural colors. There is not a savage tribe on earth that cannot understand a picture—at least to a certain extent."

"But these creatures on the moon don't seem to have any eyes. How can they understand a picture if they are unable to see it?"

"In addition to the pictures," continued the doctor, imperturbably, "I shall send life-sized models of men, women, and children dressed in modern clothing, and also models or real specimens of our animals and plants, our houses, machines, etc. Perhaps our Lunar friends will send me in return some models of things on the moon. What a triumph it would be to receive some of their machines or to analyze some of their chemical productions. Think of the possibility of my learning in a few years what it has taken these creatures hundreds of thousands of years to discover! Why the prospect is dazzling! All that I am afraid of is that my intelligence is too limited to enable me to understand their machines. I shall be as unable to make heads or tails out of them as Christopher Columbus would have been if he had found an electric motor with the storage battery attached. He would see that the armature revolved, but could form no idea as to what made the thing work. Similarly, if the moon-people send me a machine worked by atomic force, it may teach me no more than the motor would teach Columbus!"

Silas Rockett sneered contemptuously. "It's my opinion," said he, "that you might as well send your specimens to a school of fish. They would be just as likely to understand them as these creatures in the moon, of whom you seem to have so high an opinion. Besides, I see one slight objection to your scheme."

"What is it?"

"How are you going to send your specimens to the moon?" And as he uttered the words, Silas gave a delighted chuckle, for he thought he had caught the doctor napping.

But Doctor Hackensaw smiled complacently. "True," said he, "the sending of a car or projectile to the moon is by no means an easy thing to do, but I have solved many tough problems in my life, and I think I can solve this one. In fact, I may say, that I believe I have solved it already. But that's another story!"

Helicopter Lifts Three

The helicopter of Etienne Oehmichen in its latest trials lifted three persons to a height of five meters, says a Paris dispatch. The machine also twice rose with the same number of passengers to heights of three to five meters.

It now has to its credit a total of two hours in flight, with one flight of nine minutes, and the average of all the flights three minutes. It also accomplished a horizontal flight of 400 meters.

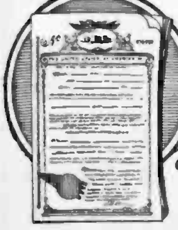
After the engine, which was worn out, is changed, the inventor will attempt a kilometer flight in a closed circuit.

New Seaplane Record

A world's record for seaplanes over a three kilometer course was established on June 7, by aviators of the Air Squadrons of the Battle Fleet when Boatswain E. E. Reber, piloting a torpedo seaplane, attained a speed of 102.88 miles an hour.

Lieutenant L. D. Webb was second in the tests, making 102.78 miles an hour. He flew in an M-O Monoplane recently added to the aerial equipment of the North Island Naval Air Forces.

Lieutenant G. T. Cuddihiy was forced to land when his T-S plane lost a propeller. He escaped injury.



PATENT ADVICE

Edited by Joseph H. Kraus

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.

OUR ADVICE VERIFIED

In the May issue, Patent Advice Department, A. Kurzawski, of Los Angeles, California, asked a question regarding a water tractor. We did not advise application for a patent. Our advice in this case is further backed by a letter which we have received during the past month from Rolph J. Lackner, of New York City. We desire to thank Mr. Lackner for his kind letter, and wish there were a great many more readers of this column, who would send in their experiences with patents, so that we may give future inventors the benefit of the experience of others, and which cost them in some cases quite a fortune. We often receive letters of the nature printed below, and because they do not relate directly to some patent advice previously given in these columns, but describe inventions upon which but a weak patent might have been secured, we have not taken the liberty of publishing the same. We will make it our duty to publish from time to time letters relating to patent advice given on this page. Mr. Lackner writes:

"For the benefit of Mr. A. Kurzawski, and with reference to your reply No. 709, given in the May issue, and for the benefit of others who may be working on similar devices, I wish to tell of my experience with a similar idea. Back in 1910 I designed a small water tractor, which would not only permit a flat-bottomed shell to virtually skim along on the water, drawing no more water than the shell itself, but would also permit it to be driven up on shore like a car. The front-back wheel arrangement over which the endless paddle chain was placed, was a failure with regard to economy, although it proved more successful with regard to the increased speed obtained. This was then changed by me to a device having two wheels in front, and two wheels behind, set between two shells, thus forming a double boat. This method placed the hubs of both sets just far enough apart to prevent the sprockets from touching. The paddle chain could in this manner, be made very tight, and the drag reduced to almost nothing. Mechanically, it was a success. I then changed the device, coming back to the single shell, and using a double arrangement in the back for driving, while single paddle wheels with raised sides in front were employed for steering. I found no demand for anything of the kind, so I dropped it, as I was personally unable to do what the editor of Patent Advice column so often claims is necessary, that is, manufacture the article and *create* a demand. Meanwhile, I also experimented with a floating tricycle, the tricycle being reversed, two wheels being placed in front, and one at the rear. The device was propelled by an ordinary screw propeller, set at such a pitch as to lift up the tricycle at the same time that it propelled it, so that it would draw very little water. The working model operated exceptionally well, but—again no demand. It would, therefore, not pay Mr. Kurzawski, nor anyone else, to devote further time or money to this device. I have expended several thousand dollars myself, receiving nothing in return. Neither of the two systems have been patented by me, although they are well protected by priority claims, searches, and every other legal method which my attorneys have been able to call into use.

(The editor of this column will appreciate the receipt of letters similar to the above, referring to experiences with various devices, similar to those on which we give "patent advice.")

FLY TRAP

(724) M. E. Ferris, Shuns, Tenn., asks whether a device to kill flies by sucking them into a trap could be built and patented.

A. Although the device could be made which will draw flies into it by means of suction, flying three of four feet from the nozzle, the expense of operating such a device would be rather high. The idea does not impress us favorably, and we doubt that it could ever be marketed.

AUTOMATIC SHIP STEERING SYSTEM

(725) Oscar Ferrell, Jr., San Antonio, Texas, asks whether a device to keep a vessel along a certain definite and straight course would be of value.

A. There are a few devices which do exactly what you describe, the first of these is a strictly magnetic compass invented by a Commodore Andrea. The second is a gyroscopic compass, both of which control a ship along its course. Torpedoes as you know, are likewise set upon a certain course, and then maintain that course without deviation.

CARTOON MOVIES

(726) Ernie F. Hiser, San Francisco, Calif., writes:

Being a maker of cartoon movies, I would like to know whether I should copyright or patent a system, whereby I can make cartoon movies of delicate surgical operations in about a tenth the time usually required, and can show the operation in absolute detail.

A. If you could see your way clear toward making the films, similar to the samples you have forwarded, without patenting the process, we would advise that you do so. As you undoubtedly know, a patent broadcasts your invention, and even though other individuals may be prevented from using the system, there is little possibility of your proving that they have employed your principle, and therefore, they could get away with quite a good deal of valuable data. If you find it necessary to have draftsmen or other artists draw for your system, or find it necessary that a doctor or surgeon be at your side while making your photographs, we would advise that you apply for a patent on those most important processes, and leave the critical parts of the systems out of the patent, keeping them as trade secrets. Remember that your trade secrets, if they are learned, will practically "break" you; but if they are retained as your private property, may "make" you. The patent will protect your system and prevent others from using it, provided that you can prove that they do so. The copyright will not protect you in any way. Neither will the secret protect you when once disclosed. The film itself should be copyrighted, however, to prevent other concerns from using it as a whole, or in part, and a frame from each new version of the operation, or each scene should be forwarded to the copyright bureau. The films are very fine indeed, and we wish you the best of success in your venture.

Around the Universe

By RAY CUMMINGS

(*Continued from page 331*)

"That's where the sun strikes the tops of the mountains," Sir Isaac explained. "The dark places are valleys and plains. . . . Let us have breakfast. Aren't you hungry?"

"No—yes, sure I am." Tubby rose to his feet from where he had been kneeling heavily on the floor. "That Venus is awful pretty. How far away is she? When do we get there?"

"We intersected her orbit at a point 1,142,606 miles away, roughly speaking." Sir Isaac replied. "I had to change our velocity once or twice during the night—but still I fancy I may say we have done fairly well." Sir Isaac drawled this out complacently. He was, indeed, very English at times.

"I ain't got nothin' to complain of," Tubby agreed. "When do we land?"

"Our present velocity is only 575,001 miles per hour. Venus is coming toward us at the rate of some 68,000 miles per hour. . . ." Sir Isaac seemed to be calculating in his head. ". . . But allowing time for landing—we shall have to slow up much more a little later on, you know—well, I think we should be there by ten-thirty or eleven o'clock this morning."

"Very good," said Tubby briskly. "Come on. Let's eat."

They had bacon and eggs for breakfast, and iced coffee with whipped cream, because it was too hot for regular coffee. Tubby would have made pancakes, but there did not seem to be any maple syrup, at which he was exceedingly annoyed. Several times during the meal Sir Isaac went into the instrument room for a moment to make a brisk calculation, to verify their course and to decrease their velocity a little.

Tubby's questions about Venus were incessant at first; but as Sir Isaac said, why discuss it theoretically when they were to see it so soon?

The store-room, which they were using as a dining room because it adjoined the kitchen, was directly under Tubby's bedroom. The sun hung level with its window, but they kept the shade closely drawn. After breakfast they returned to the instrument room, Tubby insisting he would not wash up the dishes so soon after eating; and Sir Isaac showed him the earth. It was about level with the instrument room side window and thus almost exactly opposite the sun. So far as Tubby could see it was a star no different from any of the rest of them, except possibly a little larger. The moon, of course, was invisible.

Venus, through the window beneath their feet, had grown very much larger during breakfast. It was now an enormous glowing ball, half dark, half light, apparently nailed fast to the black surface of the firmament. The sensation that they were high above it and falling directly down to its surface came to Tubby suddenly. It made him a little giddy at first; but the unpleasant feeling soon passed away.

For nearly an hour they sat talking idly, while this glowing sphere beneath them grew steadily in apparent size. They could distinguish even its dark portion quite clearly now, and its convexity was unmistakable. They were hardly more than 25,000 miles above its surface, and falling slightly toward its northern hemisphere, when Sir Isaac suggested that Tubby wash up the breakfast dishes.

"I shall go down through the atmosphere very slowly," he said. "But still I think we shall be there in rather more than an hour."

Tubby hastened into the kitchen, and Sir Isaac, pencil and pad in hand, took his station at the keyboard. When Tubby finally returned the instrument room was considerably darker than before. Sir Isaac, with two small electric bulbs lighted, was still seated at the keyboard.

"Say," began Tubby indignantly. "The sun went behind a cloud or somethin'. I ain't quite finished, but I don't know how to light the lights."

They had already entered the atmosphere of Venus, and had encountered, as chance would have it, a heavy bank of clouds—heavier than clouds ever are in the atmosphere of the earth. The sun thus obscured, the interior of the vehicle had grown quite dark.

"Never mind," said Sir Isaac. "Let it go. We'll be there very shortly."

Tubby located his Panama hat, rolled down his sleeves, and donning a thin blue serge jacket, sat down to await their landing. He could see nothing but grey mist through either window for a time; then, as they burst through the clouds, the room suddenly brightened.

Sir Isaac bent over the window in the floor, calling to Tubby. Beneath, spread out in a vast panorama extending to the horizon in every direction, lay the landscape of Venus—forests of green vegetation; a thin silvery ribbon of water; tiny grey blobs that were cities; and in the distance a range of blue-green mountains with heavy white masses of clouds above. And, curiously enough, by a familiar optical illusion, it seemed now a concave surface, as though they were hanging over the center of a huge shallow bowl, with the horizon rising upward to form its circular rim.

"My!" exclaimed Tubby. "Ain't that pretty? Just like bein' in a airplane, ain't it, perfessor?"

Sir Isaac, hovering anxiously between the floor window and the keyboard, was now exceedingly busy.

"I've got to select a landing place," he said. "If you see a large open space where there are no trees, tell me at once."

Tubby, forgetting the possible damage to his white trousers, sat down on the floor beside the window, peering intently downward. They were falling rapidly; the landscape grew momentarily larger in detail, passing slowly to one side as they fell diagonally upon it.

The instrument room was now hotter than ever before. Tubby took off his hat and coat again, and dashed the dripping perspiration from his face.

"Hey perfessor, slow up a little," he called to Sir Isaac at the keyboard. "We're gettin' down pretty close."

They were now at an altitude of hardly three thousand feet. The circular horizon had already risen so that the range of mountains in the distance was visible through the side window. It was a beautiful day outside—subdued rays of sunlight filtering through the white cloud masses and falling upon the vivid green countryside in brilliant patches of light.

They passed over the narrow river, and Tubby saw an open space surrounded by tremendous forests of tangled green vegetation, with occasional white blobs that might have been houses. Beyond, perhaps five miles distant, a city lay—its low stone buildings gleaming a dazzling white.

When they were directly over the open space, Sir Isaac depressed another key sharply; and the vehicle began falling vertically downward, with constantly decreasing velocity, until, when they were only a few hundred feet up, it seemed floating gently down rather than falling.

Sir Isaac's eyes were now glued to the window, his fingers resting lightly on the keys. Tubby stood up and put on his coat again; and a moment later, with scarcely a perceptible jar, they landed on the surface of Venus.

Sir Isaac relaxed, his face radiating triumph.

"We have landed," he cried exultantly. "A perfect trip, my dear fellow—12 hours, 14 minutes and 7 seconds elapsed time!"

"Right," said Tubby. "We're here. Come on perfessor, let's go outside an' get some air."

"What's that?" Tubby exclaimed abruptly. "Don't you hear somethin,' perfessor?"

Music was wafting to them on the breeze—soft, liquid tones like the music of a harp, and the sweet, pure voice of a girl singing.

"It's over there," Tubby half whispered. "Over in the banana trees. Come on—let's go see."

They crept quietly forward; and within the grove of trees came upon a tan-bark path. As they followed it the music grew steadily louder, until nestling under the huge spread of banana leaves they saw a little white marble pavilion, with a tiny splashing fountain before it. The figure of a girl in white reclined beside the fountain—a girl who was apparently alone, playing on a small harp-like instrument and singing to its accompaniment.

"Hello-o!" Tubby called incautiously.

The girl sprang erect; and stood trembling, lyre in hand, as they hurried forward. Tubby saw she was a rather small, very slim girl, dressed in a flowing white garment from shoulder to knee, which was gathered at the waist with a golden cord whose tasseled ends hung down her side.

"Good morning, ma'am," he said graciously. "It's a nice day, ain't it?"

The girl smiled, seemingly reassured by his greeting.

"We trust you speak our language," Sir Isaac added anxiously. "It has always been my theory that on Venus——"

The girl replied in a gentle, softly musical voice:

"I speak the language of the North Country of Venus, sir."

Her fear seemed to have left her. She stood, with dignified bearing, waiting for them to explain their presence.

Sir Isaac, with infinite relief on his face, turned to Tubby. "You see? I am vindicated. I always knew that on Venus—particularly in the North Country—the language was——"

Tubby frowned. "*My* name's Tubby," he said to the girl. "An' my friend's name is——"

"Sir Isaac Swift DeFoe Wells-Verne," stated Sir Isaac impressively. "We are charmed to meet you, Miss—er——"

"I am called Ameena," said the girl simply; she extended her hand in most friendly fashion.

When they had all shaken hands, she added:

"You are not of my world, surely. We so seldom have visitors here, I cannot tell——"

"We're from the earth," said Tubby promptly. "We just got in this mornin'."

"The earth!" Ameena exclaimed. She seemed suddenly perturbed. "I had thought you were Mercurian—men of the Light Country perhaps. We have never had earth-men here before. Never have I seen——"

"No," said Sir Isaac. "We are the first."

The girl had seated herself on the marble rim of the fountain; her pretty little face was clouded over with anxiety.

"I am so glad you came," she said after a moment of silence. "Now I can warn you of the danger to your earth. My people are so indolent. The Martians are about to descend upon your earth and conquer it. Rebels from the Twilight Country of Mercury are their allies. Only last month they were here in Venus—emissaries asking our people to join with them." She shrugged. "We would not do that, of course. What is war to us? These Martians do not covet *our* world, for we have nothing—only our fruits and our wine, and our simple buildings, and our music and poetry—and love-making."

She added, "But your earth—that is different. Your world they desire. They——"

"Martians to conquer the earth!" Sir Isaac gasped, stupified.

"They have gone to Jupiter also," Ameena went on. "When they found we would not join with them, then they said they would enlist help from the great Jovians themselves. I do not know if——"

"Oh, my gosh!" Tubby was almost speechless with fright.

"To conquer the earth!" Sir Isaac repeated. "When, Ameena? Only tell me when?"

She answered quietly, but with obvious agitation:

"Already they have conquered your moon. Your poor Selenites could offer but little resistance, and a Martian outpost is established there. And the Twilight army of Mercury is already massed in readiness on Mars."

She paused; then added swiftly:

"At the next opposition of Mars with your earth—only two months off they say it is—then the Martians and their allies will descend in hordes upon you!"

Chapter IV

IN WHICH TUBBY TAKES COMMAND AND A FATAL CATASTROPHE IS IMMINENT

In truth it was a drastic, desperate situation for their native earth of which the voyagers were thus unexpectedly informed. Even without his reference books, or the use of mathematics, Sir Isaac's well informed mind told him that they had no time to waste. Mars would reach opposition—that point in its orbit when it was nearest the earth—in just 57 days, 6 hours and 30 minutes from the present moment. Sir Isaac knew that. He also knew that if the miserable renegades of the Twilight Country of Mercury were allied to the Martians in an attack upon the earth, this attack, when it occurred, would be irresistible. And already the enemy had conquered the moon—occupied it—established there a hostile outpost barely 250,000 miles away!

Sir Isaac's stern, intellectual face was pale as he questioned the Venus-girl more closely. Tubby, when the details of this dastardly plot began to sink into his mind, spluttered with indignation.

"How dare them people attack our moon?" he demanded. "That ain't right. We never did nothin' to them. What are we goin' to do about it, perfessor? We got to do somethin'."

Sir Isaac had seated himself beside Ameena on the fountain rim. He was trembling a little, and his thin lips were pressed tightly together.

"Yes," he said, struggling to keep a semblance of composure in his voice. "Yes, you are right. We must do something. But what?"

"That's what I said—what?" Tubby prompted. "Go on, perfessor."

He had so forgotten Ameena's gracious beauty in the excitement of the moment that his hat was now jammed on the back of his head, and his fat little fists were clenched belligerently.

"It isn't the moon I'm worried over," Sir Isaac went on musingly. "That's a mere detail. It's the safety of our earth itself. If they land there in any strength at all we'll be annihilated in a day—every living being on the earth! Why with that Mercurian Light-ray—and with those great machine bodies to house the Martian Intelligence——" Sir Isaac broke off, overcome at the thought his words invoked. He recovered after a moment, however, and added to Tubby and the girl impartially:

"I fancy you have never read my books. '*The War of the Worlds,*' and '*The Fire People?*' I've told all about it in them."

Ameena shook her head; Tubby seemed embarrassed.

Sir Isaac obviously was disappointed. "Oh well, of course here on Venus they had no sale. It is immaterial. . . . This attack on our earth is too horrible—it is unthinkable. It must not be."

"No," agreed Ameena soberly. "It must not be. But what can we do to prevent it?"

"We?" exclaimed Sir Isaac. "You will help us?"

She held out her two hands simply; and Tubby and Sir Isaac impulsively grasped them.

"I could not let my cousins of the earth come to harm for lack of *my* help," she said quietly.

Sir Isaac, sentimental by nature, was again overcome with emotion; Tubby pressed the girl's hand warmly, beaming on her.

"That's fine, Ameena," he declared. "You're a regular girl, ain't you?"

There was a brief pause. Then Ameena said:

"I do not know if in Jupiter they are lending help to the Martians or not. But in the Light Country of Mercury I know they hate the Twilight People—these outlaw neighbors of theirs who are joining with the Martians. They of the Light Country, perhaps, would help us."

"The Light Country of Mercury!" Sir Isaac echoed. "By jove, how stupid of me! Of course! They, too, have the Light-ray. With one Light-ray we can fight the other!"

"Fine," agreed Tubby, still beaming at Ameena, who flushed prettily under his openly admiring gaze.

Sir Isaac stood up with determination. "Mercury is now fortunately approaching inferior conjunction with Venus. It is barely thirty million miles away from us at this present moment. Let us go to Mercury at once!"

"Come on!" cried Tubby enthusiastically. "Let's go. Let's aim to get there this afternoon—we can if we hurry." And clutching Ameena by the hand, he started off at a run through the giant banana grove, Sir Isaac following close behind.

After a hundred yards Tubby stopped abruptly, almost jerking Ameena off her feet.

"Say, listen, little girl—how about your family? Ain't your family liable to get scared, you runnin' out into space this way without sayin' nothin' to nobody?"

Sir Isaac also seemed worried by this thought, but the girl smiled readily. "I have heard about your earth families," she said. "In Mercury they have them also. But here on Venus there is only the State and the Individual. At fourteen I was free from control of the State. I am my own mistress now." She raised her arms with a pretty gesture. "Even love has not come to me yet. I am free."

Sir Isaac was relieved. "Of course! Naturally. How stupid of me. *I* should have known that on Venus——"

"Great," said Tubby. "Come on then—let's get goin'." He started off again as fast as his fat legs would carry him.

They departed from the surface of Venus ten minutes later, hurtling up through the atmosphere at a velocity that heated the interior of the vehicle like an oven. Sir Isaac put its cooling system into operation at once—chemically cooled coils over which air was driven by electric fans and then circulated through the various rooms—after which, ignoring their guest, he seated himself at the instrument-room table and began a computation of their course to Mercury.

Tubby showed Ameena over the vehicle with enthusiasm. He had forgotten for the moment the dire portent of this new journey and was like a boy on a holiday. The girl was intensely interested in everything, especially in the marvelous, ever-changing aspect of her own world as they slowly turned over and dropped away from it.

"You can have all the upstairs to yourself," Tubby declared, with due regard for the conventionalities. They were standing then in the doorway of one of the dainty little chintz bedrooms. "The perfessor an' I'll bunk downstairs. He's a real nice guy, the perfessor—you'll like him."

"I'm sure I shall," Ameena said. Her eyes, glancing at Tubby sidewise, were veiled by their heavy black lashes. She added softly:

"And you, too, my friend Tubby."

Tubby did not quite realize it then, but, indeed, this Venus-girl, typical of her race, had a distinct talent for love-making.

When they came to the kitchen Tubby was much embarrassed over the remains of the breakfast dishes. But Ameena proved herself a real housewife by immediately assuming charge of this department of the vehicle. She began washing the dishes at once—a curiously incongruous sight in her Greek-maiden robe as she bent over the kitchen sink!—while Tubby stood admiringly by, watching her.

When the kitchen and store-room were immaculate, Tubby and Ameena returned to the instrument room. The sun was shining up through the lower window; the vehicle was cooling off a trifle since leaving the atmosphere of Venus; they were now well launched into space.

Sir Isaac, having completed his computations, greeted them triumphantly.

"We have traveled 2,138 miles," he said. "I am heading directly for the sun now. I have been taking it very slowly until a moment ago."

"Very good," Tubby agreed, with a most business-like air for Ameena's benefit. "But we got to hurry from now on if we're goin' to get there today."

They sat down then to discuss the future. There was really very little to discuss, as a matter of fact, for Ameena's knowledge of war conditions throughout the solar system was very slight. What the voyagers could do to protect the earth depended upon two factors. Had the great Jovians joined in this dastardly war? And would the Light Country of Mercury lend its aid—its Light-rays and other weapons—for the earth's defense?

"Well," said Tubby, "we'll know pretty soon. What's the use arguin'? Ain't I right?"

Sir Isaac yawned involuntarily in spite of their interesting argument. He looked embarrassed.

"You're sleepy," exclaimed Tubby solicitously. He added to the girl:

"The perfessor ain't had a wink of sleep since we left the earth last night. He'd better go take a nap."

Sir Isaac was indeed tired out. "I must direct our flight," he said. "I cannot leave our course to——"

"Why can't you?" Tubby demanded. "I ast you twenty times already to show me how this here thing works. I can run it the same as you, if you show me how just once."

In the face of his growing fatigue which would not be denied, Sir Isaac was forced to yield.

"My inter-planetary vehicle operates upon a very simple principle," he began. "First you must know that the law of gravitation says that every body in the universe attracts every other body directly as the mass and inversely as the square of the distance between them."

Tubby and Ameena were all attention.

"We don't quite get you," Tubby said.

"Directly as the mass means that if one body weighs 100 tons and another weighs 10 tons, the big one will exert ten times the attractive force of the little one."

"That is very clear," said Ameena.

"Go on," nodded Tubby.

"And inversely as the square of the distance means that when bodies are twice as far apart they only exert one-fourth the attractive force upon each other. Thus you see every mass of matter in the universe is attracting every other mass according to those laws.

"Now each of the six faces of this vehicle—top, bottom, and the four sides—is lined with a metallic plate. This very curious metal is found principally on Mercury—although, as I have shown in my books, it has been prepared by one scientist on earth—he who went first to the moon. My projectile, fired from an enormous cannon, you remember, failed to reach the moon, but merely encircled it."

"I remember that other one," Tubby exclaimed. "'*The First Men in the Moon*.' That was a great book. Go on, perfessor."

Sir Isaac was pleased. "Yes. . . . That was where I explained my gravity screen. . . . Well, we are using now a device very much like that, only vastly more efficient. You see, in this particular inter-planetary vehicle I have a current something like the Mercurian Light-ray, and something like our own electricity. With it I charge any or all of these metallic plates both negatively or positively. I mean I can make them *neutral* to gravity—so that gravity is cut off entirely as in the case of the gravity screen. Or I can make them *attractive*, or *repellent*. Without any charge, you understand, they are attractive, as all matter is. With my negative charge they repel with exactly the same force as normally they would attract."

"Ah," said Tubby.

Sir Isaac warmed to his task. "Let me explain to you the exact result of this. When we were resting on the earth's surface, I cut off—only partially, for you see the change may be made with any rapidity desired—the gravity from our base. Having then an insufficient attraction from the earth to hold us there, we left its surface, flying off at a tangent because of the earth's rotation on its axis. . . . But I won't go into that. . . . Once in space, as we are now, I merely make one face attractive, and the others neutral or repellent. Thus the attractive face acts on whatever heavenly bodies lie in the direction, and we are drawn toward them. For greater speed I also use the repellent power of those bodies lying behind us. For instance, after leaving the earth, I used the attraction of the sun—only a portion of it, of course. Later, merely for experiment, I combined with that a fraction of the earth's repulsion. Early this morning, when we approached Venus, I used *her* attractive power, cutting off the sun completely."

quite similar to the keyboard of a very large typewriter—and with more keys. These keys were of three different colors—white.

Sir Isaac turned to the keyboard. It was red and black—and all of them were numbered plainly.

"These keys," said Sir Isaac, "you will observe are on six banks—each bank governing a different face of the vehicle. For instance——" He indicated the lowest row of keys—"this bank governs our base. And this, the top of the vehicle—and these are the sides.

"There are, you notice, fifteen keys on each bank. When they are all up there is no action at all—the face allows any heavenly body to attract with its full, normal force. But, when I press down this red key—each bank has one, you see—then the face becomes neutral to gravity. The seven white keys give seven different intensities of attraction, and the seven black ones give seven different intensities of repulsion. A key pressed down stays down until you pull it up."

"Sure," agreed Tubby. "That ain't so awful complicated."

Sir Isaac went on:

"You will understand then that when number seven white key is down, the face is fully attractive, just the same as it is with *all* the keys on that bank *up*. Do you follow me?"

"Aboslutely," nodded Tubby. "I doped that out long ago."

"Well," said Sir Isaac, "with these ninety keys, working singly or together, a very great number of combinations can be obtained. We can go in any direction we choose, and at almost any velocity—at least I have never been able to calculate any limit to the velocity if sufficient time for acceleration is allowed."

"Right," agreed Tubby. "You mean we don't get up speed all at once—we keep goin' faster. That's good. . . . Show us what's doin' now."

"Our present course is very simple," continued Sir Isaac. "You observe five of the red keys are down—the top and all four sides of the vehicle are neutral to gravity. On the bank governing our base the *first* white key is down. We are being drawn toward the sun, pulled by one-seventh of the sun's attraction. If we wanted to go faster we could use more of the sun's attraction, or some of the repulsion of Venus. If we wanted to go slower, we could combine some of the *attraction* of Venus, which would act as a drag. By balancing the attraction of Venus and that of the sun we could stop entirely. . . . I think I shall use another seventh of the sun's attraction. Watch carefully."

Sir Isaac suited the action to the word, pressing down the second white key of that bank, and then releasing the other.

Tubby watched closely. "That's easy. What else?"

For half an hour more Sir Isaac explained the navigation of space—with practical demonstrations during which he made the heavens swing over at will in most dizzying fashion as he altered the vehicle's course. Finally Tubby announced himself satisfied, and competent to assume charge for a few hours at least.

"You go lie down," he said. "We'll get you up when Ameena has lunch ready."

Still Sir Isaac hesitated. "In half an hour," he explained, "I would, I think, increase our speed by using about three-sevenths the repellant power of Venus."

He indicated the changes. "Our velocity is steadily increasing as we approach the sun—but we must go still faster. We *are* in a hurry."

As he turned to leave the room, his face clouded with sudden anxiety.

"We shall shortly attain a velocity of nearly seven million miles an hour," he said soberly. "I—I hope I'm not taking too great chances. It's so crowded in here with meteorites. We've been marvelously lucky so far."

"Go on to bed," commanded Tubby. "I ain't goin' to let us hit nothin'. I'll watch. If I see anything comin' I'll thump them keys, or yell for you."

Most reluctantly, Sir Isaac gave up command; and, with Ameena's gracious permission, he retired to one of the upper bedrooms.

It really was Ameena's fault, though Tubby was too much a gentleman ever to say so—for if Ameena had not called him into the kitchen it could never have happened. She had gone to prepare the noonday meal, and Tubby reluctantly had parted with her and maintained his post at the lower window of the instrument room. The sun shone up at him intolerably bright.

Nothing showed in the sky below, except that huge, flaming red ball slowly but steadily increasing in size—the sun as it appeared through the smoked glass—and those glorious constellations of stars hanging immovable in the black firmament. In thirty minutes exactly, by the instrument room's chronometer—Tubby had added to their velocity three-sevenths the repellent power of Venus. This world they were so rapidly leaving hung directly overhead—an enormous silver-blue sphere now completely illuminated by the sun, but visible only from the upper windows of the vehicle.

It was just after he had put on the additional speed that Ameena had called Tubby into the kitchen to ask him how to open a can of tomatoes, for canned goods were unknown on Venus. Tubby, once in the kitchen, had forgotten to return to his post. He was sitting in the doorway of the adjoining store-room, chatting vivaciously with Ameena, when suddenly he became aware of an unusual light coming diagonally in through the side window.

Leaping up, he saw in the black, starry void a huge silver disc—a thousand moons in size! It was below them, off to one side. It was so close he could see barren, rocky mountains on it; and it was turning over like a ball thrown into the air. Even while he gazed, with his heart in his throat, it doubled in size, so stupendously fast was it approaching—and already exerting its attractive power upon the base of the vehicle, it was altering the vehicle's course so that the heavens began shifting sidewise.

With a startled cry, Tubby dashed into the instrument room, Ameena following him with the can of tomatoes still in her hand. Through the instrument room floor window the heavenly derelict, again doubled in size, shone directly beneath them. They were rushing into it, drawn irresistably by its attraction!

Tubby took one horrified glance, and then, jumping to the keyboard, he depressed half a dozen of the keys indiscriminately. There was no answering vibration perceptible within the vehicle; but outside its windows the heavens were whirling! The sun, Venus, the threatening derelict globe, a myriad of stars—all flashed past the windows so rapidly they were distorted into mere blurs of light. The vehicle, beyond control, was spinning on its axis and falling abandoned in space!

Tubby and Ameena, standing stock-still on that solid, apparently motionless floor, were giddy at the sight.

"Oh-h, perfessor!" Tubby bellowed. "Help, perfessor! Come here quick! We're all fallin' to pieces!"

Sir Isaac came clattering downstairs, his apparel awry, his face still dazed by sleep. With one quick glance at the windows he hastened to the keyboard. Tubby and the girl stood anxiously beside him.

"Somethin' w-went wrong," Tubby chattered. "There's a b-big world right outside. We was r-runnin' into it."

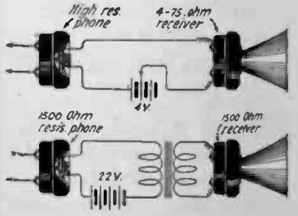
The vehicle, spinning like a top, gave Sir Isaac no opportunity of locating the correct keys to depress. He first threw them all into neutral; then tried, tentatively, throwing the attraction into the base of the vehicle for that instant when it was facing Venus, and releasing it an instant later.

How to Hook-Up A Transmitter Button to Make an Efficient Loud Talker

A Transmitter button with a few dry cells and a telephone receiver will make a remarkably simple and efficient loud talker. A Microphonic amplifier of this type is just the thing for use with a radio set. The weak music and signals may be amplified many times their original value. It is possible to entertain a large audience with a simple radio equipment if a transmitter button is used in the circuit as explained in diagram A.

The cost is extremely low and the results are comparable with those produced by highest grade of expensive loud talkers.

As may be seen in the diagram, two dry cells or a small storage battery are connected in series with the transmitter button and a 4 to 75 ohm telephone receiver. The transmitter button is secured to the diaphragm of the telephone in the radio receiving set. To accomplish this properly, scrape off the enamel (if diaphragm is enameled) on the face of the diaphragm and solder the small hexagon nut supplied with the button to the exact center. Care should be taken that the thin diaphragm is not bent or otherwise



harmed. The transmitter button is then screwed into place. Connections, as shown in the diagram, are made with flexible wire. A horn may be placed over the low resistance receiver if desired. When the radio set is properly tuned and signals are being received, the transmitter button is operated by the vibration of the diaphragm of the receiver. As the receiver diaphragm vibrates, the mica diaphragm on the transmitter button also vibrates. The carbon grains are compressed at varying pressure; the current flowing through the local battery circuit is thus varied and results in an amplification of the sounds in the low resistance telephone loud-talker.

Diagram B, which includes a step-up transformer, is to be used with loud talking receivers of high resistance. The primary of the transformers should have a resistance of about 75 ohms. An ordinary telephone induction coil will serve as the transformer in this circuit.

You can get the above-described transmitter button FREE in subscribing to "Practical Electrics Magazine" at $2.00 per year (12 months). Send your subscriptions today.

Make all remittances payable to Practical Electrics Co., 53 Park Place, New York City.

—Adv.

For five minutes he worked, his face pale with anxiety. "Am I stopping our rotation?" he asked. "Are we slowing down?"

Tubby forced his gaze to the window and saw that the heavens were spinning with a little less rapidity.

"Go on," he encouraged. "You're doin' fine."

"I don't dare leave everything in neutral," Sir Isaac muttered to himself. His gaze was glued to the floor window; the perspiration was rolling down his face. "Inertia would carry us forward on our former course without any force of attraction. We could not avoid collision. Perhaps we cannot anyway."

"Don't say that," pleaded Tubby. "Go on. You're doin' fine."

Ameena now crouched on the floor, gripping a chair leg to steady herself; and peered intently downward through the window. At each instant when Venus came into view she called to Sir Isaac, and he promptly depressed the necessary key, releasing it once the planet had swung past. With Ameena's help he did this more accurately than before, and gradually the vehicle's axial rotation was decreased. Finally they caught Venus and held it directly beneath them.

Sir Isaac stood up, trembling. "Thank God!" he exclaimed. "We are headed the other way. The danger is past."

Now that the excitement was over, Tubby felt extraordinarily weak in the knees. He sat down in a chair, panting.

"What was it, perfessor? What happened?"

"An asteroid," Sir Isaac answered, smiling weakly. "A minor planet, unknown to astronomers. *I* knew its orbit lay in here, but I had calculated the asteroid itself to be on the other side the sun this month—fool that I was!"

A moment later, carefully, Sir Isaac resumed their former course. The asteroid had disappeared; the sun now shone up from beneath them as before.

"How close did we come to it?" Tubby asked, when they had all three recovered calmness. "I guess we didn't miss it by more'n a mile."

"We passed it about 4,000 miles away!" Sir Isaac answered.

Tubby was amazed. "Four thousan' miles! An' I thought we nearly hit it!"

Sir Isaac smiled. "I should not care to come any closer. Our velocity at that moment was 7,200,000 miles an hour. That is exactly 2,000 miles per second. In just two seconds more we would have collided with that asteroid and been annihilated! That's why I said we were crowded in here. It is very dangerous to approach within a million miles of anything."

They had lunch shortly after that, Sir Isaac insisting on having his served on the store-room floor so that he might keep close watch through the lower window there, for comets, and even infinitesimal meteorites, as well as asteroids, were to be avoided. As Sir Isaac pointed out, to collide with even a hundred ton meteorite at a velocity of 2,000 miles a second would be a fatal catastrophe!

After lunch, over their cigars while Ameena straightened the kitchen, Sir Isaac told Tubby about Mercury, which he had hoped they would reach about five o'clock that afternoon, but which now they might not arrive at before six or seven o'clock.

"Mercury," Sir Isaac explained in his slightly pedantic way, "is the smallest of the major planets, and the closest to the sun. It's orbit lies at a mean distance of 36,000,000 miles."

(*Continued on page 409*)

Around the Universe

By RAY CUMMINGS

(Continued from page 407)

"An' how far did you say Venus was from the sun?" Tubby asked. He was becoming avid for astronomical mathematics.

"Sixty-seven million," answered Sir Isaac.

"An' the earth is 93,000,000. An' the moon a quarter of a million from the earth." Tubby was memorizing the figures. "All right. Go on."

"Mercury makes one revolution around the sun every eighty-eight days. That is the length of its year. It is so close to the sun that the enormous solar attraction holds one side of it always facing that way. Hence its axial rotation is also once in eighty-eight days, and it has no day or night—always daylight, twilight or darkness according to that portion of its surface you are on."

"What part are we goin' to?" Tubby demanded.

"To the Light Country, where there is daylight—but it is not too intense. Heavy clouds and a dense atmosphere make life possible on Mercury, even though it is so near the sun. In the Fire Country, which directly faces the sun, the planet is practically uninhabited. We will land at the Great City—the largest center of population on the planet. It is the Light Country people we want to enlist as allies, against their outlaw neighbors the Twilight people and those horrible Martians."

This brought them again into a discussion of the Martian plot which they were determined at all hazards to frustrate. Ameena joined them shortly after that, and for an hour they argued, without however, reaching any new conclusions.

Sir Isaac was momentarily growing more sleepy; and finally, when Tubby had solemnly promised that for two hours he would not leave the window under any circumstances and would call out at once if anything unusual came into sight, Sir Isaac again retired. They were then about 18,000,000 miles from Mercury, which shone as the brightest star in the lower hemisphere of the firmament, visually quite near the sun's outer limb. And so great was their haste that again Sir Isaac had resumed almost their former speed.

During these two hours, Tubby and Ameena sat on the floor by the window, exchanging accounts of their respective worlds.

"I'm strong for Venus," Tubby declared once. "When we get these Martians put in their place, an' get our moon back, I believe I'll come to Venus to live."

The girl agreed that would be very nice indeed; and Tubby, intoxicated by her beauty and the fragrance of her person, suddenly laid his hand over hers.

"Ain't this romantic though—shootin' around the sky like this? Sing somethin', Ameena. Where's that harp you had?"

Ameena played on her lyre, and sang; Tubby listened, and complimented her, and urged her constantly for more. Thus absorbed in their youth, the two sat oblivious to the vehicle's course, while the sun blazed larger and hotter, and Mercury grew from a gleaming star to a silver crescent—larger and larger until, like Venus of the morning, it stretched an enormous arch in the blackness, with the sun to one side behind it.

Fortunately for the safety of these bold voyagers (and indeed for the future existence of earth itself, which depended upon the success of their mission), no other uncharted wanderers of space chanced to be in the vehicle's path during those two hours.

It was nearly half-past four when Tubby came to himself. A glance through the window reassured him that all was well, and, reluctantly tearing himself from Ameena's presence, he went upstairs to awaken Sir Isaac.

They entered the atmosphere of Mercury at 6:57 P. M., shortly after a hurried supper. Falling diagonally over the Dark Country, they came into the Twilight Zone. A few moments later the Narrow Sea lay beneath them, and at last they sighted the Great City at the edge of the Light Country.

It was 7:29 P. M. exactly when, with only a slight jar, they landed upon the surface of Mercury.

(Continued next month)

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British chemists have evolved a household gas so harmless that would-be suicides can get no more than a headache from it. The new gas, which is now in use at Newark-on-Trent, can be produced at about a third of the cost of ordinary gas. It contains only 1.4 per cent of carbon monoxide, which is the poisonous element in household gas. American gas contains more than 4 per cent of this ingredient.

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$11,000 For Spirit Manifestations

(*Continued from page 321*)

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New Apparatus for Micro-Photography

By DR. H. BECHER

(*Continued from page 347*)

sufficiently and brings all irregularities of surface into relief. This fact alone makes it invaluable in micro-photography, preventing flat pictures.

The refracting medium is made of any suitable transparent material, preferably of optical crown glass. The light enters the medium from its lower surface, being cast thereon by a mirror mounted on the base of the microscope, or the light may be projected directly onto the illuminator, thus dispensing with the mirror.

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Practical Motor Hints

By H. WINFIELD SECOR

(*Continued from page 353*)

Some of this was then inserted between the brake linings and the brake drums by means of a knife, taking care not to cut the lining.

Of course, too much should not be placed on at first, but a little can be put on every day at first, and about once a week afterward. The writer found that in this way the squawking brakes lost their squawk completely in about one week, and they stopped the car in good order even from the very first.

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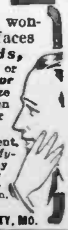

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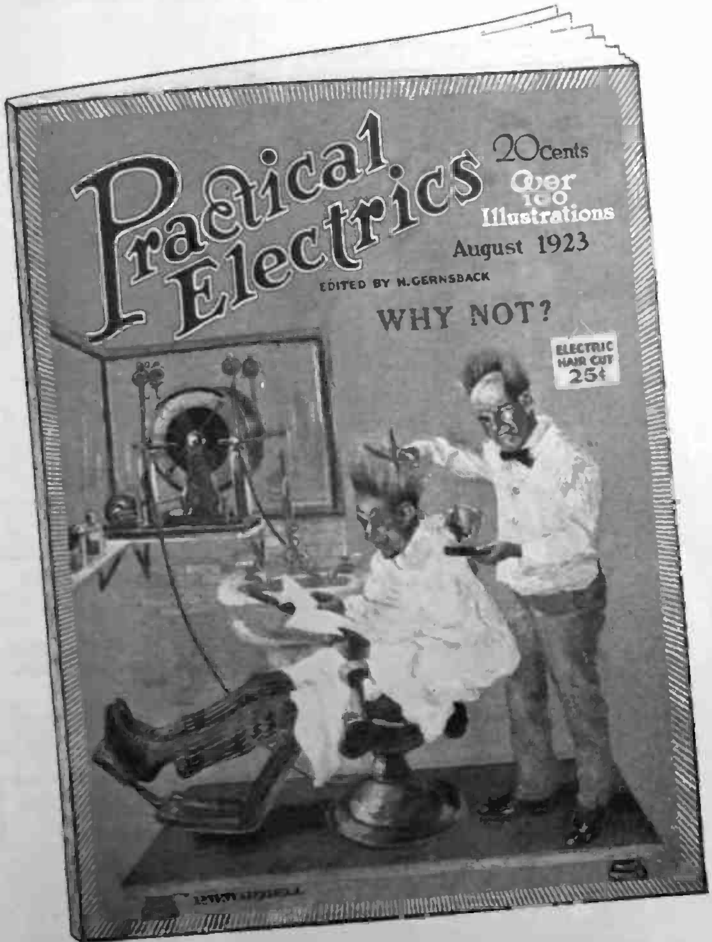

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