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June

Science and Invention

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FORMERLY
ELECTRICAL EXPERIMENTER

HOW TO MAKE A SOLAR COOKER

See Page 147

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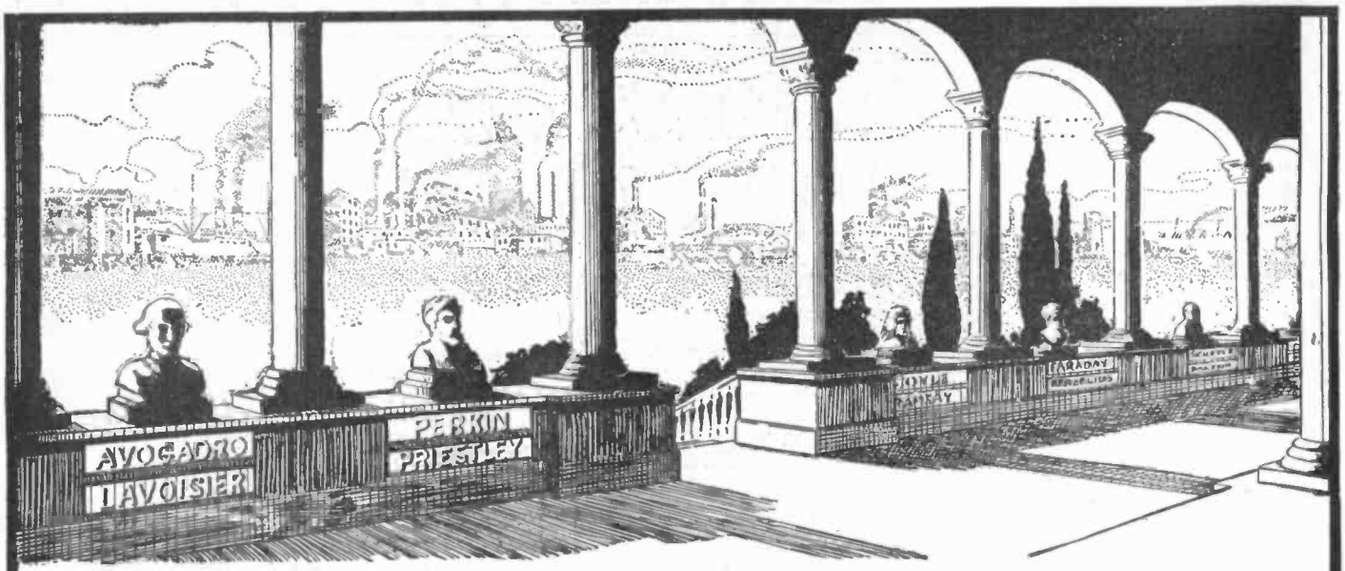

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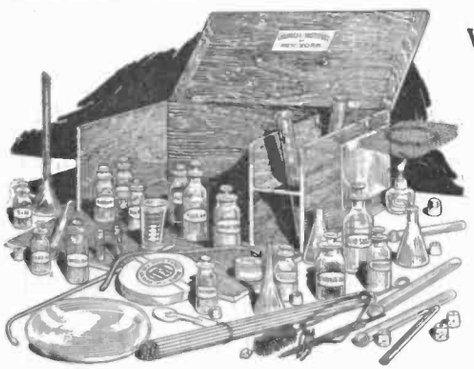

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Whole No. 122

Science and Invention

FORMERLY
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June, 1923
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SCIENCE AND INVENTION is published on the 25th of each month. There are 12 numbers per year. Subscription price is $2.50 a year in U. S. and possessions. Canada and foreign countries $3.00 a year. U. S. coin as well as U. S. Stamps accepted (no foreign coin or stamps). Single copies, 25 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., Inc. If you change your address notify us promptly, in order that copies are not miscarried or lost.

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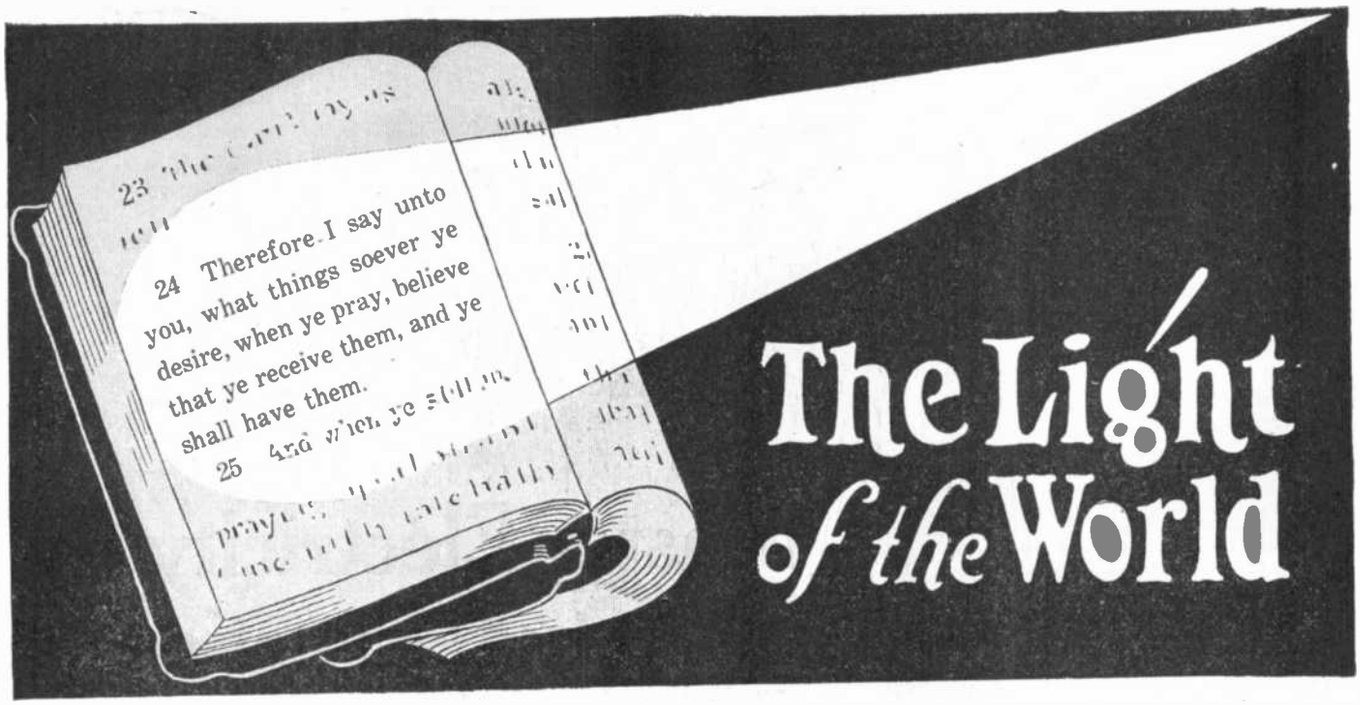

JESUS realized that men and women living in this practical, common sense world needed many different things for their comfort and happiness. Even at the time when He was here, they needed food, and clothing, and shelter, and love, and music, and the means of travel and transportation. And the needs of present-day men and women are not very different from the needs of men and women who lived in Palestine nineteen hundred years ago.

Jesus Himself had all of these things. He wore good clothes, ate good food, and went when and where He willed. The comforts and luxuries of some of the best homes in Jerusalem and other cities and towns were His whenever He chose to avail Himself of them, and among His intimate friends were many men and women of wealth, refinement and high position. In the text illuminated by the ray of light at the top of this page He tells how to get these things.

The tragedy of the whole matter is that so few people have received the things for which they prayed, and that so many good Christians are poor, and sick, and disappointed, and miserably plodding along toward the end of life sustained by the hope that the next world will be better than this one. Some who have prayed in vain attribute their failure to lack of faith. Others have concluded that Jesus had in mind some kind of vague and intangible spiritual rewards when He said people could get the things they desired by praying for them.

Whatever else Jesus might have been, or might not have been, He was a great teacher, had uncommon practical sense, and expressed Himself in clear and simple language. He was not a practical joker, nor did He give His people a stone when He knew they wanted bread. When He said, "What things soever," He meant, *"What things soever."* Nor can it any longer be said that the failure of so many millions of people to get the things for which they prayed was due to lack of faith. This failure was due to the wrong kind of faith. The fault was in the quality of the faith and not in the quantity. The text at the top of the page requires that one who prays for a certain thing shall believe that he is already possessed of it, even as he prays. The American version of the New Testament puts this belief in the past tense—"believe that ye have received," etc.

But can you believe that you have already received something which you know almighty well you have not received? The chances are thousands to one that you can't do it. And believing that you shall receive will not get you anything, however fervent your faith may be. The wonder-working science of Practical Psychology, among many other remarkable achievements, has devised a number of simple little methods whereby one may induce himself to believe for a moment that he has already received the things which he intensely desires, or prays for, thereby enabling him to comply with the terms prescribed by Jesus, and actually to get the things he desires.

Judge Daniel A. Simmons, one of the most widely known practical psychologists in the world, has enabled a great many men and women to get the things they intensely desired, or prayed for—magnificent homes, fine jewels, vastly increased incomes, marvelous healing of diseases, important promotions, coveted positions, abundant success in business and professional affairs, and many other such like things. The Judge has written a plain and simple manuscript message, entitled "REALIZATION," which will reveal to you your marvelous unusued possibilities, and point out to you just why and how you can get the objects of your desires and prayers. We will be glad to send you a copy of "Realization," fully postpaid and

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Volume XI
Whole No. 122

Science and Invention

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

JUNE
1923
No. 2

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

Spiritism

WITH this issue, SCIENCE AND INVENTION embarks upon a far-reaching campaign to enlighten the public on Spiritism in general. SCIENCE AND INVENTION takes the stand that practically all spiritualistic phenomena that have been exhibited so far rest upon a foundation of either pure fraud or deceit or, to be more charitable, upon self-deceit of certain investigators. Every so-called spiritistic phenomenon that has been produced so far by mediums, or by other investigators, can be performed by ordinary scientific means, without the spiritistic "hocus pocus."

Let it be said right here that we are not total disbelievers, for there are many phenomena that cannot be explained satisfactorily today. These, however, are not supernatural, and certainly have nothing to do with the souls or spirits of the deceased.

For instance, science cannot explain satisfactorily how the homing pigeon returns; also it seems to be an established fact that there is such a thing as telepathy. Moreover, the human body has a mysterious aura which can be seen under certain conditions. All of these things, however, have scientific facts as an underlying basis, although they are often confused with spiritistic nonsense.

We do not believe that up to this date a means has been found whereby dead persons can communicate in any manner, shape or form with the living. We repeat that we sincerely believe that all manifestations, said to be spiritistic, are based upon either fraud or self-deceit. There is, and will be, no effort on our part to confound religion with spiritism, as is now the vogue. SCIENCE AND INVENTION does not question the hereafter.

We do not wish to question anyone's religious beliefs, but we DO wish to take an emphatic stand against all unscientific demonstrations and all spiritistic "hocus pocus" which, as a rule, is designed only to prey upon trusting and believing people, either to extract money from them directly or indirectly, or otherwise to obtain publicity for certain individuals, be they mediums or investigators.

In making our $1,000.00 challenge, which will be found elsewhere in this issue, we are doing this because we believe that it is our duty to uncover all spiritistic frauds that have been perpetrated too long upon a gullible public.

Of course, not everything is fraud. Much is self-deception, which may go as far as self-hypnosis. If you sit in a darkened room, and are keyed up sufficiently well, and your nervous system is receptive, your senses will play you all sort of tricks, which would not happen to the investigator in broad daylight under normal conditions.

The psychic investigator understands this phase thoroughly, and also knows how self-hypnosis under such circumstances works, particularly when the spiritistic investigator is anxious to believe the most incredible things that are going to be enacted in front of him.

The subconscious mind is a wonderful machine, as anyone who has read Coué can testify. If you are in the right frame of mind, you can make yourself believe almost anything.

Furthermore, it may be noted right here that nearly all of the distinguished converts to spiritualism are, without exception, old men, well past 50 and 60, and some of them are much older than this. Their senses are certainly not as sharp as would be those of a younger man, and this phase alone is significant to those who are looking for the bare unvarnished truth.

This condition of elderly investigators is not at all mysterious, and we do not wish to imply that these gentlemen are senile and that their minds have become affected—not at all!

In the first place, physical impressions by older men are not as well defined as those of young men. Furthermore, and most important, is the fact that the older the individual the more the chances are that he has had some great bereavement during the latter part of his life, which loss he may feel keenly. It may be his wife, it may be a grown son, a brother, or a sister, which loss is felt much more keenly by the older than by the younger persons.

Furthermore, the older a man becomes, the more he is apt to think of death, when death is a remote possibility with the younger man.

All these things make the older individual a much better subject for spiritism than the younger. His frame of mind is such that he is far more easily impressed, and he would rather believe than disbelieve comforting thoughts.

The fundamental trouble with spiritism is that it confounds psychic phenomena with manifestations from spirits, although the two are about as closely connected as radio telephony is with thought-transference.

It is a scientific fact that there is such a thing as a medium, which we do not deny. There is also such a thing as hypnosis. It is well known that you can throw a subject into a hypnotic trance, under which the body and mind take on entirely different functions from those related to a normal condition. In a trance the medium will readily do, under suggestion, what the hypnotizer orders. These are facts which no scientific authority questions. But the connection between a hypnotic trance and departed spirits through such mediums is a far cry. There is no connection whatsoever that science knows of. But any strange action of a medium in a trance is immediately interpreted to be a sign or a communication from a deceased person, for no reason whatsoever. We do not question mediums as such in trances or when under an hypnotic spell, but we find no scientific basis for any connection between such a medium and a departed spirit.

Why must the spiritists have recourse to darkened rooms and to all sorts of other mummery in order to get their table-rockings and other manifestations? If the spirits are genuine, there is no question that they would just as readily give manifestations in the daytime as in the night—in the light as in the dark.

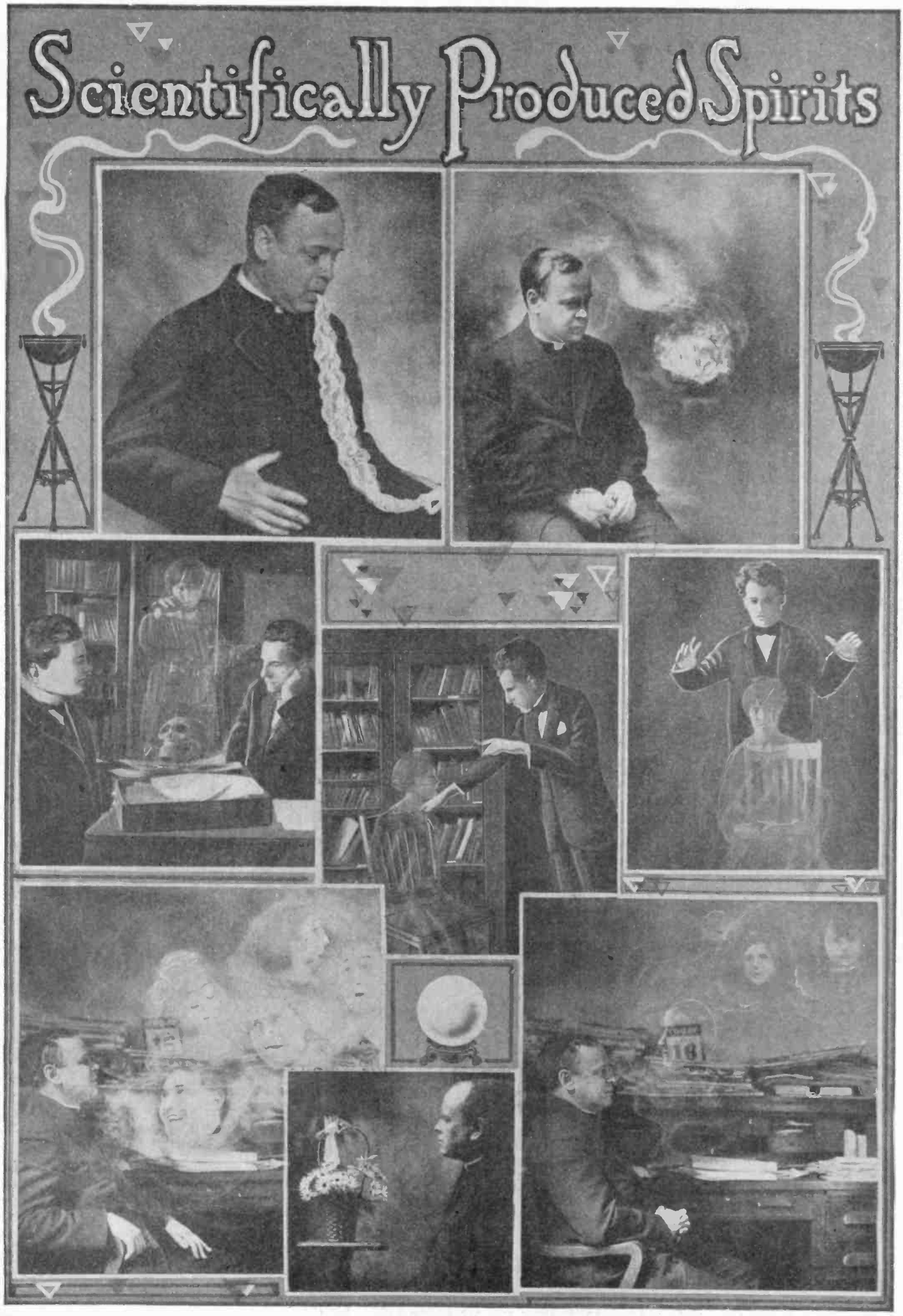
We believe that it is the height of cruelty to deceive well-meaning people with the present-day spiritistic hokum, and we do not believe that any good can ever come of it.

SCIENCE AND INVENTION, from month to month, will show the facts as they exist, but on the other hand it will be the first to report accurately the communications or signals from the dead, *whenever it can be proven that there exists an actual scientific basis for such a phenomenon.*

As long as the so-called spirits of Napoleon, Alexander the Great and hosts of other great historic personages are made to rattle dishpans, lift chairs, upset tables, and are supposed to be made to do all sorts of such childish nonsense, SCIENCE AND INVENTION will have nothing but ridicule for such rubbish as it exists today.

H. GERNSBACK.

Scientifically Produced Spirits



The Photographs Shown Above Were Taken Under Test Conditions. A Complete Expose of the Methods Employed in Taking Them Will Be Given in the Next Issue of This Journal.

A Challenge

$1,000.00 Prize Offer!

SCIENCE & INVENTION TO INVESTIGATE SPIRITISTIC PHENOMENA!

IT is with great chagrin that SCIENCE & INVENTION has followed the recent trend in certain quarters towards spiritism and allied subjects.

Great publicity has been given to certain foreign investigators in spiritistic phenomena whose work, to our mind, is not based upon any scientific foundation.

We have made our position clear in our editorial of this issue, and we are willing to back up our contentions and beliefs by our money as well.

There is at present a marked tendency to confound psychic phenomena with spiritism, two subjects that have nothing in common whatsoever.

SCIENCE & INVENTION believes in certain psychic phenomena and certain manifestations of the subconscious mind, particularly when the body is in a trance or hypnosis. The latter are scientific facts but they have absolutely no proven connection with the spirits of the deceased.

In other words, SCIENCE & INVENTION does not believe that there is a scientific foundation at the present time for the belief that the deceased are able to communicate with the living by any means whatsoever.

SCIENCE & INVENTION also believes that all of the so-called spiritistic phenomena and manifestations can be produced by scientific means without the aid of the spirits of the deceased.

The editors take the stand that such so-called spiritistic manifestations are either based on deliberate fraud or are the result of self-deception or self-hypnosis.

SCIENCE & INVENTION believes that all spiritistic manifestations, be they table-rappings, automatic writings, spirit photographs, etc., are all based upon natural phenomena in which the spirits of the deceased play no part whatever.

SCIENCE & INVENTION offers to duplicate any such manifestations, and will forfeit $1,000.00 if it is unable to do so.

SCIENCE & INVENTION has engaged the services of Joseph Dunninger, one of the greatest exponents of psychic phenomena in the United States, as its authority to duplicate and pass upon such tests.

Mr. Dunninger has demonstrated his ability as a mental telepathist, mind reader, and illusionist throughout the country, and is considered one of the best living authorities on spiritism.

In our investigations Mr. Dunninger will be assisted by a body of scientists, and a committee of prominent magicians, who will investigate the authenticity of the tests presented in the contest for this prize.

The contestants must abide by the following conditions:

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, can not 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.

A $1000.00 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, etc., to the satisfaction of a disinterested body of scientists.

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; tests such 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.

9—Methods employed by telepathists, mind readers, and mental artists, will not be accepted as evidence of spirit force.

10—Should preparation for duplicating a medium effect require a space of time for building or creating the necessary paraphernalia, such time as is necessary must be granted by the contestant.

11—This challenge expires on May 1st, 1924. In case of a tie, a duplicate prize will be awarded each contestant so tying.

12—In case the $1,000.00 has not been awarded by May 1st, 1924, SCIENCE & INVENTION may, at its option, withdraw the offer of such prize.

13—In case a prize is awarded to any contestant, SCIENCE & INVENTION agrees to pay this amount in gold, within ten days after the findings of the disinterested committee.

We desire to impress upon the minds of our readers that it is not the desire of SCIENCE & INVENTION to ridicule those who sincerely believe in so-called spiritistic manifestations. We desire to show that the communications and manifestations alleged by mediums and spiritists to emanate from the other world prove nothing and can be duplicated by an accomplished magician. We hold that these manifestations are not sufficient to prove that the communications are supernatural or that the physical manifestations are the actions of the dead.

Up to this time there has not been any scientific basis to prove conclusively by scientific means that there is a communication between the deceased and the living. Whenever scientific proof is given that such communication exists, SCIENCE & INVENTION will be the first to publish such a discovery.

Science Versus Spiritism

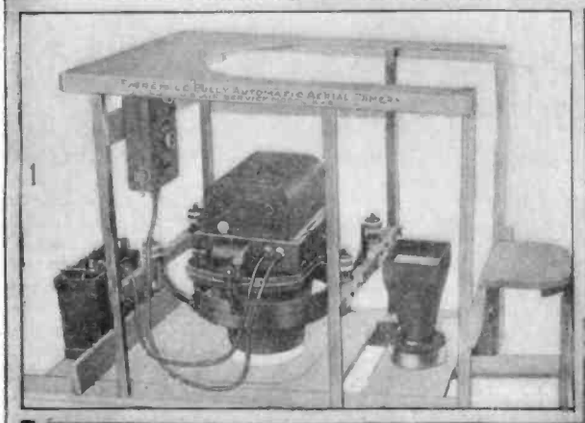
By JOSEPH H. KRAUS

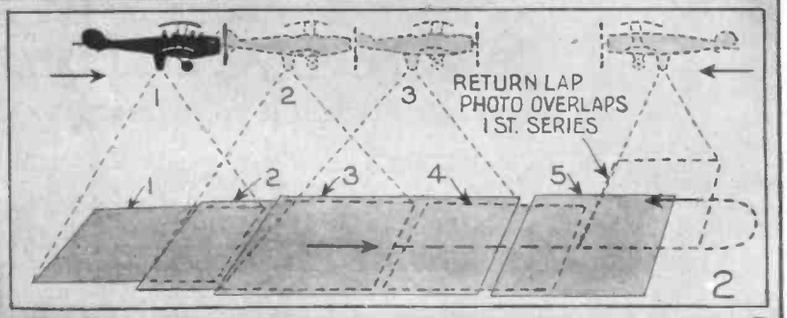
LONG and bitter have been the battles between spiritists or spiritualists (use whichever term you desire, as they are practically synonomous), and scientists. Such eminent men as Sir Arthur Conan Doyle, Sir William Crookes and some of our own American scientists, have fallen victims to mediums and although they themselves do not willingly attempt to deceive the public, we believe that their powers of perception are weakened by clever mystifying and awe-inspiring, supposedly occult manifestations, and we see these clever men preaching to the public and announcing the possibility of communicating with those who have passed through the veil which separates life and death. Sir Arthur has been deceived many times. One of those who found him an easy prey was the famous medium Eusapia Palladino. On the other hand we are of the opinion that Sir Arthur Conan Doyle is absolutely sincere in everything that he preaches. But we do not believe that those effects which he exhibits are actual spiritistic manifestations.

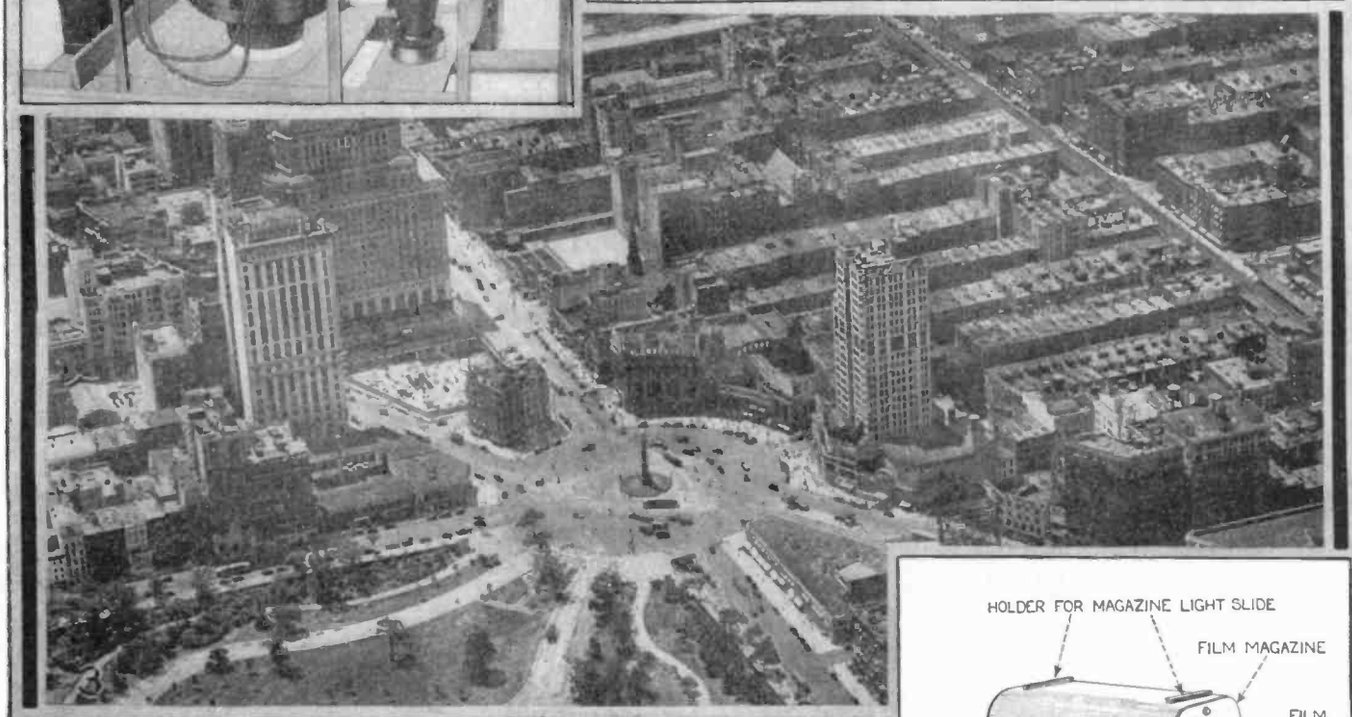
Years ago the writer, being very much interested for personal reasons, in spiritistic phenomena, visited or rather attended seances of nearly every medium who was well known in and about New York. Each had a different version of her own powers; some would imbibe the spirit forces of those deceased, going through gyrations which in ordinary circles would class them amongst escaped inmates of hospitals for the insane. The individuals of this class would then recant the stories which they had received after being invested with the "spirits." After this a long, weird tale was told describing the mental effects upon the poor mediums, who were so exhausted at the end of the seance (principally from their violent twitchings which they produced during the session, in order to regain their composure when they

(*Continued on page 203*)

MAPPING FROM THE AIR







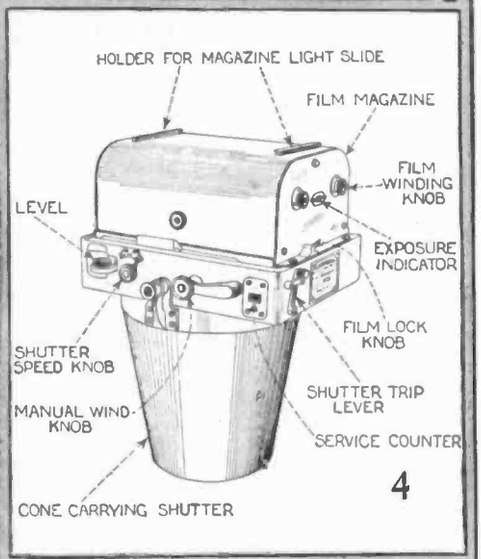


Fig. 1 Shows the Automatic Airplane Camera with Electric Control for Taking a Successive Series of Pictures, as Installed in the Cock-Pit of an Airplane. Fig. 2 Shows How the Successive Pictures Are Taken One After the Other, so as to Overlap Thoroughly as an Aid in Assembling the Prints Afterward Into a Composite Photograph Map or Scenic Panorama. This Overlapping Allows of Liberally Trimming the Prints so That They Will Match Perfectly. Fig. 3 Represents One of the Finest Aerial Photographic Pictures Ever Taken. It is a View Above the Entrance to Central Park at 59th Street and Broadway, or Columbus Circle, Looking Southward. Fig. 4 Shows Details of the Automatic Aerial Camera, While Fig. 5 is a Map View Taken Directly Overhead of Columbus Circle and Vicinity; See Also Fig. 3. Fig. 6 Shows Experts Matching Prints to Make Large Composite Aerial Photo of New York City.

Mapping from the Air

By JACK D. DESHA

AERIAL PHOTOGRAPHY EXPERT

"WHY, that's the same field I planted to corn last year!"

Thus spoke a Southern New Jersey farmer when the representative of a public utility company approached him to buy a right of way through his farm for a high power transmission line. Instead of sending their representatives out with the ordinary topographic maps or blue prints, this company had secured and were using the newer and recently developed Aerial Photographic Map. By its use the farmer was easily shown the exact property they wished to buy and knowing what the company was talking about, agreed to the sale at once. He was not suspicious as he had been on similar occasions in the past when he had been asked to sell land as laid out on the typical line map which he as a layman did not understand.

While this newest variety of map is so easily read and understood—being in reality a picture composed of a series of Aerial Photographs taken looking directly down towards the earth's surface—it is not the easiest of maps to make and the science of making such maps has not sprung up over night. It is rather the result of years of painstaking effort, study, research, experiment and practice The rather common impression which prevailed immediately after the World War, that all that was necessary in order to make an aerial map was an airplane, a camera (of any description) and a dark room, has long since been exploded. The construction of these maps requires the services of trained civil, mechanical and aeronautical engineers; photographic chemists of experience; precision instruments, specially built and adapted to this service; as well as careful plans and considerable capital.

Experiments looking toward the construction of maps made from photographs taken in the air date back into the early nineties, when engineers in Austria and Germany were trying to secure their photographs by suspending cameras in the air from such unstable and unmanageable supports as kites! Then came the dirigible, a decided improvement on the kite, but soon pushed into the background by the advent of the World War and the perfection of the fast moving and easily maneuvered airplane. That was the real start of an industry that is destined to provide maps not only of areas which are known and inhabited, but of even greater importance, of those great areas in Asia, Africa and South America which will be explored in this way and developed into habitations for man and his industries during the present century.

It was discovered early in the war that the then available cameras were unsuited for use in airplanes. Cameras of an entirely different design had to be built. The speed at which the plane traveled made it necessary that the camera body be rigid and at the same time light The vibration of the motor must be absorbed and not allowed to shake the camera at the moment of exposure; the shutter must operate at the greatest possible speed due to the rapidity of travel, thus calling for a larger aperture to admit more light to the sensitized gelatin surface of film or plate, which film or plate must be many times more sensitive or photographically speaking, "faster," than the ordinary one.

All of the above requirements have been met and overcome. Today the Photographic Sections of both the United States Army and Navy Air Services are equipped with precision aerial cameras embodying all of the above described features and many others. This instrument or camera is known as the Model K-3, Automatic Aerial Camera.

The camera proper consists of four principal parts; the Camera Body, the Shutter in its Cone, the Film Magazine and the Camera Mount

The Camera Body contains the main drive mechanism, which is driven by a 12-volt electric motor. The functions of the main drive are to control the motor circuit, rewind the shutter after each exposure and wind the magazine drive which in turn spaces the film between exposures and operates a pressure plate for holding the film flat at the time the exposure is made. On the body are also mounted the necessary controls, such as the knob for setting the shutter speed, the level and sockets for the electrical connections as well as the levers for manually tripping and rewinding the camera.

Mapping from the air is not only a war-time stunt, but an accomplishment which bids fair to come into use more and more for peace-time requirements. Imagine the geography of tomorrow with its dozens of aerial map views of cities and mountain ranges, lakes and rivers, which are much more instructive and comprehensive in every way than the pictures to be found in the ordinary book of travels. Surveyors will find the airplane mapping service of tremendous value, as this science has been brought down to the point where, by means of an automatic camera, successive overlapping pictures can be taken of a given piece of territory, so that eventually all of the prints can be trimmed and matched to give a technically correct panoramic view.

The shutter, which is of the "between-the-lens" type and placed near the lower end of the cone immediately behind the lens itself, opens over an aperture of approximately 3 inches. The shutter speeds, three in number, are controlled by a reliable inertia device which is not affected by temperature or other varying conditions. With an efficiency of 60% at 1/150 of a second, 75% at 1/100 of a second and 85% at 1/50 of a second, the K-3 shutter is far in advance of other "between-the-lens" shutters. Interchangeable cones are made for different focal length lenses which may vary from 6" to 20". The "between-the-lens" shutter is the only type with which accurate maps can be made, as it minimizes the distortion and eliminates uneven lighting. The focal plane shutter gives both distortion and uneven lighting, the first due to the length of time required for the slot to pass over the entire film and in the second to the variation in rate of speed to which different parts of the film are exposed.

The Film Magazine takes a roll of hypersensitive, panchromatic film 9⅛ inches wide and 75′ long, which is sufficient for 115 exposures. At the time the exposure is made vibration in the camera itself is eliminated as the motor is stopped. The film is held against an optically flat glass by the pressure plate. This glass plate is accurately marked with lines which are photographed on the film for determining shrinkage and locating the exact center of the negative.

In addition to the camera proper, the complete equipment includes the Intervalometer, which is a timing device for tripping the camera at regular predetermined intervals which can be varied from 7½ to 90 seconds. Signal lights connected to the camera are placed in both observer's and pilot's cockpit and flash a warning some 6 seconds before the shutter is automatically tripped. A negative sighting lens is used by the photographer in watching his course of flight. The camera with mount and one 75′ roll of film weighs 46 pounds, the intervalometer, 5¾ pounds.

This camera is designed to meet all the requirements of modern aerial photography being applicable for single objectives, for the oblique or perspective view and for stereoscopic views, but its greatest utility is derived in the taking of a series of overlapping pictures from the vertical over large areas to be later matched together into a single continuous picture, mosaic in character and, provided the proper ground control is used, having all of the accuracy, far greater consistency and many times the detail, that can be secured from maps made entirely by tedious, slow and costly ground methods.

In making a map by any method it is necessary to have some control, that is points whose distance apart and difference of elevation are very accurately known and which serve as a basis or starting point for measuring the position of intermediate points. The less control we use, or putting it in other words, the further apart we can place our points the less will be the cost of the map. In the development of Aerial Photographic Maps less control points obtained on the ground are used than in the past, the intermediate control points being secured by plotting from the photographs themselves.

Thus it will be seen that primarily the problem is one of engineering and that while the photography must be of the best and is an invaluable aid, it is only one of the elements that enter into the proper construction of such a map.

After the flying has been completed the first step is to plot on large boards this control "net" at the scale desired in the finished map. Then a print is made from each of the negatives secured on the flight The first problem is that of bringing all of the prints to the same scale even though it may not be the same scale as that of the finished map. In flying and taking the negatives an overlap of at least 50% of one film on the other is always obtained. This overlap is both linear and lateral. So it is perfectly possible to measure between the same two identical points on two overlapping photographs. By doing this it is possible to determine how much the second print must be either enlarged or reduced to bring it to the same scale as the first photograph.

After the individual prints are brought to exact scale they are fastened down with special adhesive preparations which neither expand nor contract the paper.

X-Ray Movies of the Body

By A. P. PECK

ON account of the wonderful advances made in motion picture production within the past few years, the title of this article should not be a surprise. When one can see the "impossible" feats performed in the movies, it does not take a very great stretch of imagination to picture to one's self, X-ray movies. A leading electrical manufacturing concern has produced a two-reel film entitled "Revelations," which deals with the production of these rays as well as with many of their uses.

In connection with this film, animated drawings are used for depicting the process of the production of X-rays. The electrons are shown passing through the space within the tube and striking the target; the paths of the X-rays thrown off from this target are shown by dotted lines. As is usual in this type of cartoon or drawing the action is followed through very accurately and a wonderful amount of knowledge regarding the production of X-rays is obtained by viewing the picture. Of course, one must remember that particles of matter invisible to the eye are recorded on the film in greatly exaggerated size. This is especially true in the case of the electron streams and the X-rays, the constituents of both of which are invisible to the human eye. The former are, however, for clarity's sake, enlarged in size many millions of times and are represented on the screen by very large dots. The speed of flow is at the same time reduced so that they can be easily seen, and when they strike the target within the tube, they appear to burst in a manner which resembles strikingly, an explosive shell from a gun hitting the earth. From the point of impact the X-rays are shown shooting off in progressive lines.

After the showing of these animated drawings various uses of the X-rays are shown in a very comprehensive manner. For instance, the interior of an up-to-date dental office is shown and the method of taking X-ray photographs of the teeth is entered into. It is shown how a small strip of photographic film is placed within the mouth of the patient and the X-ray tube brought into proximity to the side of the patient's face. The tube is then actuated for a few seconds, whereupon the exposed film is removed and developed. Of course, during the entire process the strip of film is kept covered by being placed in a black envelope to protect it from ordinary light rays, but the X-rays penetrate this with greatest of ease.

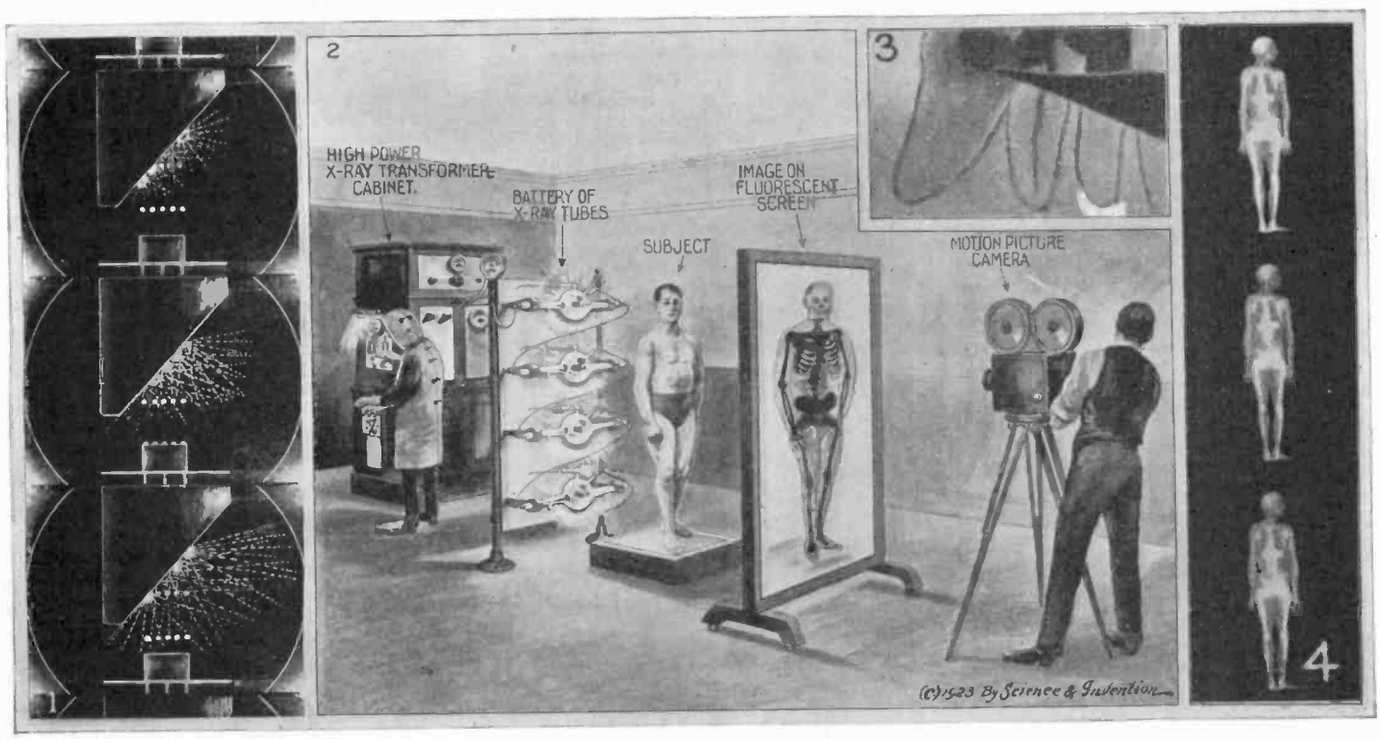
Various types of X-ray apparatus are shown together with many of their uses in hospitals and other institutions. It is shown how the tube can be placed in many positions such as under or over a patient reclining in a bed, in order to secure photos from various viewpoints.

One of the most spectacular portions of the film is that showing an X-ray photograph of the entire human body. When one considers that a single X-ray tube will only take a portion of the body at one time, the stupendous amount of work necessary for such a photograph will be realized. It is necessary to employ a battery of X-ray tubes arranged in a very particular manner for making this photograph and our illustration, in a somewhat simplified presentation, shows a method of doing this work.

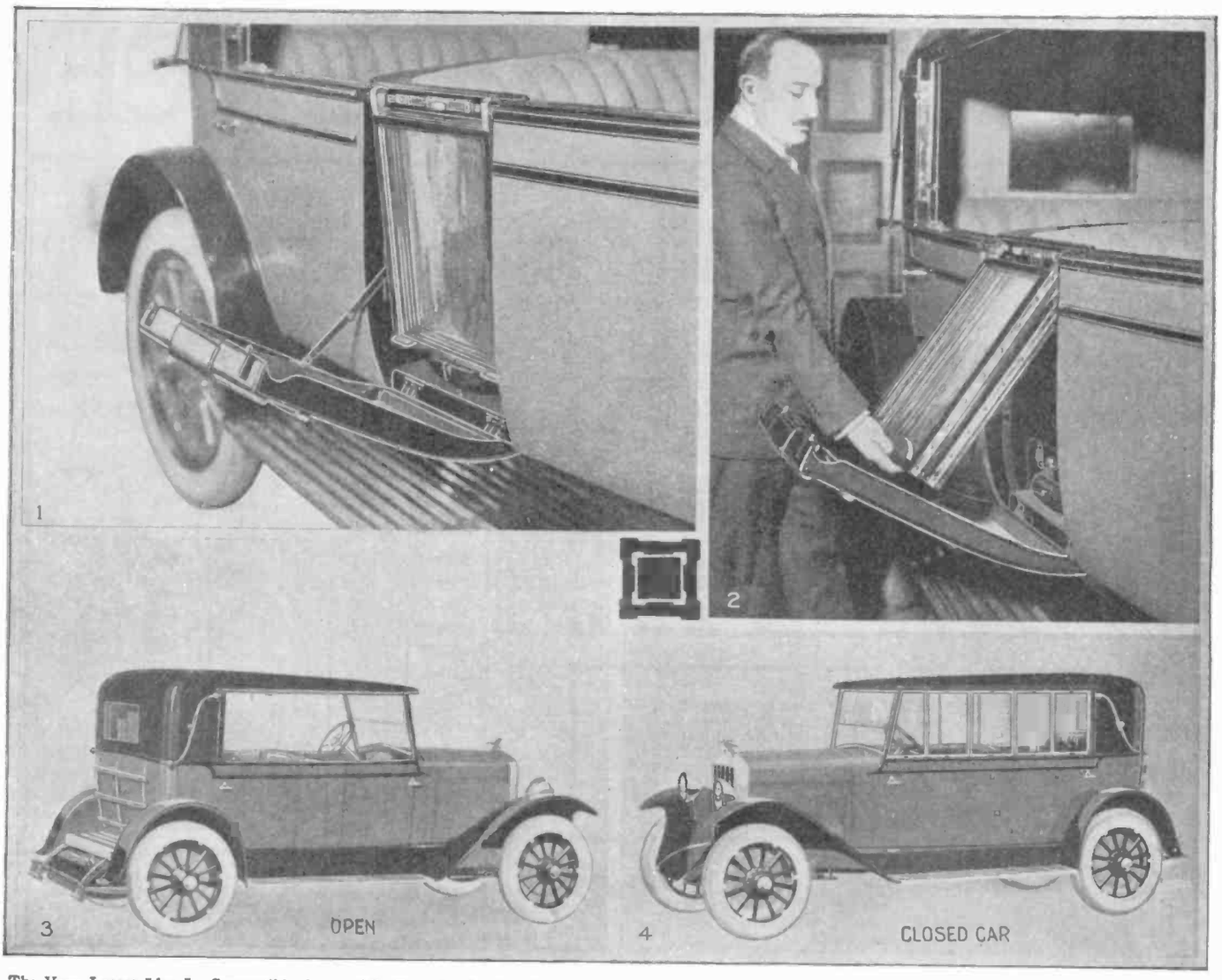
As is well known, the continuous exposure of the human body to the influence of X-rays is highly injurious to the tissues and in cases has resulted in the necessity of amputating the hands and arms of workers continually exposed to these rays and has killed a number. The X-rays have been found valuable in treating cancer, wherein they are used to "burn" away the diseased tissue. Obviously, if they will attack the latter they will also destroy healthy tissue, and for this reason the X-ray technician shown in the illustration must necessarily wear protective clothing. The rays will not penetrate lead and, therefore, he wears a coat composed of a metallized fabric having lead as its base. His gloves are made up of the same material and a lead helmet protects his face and head. In the front of this helmet are openings covered with a particular kind of lead glass, which protects the eyes from the rays but still allows the wearer to view his work. It is the constant exposure day after day to X-rays that results in complications, and, therefore, a patient can be safely exposed to their action for a few moments without any harm being done.

Now, in order to take a photograph of the entire human body at once, it is necessary that a large number of tubes be employed. Four are shown in our illustration, but in some cases it will be found necessary to use more of them and to employ extra powerful tubes. The subject to be examined or photographed is placed between this bank of tubes and a fluorescent screen. On the opposite side of this screen from the subject is set up a movie camera. Now, when the X-ray apparatus is put into action, an X-ray image is thrown upon this fluorescent screen and may be photographed by the operator of the camera. Extraordinary results may be obtained in this manner, and a strip of film taken from the motion picture mentioned above is shown on the right of the illustration.

The value of such photographs to the physician can easily be understood. He will be able to examine the entire body from one photograph without the necessity of making several exposures with consequent danger to the patient from exposure.—*Photos, Courtesy General Electric Co.*



On the Left of the Above Illustration Is Shown the Cathodic Bombardment Which Takes Place In An X-ray Tube. As Depicted By a New Motion Picture Film. The Center Illustration Shows the Method Used In Taking X-ray Motion Pictures. A Whole Battery of Tubes Connected In Series Produces the Image On the Screen Coated With Barium-Platino-Cyanide. At the Right Is a Strip of Motion Picture Film Showing X-rays of a Complete Human Body. All the Boney Movements May Be Seen In This Picture, and Inserted In the Illustration Is An X-ray Photo of the Teeth.



The Very Latest Idea In Convertible Automobile Tops Is the One Here Illustrated. It Was Designed By a French Body Builder, and It Has Now Reached America, Where It Promises To Be Popular. The Glass Sash Folds Up On Specially Built Hinges Into the Doors, As Shown. Thus One Can Enjoy All the Pleasures of An Open Car In the Summer and a Tightly Closed Car In the Cold Winter.

Convertible Sedan-Touring Car

By CHARLES G. PERCIVAL

FOR the owner who desires an all-the-year-round car, there has been designed by a French auto body builder an automobile body attractive in appearance, light in weight and yet practical for use in all sorts of weather. This new convertible type of body has reached America, where it promises to be popular.

The device is simplicity itself and it can be converted from an open to a closed car in one minute. The large plate glass windows are held firmly in a narrow metal sash. They are joined by full length piano hinges and fold compactly upon one another. The center window is hinged at the bottom and when all windows are folded the entire device swings down and fits snugly into a side panel of the body. Each connection is absolutely secure and there is no possibility of rattle nor danger of breakage. There is no fuss with snappers or buttons, or trouble with curtains that do not fit.

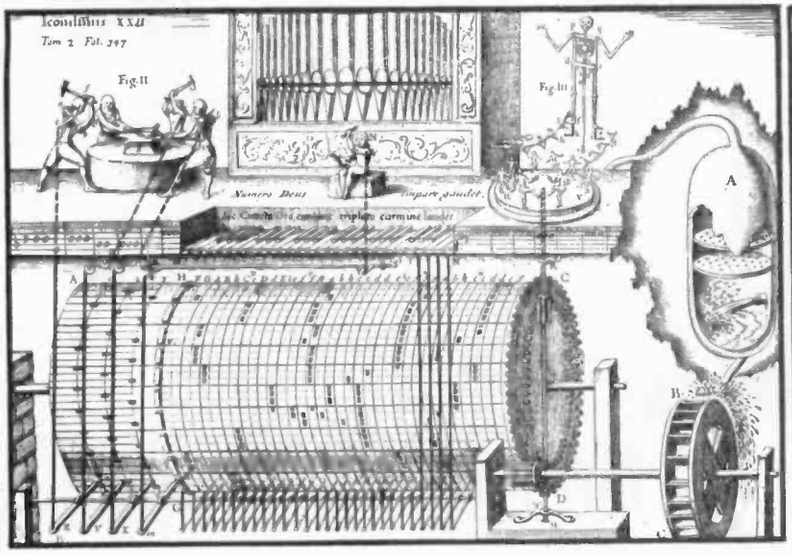
Pilotless French Plane Controlled By Radio

A REMARKABLE series of experiments has been carried out at the Villesauvage airdrome at Etampes with an airplane directed by wireless from the ground. The work has been done under the supervision of the Military Technical Committee, which is entirely satisfied with results up to the present. The inventor of the appliance used is Captain Boucher, ably seconded by two engineers, Percheron and Bernady.

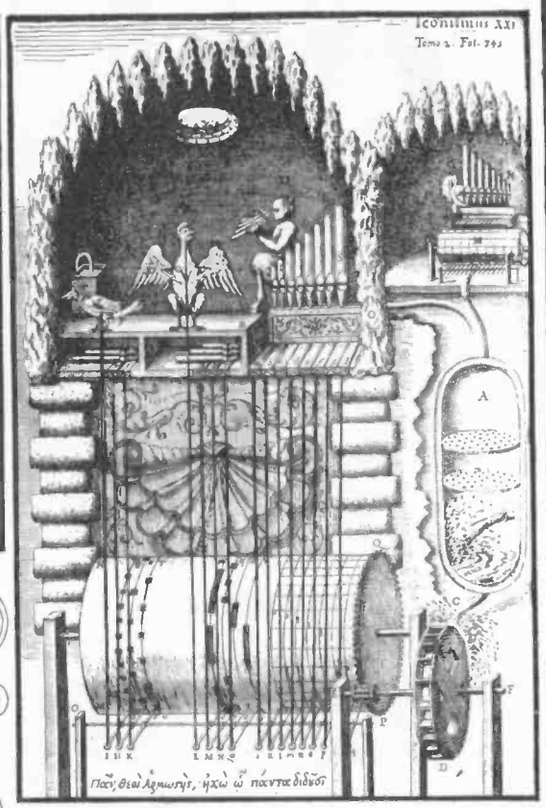
On April 10th, successful flights were made at a height of 500 meters. The machine was a large Voisin bombing plane with a 300-horsepower engine. It flew easily, maneuvered freely and landed and rose several times in succession without a hitch of any kind. Percheron and another engineer were aboard taking observations. A Sperry stabilizer with four gyroscopes maintains equilibrium automatically, while a special device cuts off the spark when the machine nears the ground so that it lands as gently as a plane guided by a pilot.

Captain Boucher pointed out many uses to which a pilotless plane could be put both in peace and in war as soon as the appliances have been perfected, which he is satisfied will be accomplished very shortly. Among possible uses to which he pointed one of the most important is in the mail service. Captain Boucher declares that under existing circumstances a pilotless machine with a turbo compressor could fly at a high altitude and great speed and deliver at Paris mail from Marseilles in two hours, from Algiers in four, and from Tananarivo, Madagascar, in forty.

ANCIENT SCIENCE

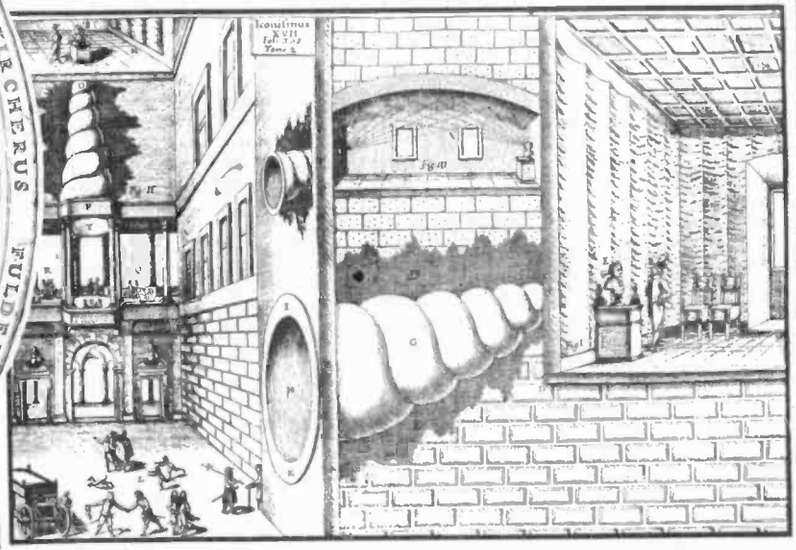


An Ancient Self-Playing Organ. This Is Driven By a Water Wheel Rotating a Drum With Pegs On Its Surface To Operate the Tracers, and Incidentally To Actuate the Various Automata. Father Kircher Set Great Store By the Automatic Figures, and In Those Days a Great Deal of Attention Was Given to Such Little Manikins.



This Is Another Version of the Same Subject. Here We Have a Small Organ, Which Is Supposed To Reproduce the Music of the Pan Pipes As Played By the Faun In His Little Cavern. An Echo of the Notes Was Desired, So In Another Little Cavern, the Nymph of the Echoes Has Her Own Organ and Reproduces the Notes of the Faun's Pan Pipe.

Portrait of Father Kircher In the Sixty-Second Year Of His Age, Taken In 1664, According to the Inscription. He Was One of the First To Study Egyptian Hieroglyphics, Which By a Certain Effort Of the Imagination, May Bring Him Into Relation With the Tut-ankh-Amen Discoveries in Egypt.



Shell Shaped Acoustic Tubes, Which In Their Results Father Kircher Claims Surpass the Ear of Dionysius, the Tyrant of Syracuse. We May Look On These As the Predecessor of the Dictaphone, But of Course These Are Purely Acoustic. It Is Interesting To Notice That In One Case He Relies On the Echoes From An Arched Roof To Focus the Sounds Upon the Little Bust Which Is Supposed To Enunciate the Words.

Ancient Dictagraphs and Organ Players

By T. O'CONOR SLOANE, Ph. D.

IN our May issue we showed reproductions of some old optical instruments—microscope, telescope and magic lantern, from the Kircherian Museum in Rome. These are most interesting, showing old-time developments of optics, and incidentally giving a very early example of a perfected magic lantern, dating but a few years after the active days of Father Kircher's life, who was undoubtedly the inventor. So it may be said that to him is due the enormous development of the moving picture, for without the magic lantern it would never have been anything but a toy affair.

We now come to sound, and here we go back to Father Kircher's old books written by him. He was responsible for some forty volumes all in Latin. One of the illustrations shows in very wonderful development what we may term the Ear of Dionysius, who was called the "Tyrant of Syracuse," a city identified with the legends of the work of Archimedes, and his ear so-called, was some sort of a speaking tube which led to a prison cell. By listening at the remote end it was said that the monarch could hear what was said in the distant chamber. It was a sort of predecessor of the modern electric dictagraph.

In the illustration reproduced from Father Kircher's book, *Masurgia Universalis*, is shown what we may call the Dionysian Ear, on a very grand scale. Soldiers are seen talking and perhaps plotting together, in what seems to be a courtyard of a castle, and from it tapering tubes, resembling the shells of gigantic snails, lead to distant rooms. At the right we see a bust, which is supposed to be connected with the small end of one of these tubes, delivering the message to the imperious looking individual standing in front of it, presumably repeating the words of the men in the courtyard. A variation is shown in the same plate, where a vertical tube rises out of an apparent dome, carrying the sound to a bust as before, this time the sound waves traveling vertically upward. But still more interesting is the third arrangement where the sound waves coming from the small end of the tube are reflected from the arched roof of the listening chamber to a bust, for Father Kircher's idea seemed to be always to have a bust as the reproducer of the sound.

The author lays great stress on these helical or shell-shaped vocal tubes. He says the interior should be very smooth, and if built of stone the constructor can employ plaster to smooth the interior. It would seem that the construction of such a tube in masonry would be an exceedingly difficult proposition. A brief quotation from the author gives his views on this achievement. He says that he has beaten Dionysius in the production of these sound transferring devices. Here is what our author says:

"This mechanism being perfected, I say, nothing can be said so secret in the opposite square, court, or public place, which the orifice of the tube faces, which by the shell will not be transferred to the hidden chamber. In this, therefore, thou wilt perceive the various sounds of animals, the hidden murmuring of men, songs, weeping, ejaculations of men as distinctly and clearly, as if they were produced in the very chamber, no one suspecting whence came so prodigious an effect of sound."

Father Kircher, the great scientist, was greatly devoted to music. The early students of science gave much time and thought to the production of automata, figures representing men or animals, who performed various motions, reproducing as nearly as possible the natural movements of animals and men, and these also interested our author.

One of the illustrations shows an organ driven by a water wheel, a blast being provided, according to the description, by the same jet of water which actuated the water wheel, and to make the combination complete various automata were provided. The water entered in a great jet into a cylindrical vessel with hemispherical ends. Perforated diaphragms across this vessel are provided and they were supposed to remove water spray from the air, for Father Kircher relied on the jet of water carrying in sufficient air with it to blow the organ pipes. The water escaping from the bottom turned a water wheel, and this by a pinion and a gear wheel turned a drum. This drum acted by pins driven into its surface, and properly spaced, to actuate a number of levers and these by tracers operated the keys and admitted or cut off air for the different organ pipes, thus playing an air and incidentally causing the automata to perform various movements. The birds were supposed to flap their wings, and open or shut their beaks, so that here we have the combination of automatic figures of the marionette type and of a mechanically operated organ, in a sense the origin or better the predecessor of the modern player piano.

The scientists of a few hundred years ago entertained some novel and interesting ideas concerning dictagraphs and organ players, as the illustrations on the opposite page clearly show. By means of a gigantic ear or shell, it was planned to overhear conversations in another part of the building. One of the novel points about Father Kircher's idea seemed to be always to have a bust figure as the reproducer of the sound in the listening chamber. The mechanical organ players of the type here illustrated are really works of art. Some of these organs had birds and other figures on them, all of which figures operated and gave forth the proper sounds at the proper time.

We now come to a still more interesting apparatus. Here we have the same mechanism for turning the drum. The levers and tracers are there but the automata are still more varied. The rather dreadful looking skeleton on the right performs a sort of dance of death, while a special gear keeps the little circle of figures near his feet turning around and around as long as the instrument performs. Near the center of the organ pipes and over the keyboard, is a little figure who is again supposed to move his arms about and play a pan pipe, when the organ is in operation. A horizontal shaft below the keyboard has a couple of arms projecting from it, one arm actuated by a tracer from a lever operated by the playing drum, and the other arm connected to the little figure to keep him in motion. On the left are a group of blacksmiths quite elaborately constructed, so as to deliver their blows upon an anvil, reminding one of the famous figures in Venice which strike a bell with a hammer. These two are operated by cords also actuated by levers.

He alludes to Pythagorean music, and in connection with this he refers to his blacksmiths. These, he says, are three Cyclops, with Vulcan as the director of the operations at the anvil. He says that he has played this music before many a prince with applause and admiration.

The anvil is to be made of resonating substance, and hollow so as to give a good noise. He attaches much importance to a rooster on one of the organs who is to open and shut his beak, and move his wings and tail as he crows, and he even gives the notes to be used for his crowing, for in those days much interest was taken in such things, which we now regard as little more than toys.

The hydraulic apparatus for producing the blast is not all that he relies on. Ordinary bellows operated by the water wheel for blowing organs are quite elaborately described and illustrated on different pages of the book. The cylinder, into which the numerous pegs, which actuate the organ's tracers and keys, are driven, he calls the phonotacticum. He gives numerous plans or what we may call, developments, to show how to drive the pegs for producing airs and musical compositions on the instrument.

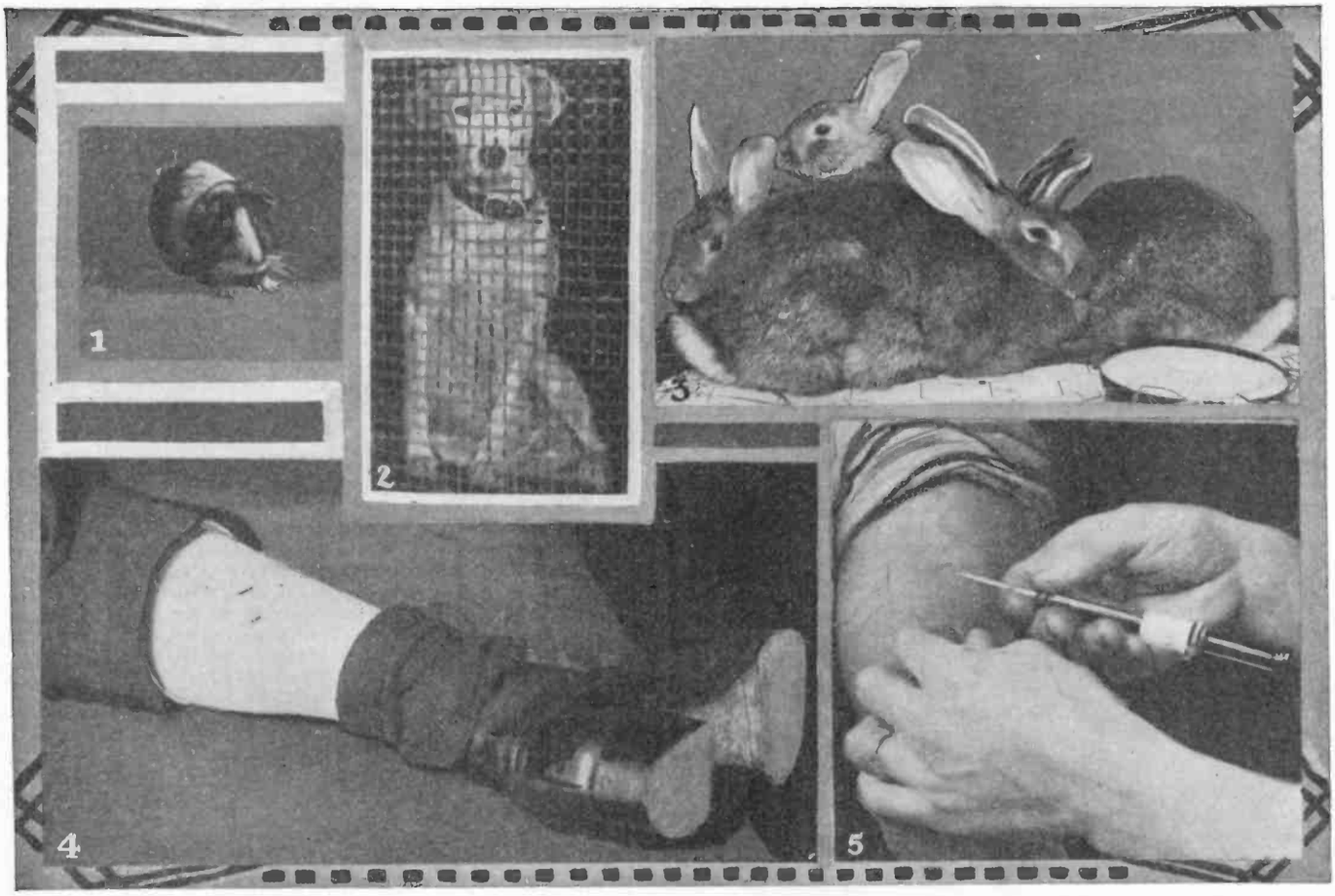
One of the automata is a faun, who, as just stated, is supposed to blow upon Pan Pipes. The author desires to produce an echo effect. The faun is in full view in the center of the organ, but off to the right, in her own little cave, is a nymph, the spirit of the echo, who has her own little organ, and by it she is supposed to repeat the notes of the Pan Pipe, so as to produce the effect of an echo coming from a hidden or partly hidden chamber.

There are many other illustrations in the book. In one of them the author shows a very elaborate set of chimes with no less than 17 bells operated by weights and governed by a clock—and it apparently is a clock depending upon rotating weights for its regulation, instead of upon an escapement.

Two or three of the illustrations show xylophones, an instrument which he terms "Zylorganum," a mistake in orthography, which is quite curious. One of these xylophones is supplemented by one or two bells, and has a block of wood on its side to be struck by a mallet, so that it really represents an instrument capable of producing the jazz music, to which modern audiences, in this city at least, seem to have become so devoted. We evidently can hardly call ourselves three centuries ahead of our author.

A theoretical question is treated as to whether sounds can be produced in a vacuum. He says comparatively little about it, but he is concise and covers the ground pretty thoroughly. He declares that a true vacuum seems hardly consistent with the philosophy of Aristotle, and to get out of this, he makes the most curious suggestion that a so-called "vacuum" may be filled with an ether—certainly a very curiously advanced theory for those days.

He credits Torricelli with the invention of his vacuum, the empty space above the barometric column.



1—Guinea Pig Inoculated With Virus From the Brain of a Dog Suspected of Having Rabies. 2—A Suspected Dog Under Observation At the Chicago Dog Pound. This Dog Developed Violent Rabies a Few Days After This Picture Was Taken. 3—Some of the Guardians (Rabbits) of Chicago's Health. 4—Wound On the Leg of a Person Bitten By a Dog Suspected of Having Rabies. 5—Injecting the Anti-Rabies Serum Into the Arm of a Patient Bitten By a Mad Dog.

Is Hydrophobia A Myth?

By ROBERT H. MOULTON

IS hydrophobia a myth? Perenially our popular prints publish doubts and denials that such a disease exists. But it is a hard and cold fact that no literature disputing the hydrophobia hypothesis is now deemed respectable by publishers whose presses grind out pabulum for the consumption of the up-to-date medico. Such writers as have gone after hydrophobia hammer and tongs in the newspapers and popular magazines are considered by men on medical training as either nature fakers or dog fanciers. These men, indeed, would as soon deny the existence of smallpox as dispute the actuality of rabies.

If there be one place where every beast of the realm is known, inside and out, from muzzle end to tip of tail, it is that great veterinary board of health, the federal Bureau of Animal Industry. Every veterinarian upon the faculty of this busy institution believes as implicitly in hydrophobia and its communicability to man as he does in bovine tuberculosis and the possibility of its infecting the human species through the medium of infected milk.

There is no greater galaxy of names associated with the study of any of the infectious diseases than is connected with the experimental investigations of rabies. The ablest scientists who have adorned the medical and veterinary professions, and to whom we owe the greatest deference for having advanced our knowledge of contagious diseases, have repeatedly shown by their experiments that rabies is a specific communicable disease, preeminently affecting the canine race, although all warm-blooded animals, including men, are susceptible to it.

Many years of patient scientific research have been required to lead these investigators to a clear comprehension of the nature and characteristics of this disease. It was known and described several centuries prior to the beginning of the Christian era, and from the dawn of history the disease has been feared and dreaded. But it has been only in comparatively recent years that we have arrived at a tolerably clear understanding of the facts concerning the disease, which have to a certain degree displaced many of the fallacies and superstitions that have had a strong hold upon the public mind for many years.

That supposed rabies is in reality tetanus, or "lock-jaw," is another charge which has been made by certain zealous champions of "man's best friend." According to one of the highest medical authorities in the country tetanus may be readily differentiated from rabies by the persistence of muscular cramps, especially of the neck and abdomen, which causes these muscles to become set and as hard as wood. In tetanus there is also an absence of a depraved appetite or of wilful propensity to hurt other animals or damage the surroundings. The general muscular contraction gives the animal a rigid appearance. The dumb form of rabies in dogs is characterized by a paralysis and pendency of the lower jaw, while in tetanus the jaws are locked. This locking of the jaws in horses is very characteristic, and in cattle or dogs it renders the animal incapable of bellowing or barking as in rabies.

In an effort to stamp out hydrophobia in Chicago, the city maintains one of the greatest and best equipped laboratories of any city in the world. A feature of this laboratory is a small menagerie of guinea pigs, mice and rabbits. These little animals are really the guardians of Chicago's health, for through their aid not only is hydrophobia discovered, but the deadly tetanus is found, the germs of tuberculosis in a human patient are detected, and the ravages of diphtheria, scarlet fever, measles, and other diseases are checked. Without the guinea pigs, the rats, the mice and rabbits the scientists would be helpless and contagion would spread in every direction.

The principal part of what may be called the city "health zoo" is located in a little room on the same floor with the laboratories in the city hall. Here numerous cages containing the little rodents are arranged along the walls. All of the animals are kept under charge of an experienced animal keeper and are cared for as carefully as if they were being prepared for prize shows. The rats and mice are fed with oats, bread and milk,

(*Continued on page* 172)

By HAROLD F. RICHARDS, Ph.D.

OF THE GRADUATE COLLEGE, PRINCETON, NEW JERSEY.

ZENO the Eleatic, statesman of Elea and philosopher of skepticism, convinced himself by a very logical argument that nothing in this universe, neither chariot nor river nor warrior, can possibly move. Zeno died believing that man's senses deceive him cruelly, giving him the illusion of motion although no motion is possible; and the thinkers of two thousand years sought in vain for the flaw in Zeno's logic. Yet his argument is very clear and straightforward. A hare is supposed to be swift, and a tortoise slow; can a hare catch a tortoise? Let the hare and the tortoise begin to run in the same direction at the same instant, the tortoise being one mile in advance of the hare; and let the speed of the tortoise be one mile per

The Speed of the Hare is Five Miles an Hour. That of the Tortoise is One Mile per Hour. The Tortoise Has One Mile Handicap on the Hare. Zeno Claimed the Hare Could Never Catch the Tortoise. What Do you Say?

hour, say, and that of the hare five miles per hour. While the hare runs from

A B CD

A to B, the tortoise will have gone forward one-fifth of this distance, from B to C; when the hare gets to C, the tortoise will have reached D. Thus whenever the hare travels over the distance that last separated him from the tortoise, the latter will have gone on one-fifth of that distance; and no matter how long they run, there will always remain a minute distance between them. Therefore the hare can never catch the tortoise.

The reader who can find a fallacy in this logic may account himself more acute, at least on this point, than all the thinkers from 430 B.C. to 1642 A.D.; although I hope no one will answer as one of my students once did, and suggest that finally the hare will get so close that he can leap forward and pounce upon the tortoise. Of course Zeno knew perfectly well that simple arithmetic gives fifteen minutes as the time in which the hare will catch the tortoise; but such a calculation by no means disproves the logical conclusion which he had reached, and indeed no sound refutation was offered until Newton and Leibnitz devised a new kind of mathematics, the Calculus, which showed that although the hare would need make an infinite series of advances towards the tortoise, the necessary advances would eventually become so small that the hare could make an infinite number of them in a finite time and so catch the fugitive tortoise.

Motion has always interested thinkers as a philosophical concept; but nowadays we are more concerned with speed, chiefly because of its vital importance in transportation, communication, and warfare, not to mention a dozen sports, and I know of no physical quantity which has been measured more ingeniously than the rate at which things move. Slow speeds such as that of a racehorse can of course be measured to a reasonable degree of precision with a stopwatch; but when we have to deal with objects as difficult to handle in full flight as bullets, the problem is decidedly more difficult, not only on account of the greater speed but also because the whole measurement must be made in the space of a few feet if we are to obtain any useful information about the rate at which air-resistance decreases the effectiveness of the projectile. Even the speed of a baseball pitched by Walter Johnson, which the tabulated figures show to be too slow to permit the pitcher to hit the record-holding automobile after it had passed him, presented certain difficulties of measurement until the high-speed camera used in making slow movies was perfected.

No. 1. Bullets, Baseballs and Brown Rabbits

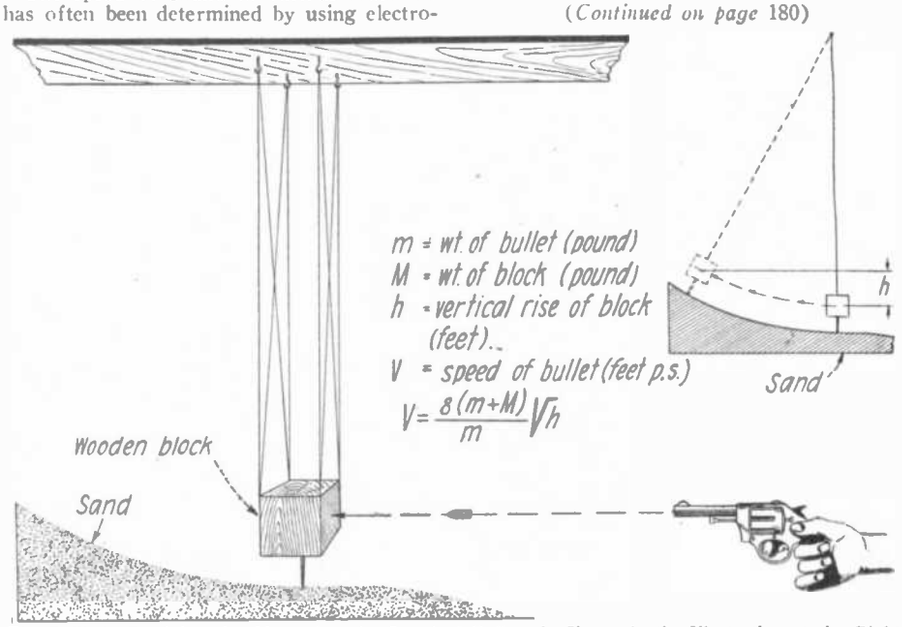
Speedster	*Speed (Miles per Minute)*
Runner (H. P. Drew, 100 yards)	0.355
Horse (Man-o'-War, 1⅛ miles)	0.615
Mongolian Antelope (Gazella Gattutosa)	1.0
Motor Boat (record, 1 mile)	1.17
Baseball (Pitched by Walter Johnson)	2.5
Body (Speed at street after falling from roof of Woolworth Bldg., 51 stories, 792 feet)	2.55
Automobile (Record 1 mile)	2.6
Airplane (Lt. L. J. Maitland, ⅝ mile)	4.33
Sound in Air	12.54
Rifle Bullet (Army 0.30 Calibre)	30.12
Sound in Steel	192.0
Alpha-Particles emitted by Radium	750,000.
Electrons, High-Speed	10,044,000.
Radio Signals, Light, X-Rays	11,160,000.

The speed of sound in various materials has often been determined by using electromagnetic signals to record the instants at which the same wave passed two points separated by a measured distance; but such a method can obviously not be used to measure the speed of light or radio waves, for there is no disturbance which travels faster than these. To determine the muzzle-velocity of a 0.30 calibre bullet from an army rifle, in the space of two feet, requires the accurate measurement of a time interval shorter than one-thousandth of a second; to find how long two colliding billiard balls remain in contact necessitates measuring time to a millionth of a second; and when Foucault determined the speed of light in a space of 75 feet, he measured intervals as small as a billionth of a second.

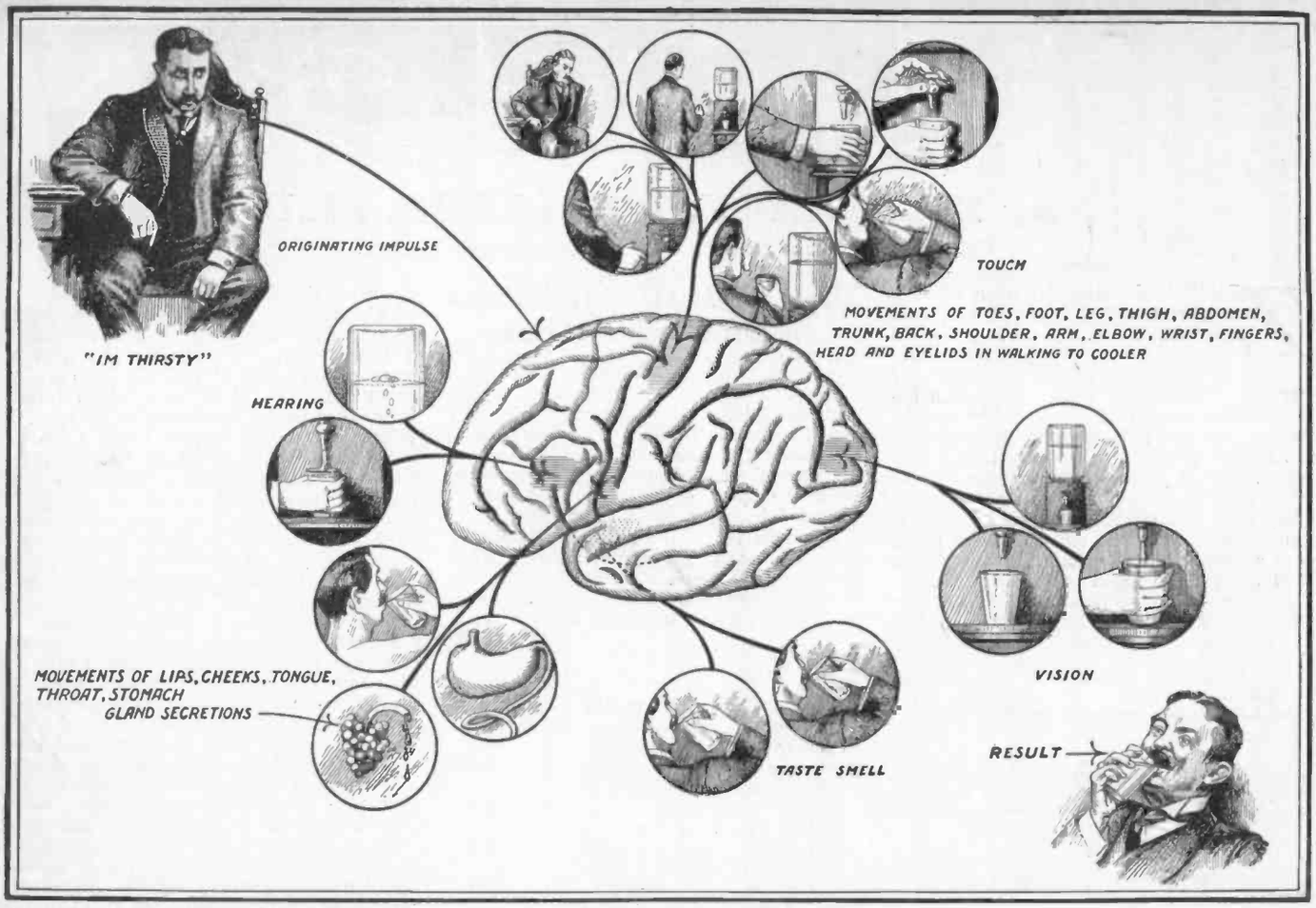
During the war the keenest ballisticians of two continents worked feverishly to solve the new problems of speed presented by the projectiles shot from high-powered guns, and very recently methods of measuring high speeds with great precision have been perfected in this country, so that finally America does not need to rely upon the ingenuity of French military engineers. These new devices will be described in following articles; but here I wish to explain an older method which is so simple that it can be used by an experimenter outside of a technical laboratory to measure the speed of the bullet of his own rifle or pistol.

This method consists in firing the bullet into a heavy block of wood which is suspended by eight strings so that it can swing freely in one direction under the impulse given it by the arrested bullet, and then measuring the position of the block at the moment it reaches its maximum height. The suspended system forms a ballistic pendulum, and the manner of using it can easily be seen by referring to the diagram. For low-calibred bullets from target pistols, a 7-inch cube of soft pine, weighing approximately 5 pounds, may conveniently be used, suspended so that its center is about 5 feet from the support to which the strings are attached.

(*Continued on page* 180)



The Ballistic Pendulum for Measuring the Speed of Bullets is Shown in the Illustration at the Right. A Bullet is Fired Into a Heavy Block of Wood Suspended by Eight Strings, So That It Can Swing Freely in One Direction. It Traces Its Course in the Sand Beneath by Means of a Needle Dipping Down Into the Sand. The Formula for Calculating the Velocity from Factors so Obtained, Is Given.



Have You Ever Thought of the Number of Mental Associations Which Occur In the Brain When the Feeling of Thirst Comes Upon the Individual? The Originating Impulse, That of the Sensation of Thirst, May Find Its Seat In Many Centers, the Throat, Oesophagus, Stomach, Etc. This Is Transmitted To the Brain, Where, By Means of Various "Association Fibres," the Individual Visualizes Walking To the Water Fountain, Seeing the Fountain, Tasting and Smelling the Water, Hearing It Bubbling, and Receiving the Cooling Thirst-Quenching Drink.

Our Wonderful Brain — How It Works

By LEON AUGUSTUS HAUSMAN, Ph.D.

RUTGERS COLLEGE, DEPARTMENT OF ZOOLOGY

OF all the triumphs of modern microscopical study, none is so interesting or significant as the light which it has thrown upon the relation of our mental powers and the minute structure of the brain. The results of the numerous researches carried on in our colleges and scientific laboratories, as well as in those abroad, have established the fact that complexity in the structure of certain portions of the brain means complexity of mental life as well. And it may be safely said, that in all the known universe we can know of nothing more wonderful than that intricate piece of machinery, the fully developed intellectual organ of man.

The human brain, built up of countless millions of tiny cells, known as neurones, is a rather bulky structure, weighing about fifty ounces in the adult. Its three chief divisions are known as the fore-brain, mid-brain, and hind-brain. In man the fore-brain is the largest, and weighs about forty-four ounces. It consists of two large hemi-ovoid masses, known as the cerebral hemispheres, or together as the cerebrum (Fig.

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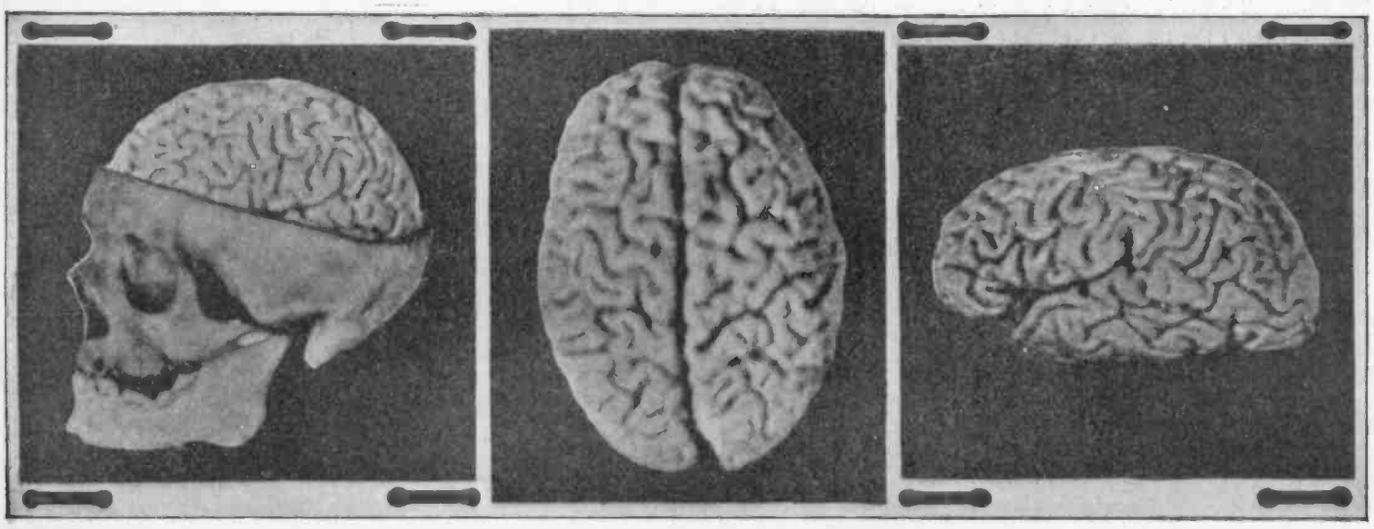
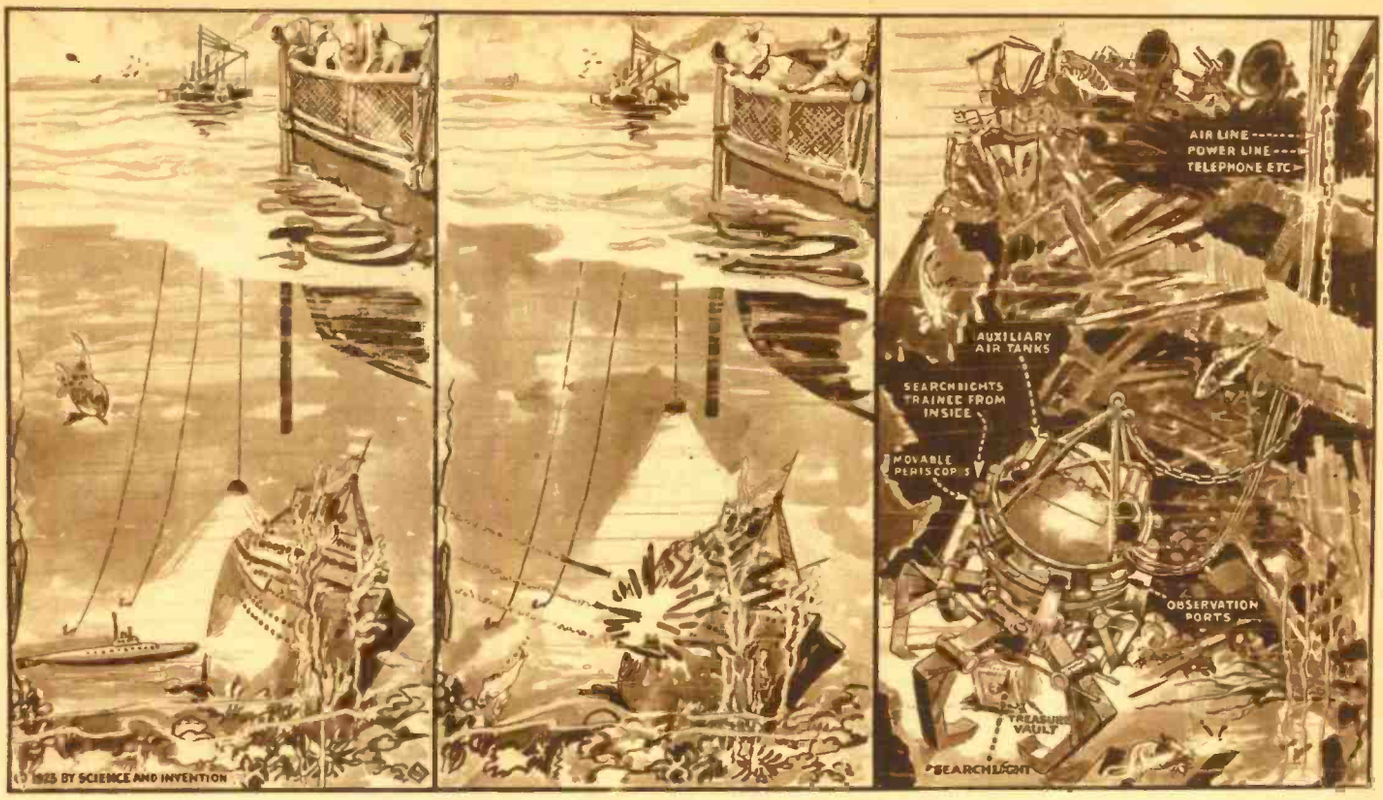


The Brain and Its Position In the Bony Case. The Intellectual Portion of the Cerebral Hemispheres Lies Just In Back of What Is Known As the Forehead.

The Cerebral Hemispheres Seen From the Top. Note the Convolutions Which Increase the Surface Area of the Cortex or Outer Rind of the Cerebrum.

The Cerebral Hemispheres Seen From the Side, the Lobes At the Left of the Above Photograph Are the Seat of the Higher Faculties.



The Three Successive Stages In Salvaging Sunken Treasure By the Newest Method To Be Tried Out In An Endeavor To Recover the Five Millions In Gold Which Sunk With the P. and O. Liner "Egypt" Eight Months Ago Off Ushant Are Shown In the Pictures From Left To Right Above. First the Wreck Will Be Accurately Charted and Inspected By a Specially Equipped Submarine, Aided By Powerful Suspended Lights and An Under-Water Periscope, As Well As Heavy Glass Windows In the Submarine; the Submarine Will Then Back Away and Fire a Series of Torpedoes At the Proper Spots On the Hull, Which Will Burst the Hull and Deck, So That the Giant Steel Octopus With Finger-Like Arms, Shown At the Right, Can Be Lowered Down Into the Hull To Pick Up Any Valuables Such As Safes, Strong Boxes, Etc., Whence the Device Will Be Lifted To the Surface With Its Load of Treasure. Men Within the Water-Tight Hull of the Salvage Device Direct Its Movements and Can Observe Their Surroundings Through Glass Port Holes and Movable Periscopes, Aided By Powerful Electric Searchlights. The Treasure-Recovering Machine Is Lowered From and Hauled To the Surface By Means of Chains or Cables and Derricks On the Salvage Craft, While the Electric Power Needed For Operating the Motors Connected With the Claws, Etc., Is Supplied Through Rubber-Covered Cables. Air Is Supplied Through the Hose, As Well As By Auxiliary Oxygen Tanks.

Giant Steel Hands To Salvage Ships' Treasures

DURING the War it was almost a weekly occurrence that one or more ships were torpedoed—that was war! Now comes a peace-time application of the naval officers' skill in accurately aiming torpedoes at a ship, in this case a sunken ship containing treasure, for be it known that the very latest style in salvaging sunken treasure ships is to explore the supposed location of the wreck with a submarine, then to back off and fire one or more torpedoes at the top or side of the ship's hull. After this a giant steel octopus with tentacle-like claws is lowered into the shattered hull and the ship's strong boxes and safes are recovered and brought to the surface.

Recent cable report from Europe describes how in this latest salvage venture, gigantic steel hands will be lowered down through the sixty-five fathoms (nearly four hundred feet of water) in an effort to recover the five million dollars in gold which sunk with the P. and O. liner *Egypt,* eight months ago off Ushant (on the coast of France). Groping through the dark waters these almost human machines will feel their way to the vaults of the ship where the gold is stored. As the illustration shows, the machine is fitted with special movable periscopes projecting from the sides, so that the men in the water-tight cabin within can look out at any angle desired, while powerful electric searchlights illuminate the water for a considerable distance around. The tentacle-like arms are operated from the center column by means of worm-screws, driven by electric motors under control of the crew within the air-tight compartment. The electricity for operating the motors and other devices including the powerful lamps, is brought down from the surface of the supply ship by means of heavily insulated rubber covered cables, while air is also supplied through an air hose. Telephone communication both ways between the surface and the exploring sub-sea craft, is available at all times.

A Swedish engineering concern has agreed to spend $500,000 to raise the gold, and they seem confident of success, so the report states. If they are successful in this venture, they will keep $3,000,000 and Lloyds, who met the heaviest loss in the shipwreck, will get the remainder.

When the wreck has been definitely located and everything is prepared, so far as the preliminary work is concerned, a specially equipped submarine will be sent to the spot and the hulk will be explored from all sides and accurate charts made. From previous data on the ship the location of her purser's departments where the safes containing the money would be stored, will be plotted and the proper target spots selected on the hull for torpedoing. The submarine will then back off a suitable distance and let go with one or more torpedoes, depending upon the final diagnosis of the engineers. The supposition is that after the hull has been properly torpedoed and opened up at the top and side, the man-made steel octopus can then readily be lowered down into the opening so formed, and the safes or other strong boxes caught in its steel tentacles and held in a vise-like grip until the exploring device is hauled to the surface, when telephone orders have been received to this effect from the men below. The steel fingers will not relax, even though the water at such a depth would overcome a diver in his suit and helmet.

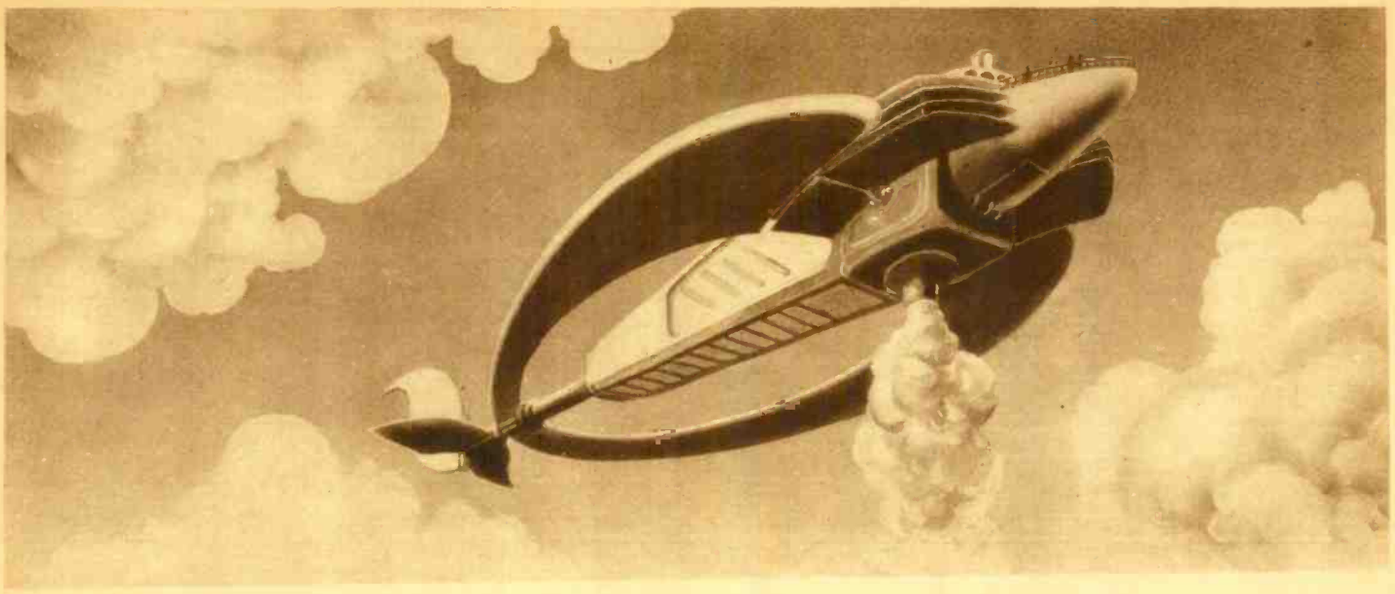
It will be seen by the design of the exploring octopus-like device here illustrated that it can crawl along slowly by lowering and raising first one set of legs and then the other. The cable report states that the details of this romantic undertaking have been thrashed out by hard-headed business men who are behind it, and that work will begin this spring. If the project succeeds, it will certainly open up the prospect of recovering untold millions now lying at the bottom of the sea.

Guns of French Fleet Outrange World

Preliminary tests recently made with the modernized French battleships indicate, it is officially stated, that the sight alterations have improved the firing distance of their 16-inch guns from 30 to 40 per cent.

While French naval circles exercise the utmost secrecy as to the exact improvement in the range of the guns and the accuracy of results, there is a suggestion that the French battleships now outdistance those of the other navies of the world unless the same process has been carried out.

It is possible to increase the range of guns, but always at the expense of accuracy and the size of the projectile used.



"Suddenly a Piercing Light Smote Upon Us Through the Open Window and, Looking Out, We Beheld the Most Grotesque Air Machine We Had Ever Witnessed. It Appeared To Be a Huge Box-Like Structure With One Circular Opening, Which I Judged To Be About Six Feet In Diameter. This Opening Was Centrally Located In the Bottom of the Machine, and From It a Dense, Yellowish Gas Was Issuing In Great Clouds. Directly Beneath the Machine Were the Immense Stockyards of the City."

The Great Food Panic

By BURNIE L. BEVILL

CARL HOLT and I sat alone in our private office at the rear end of the corridor of the seventy-eighth story of the Zolberg Building in Kokomo. It was in the latter part of July of the year 1950, and the weather being extremely warm, we had discarded our coats, and were busily engaged in the difficult task of managing the affairs of the Watermotor Company. The Watermotor Company was organized in the year 1927 by that famous inventor and scientist, John L. Gorman, after he had perfected and patented his epoch-making engine, which had revolutionized the manufacturing and transportation industry of the world by utilizing a source of power that was procurable without cost, namely, water.

The method employed by Gorman was very simple. Water in its normal state, just as it is pumped from the earth, was made to pass into an enormous electrolytic bath, which was supplied with a powerful current of electricity from a dynamo, that was operated by the same engine. In this electrolytic bath was a very light solution of trioxic acid, that extremely active and powerful reagent, which has the power of acting as a catalytic agent upon water, causing it to decompose into its constituent parts, hydrogen and oxygen, by the application of only a weak current of electricity. By passing a strong current through the water in the bath, hydrogen and oxygen were liberated in enormous quantities and drawn into the cylinders of the engine, where they were made to explode with tremendous violence by the electric spark, just as in the old style gas engine, that was in use thirty years ago.

This invention had created a sensation in the industrial world and, consequently, the spectacular rise of the Watermotor Company was to be expected. From a tiny building of only a few rooms that were used by Gorman for his workshop and laboratory in Kokomo, there had developed a vast structure of stone and steel that had taken its place at the top in the list of the world's greatest buildings. The business of the company covered the entire world, and the income of the stockholders was in excess of $500,000,000 per year.

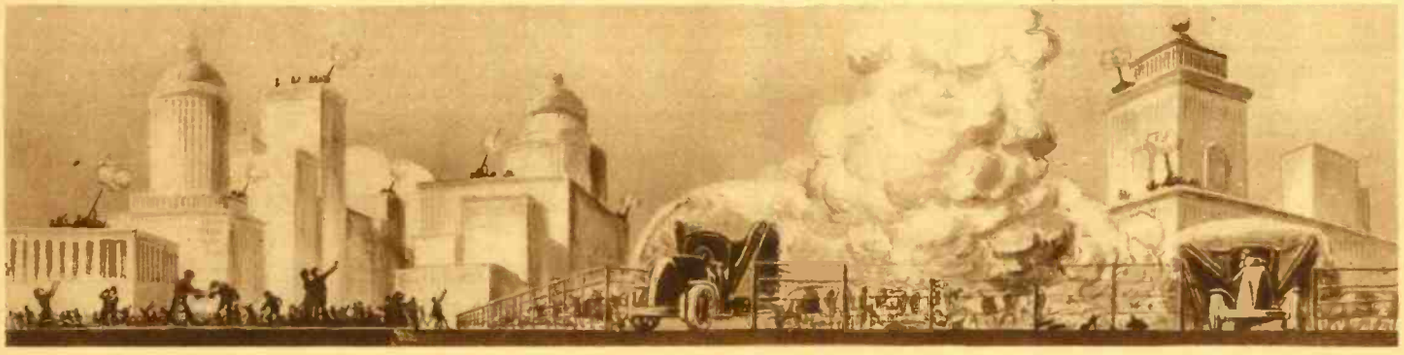
Carl and I were not directly connected with the Watermotor Company, but inasmuch as we had been employed as members of the United States Secret Service we considered that the company's business was our business. Reports had been circulated to the effect that there had been seen hovering over the World Food Corporation's immense structure in Frankfort, a huge, bird-like machine, the like of which had never been heard of before. It was said further that there seemed to emanate, from a large opening in the craft, a yellowish gas that was odorless and tasteless, and, apparently, harmless. But upon investigating the purity of the food which was a product of the plant, it was discovered that it was coated with a yellow film. It was observed that the machine never came within five miles of the surface of the earth, and great were the speculations concerning the purpose of this gigantic craft.

The Zolberg Building is the huge structure in which were located most of the offices of the largest manufacturing plants of the world. Several minor matters had arisen in connection with the affairs of the Watermotor Company, and Carl and I had been enlisted in its service to investigate. It was in this occupation that we were engaged at the present time. Without warning, the door burst open, and a newsboy rushed madly in screaming his wares.

"Three thousand men killed at the food plant this morning. All employees of the company," he yelled.

With a gasp I snatched the paper from his hand, tossing him a coin. A glaring red headline adorned the top of the page—"FOOD PLANT MYSTERY," it read. Perusing the lines hurriedly, I read, "Frankfort, Ky., July 31—What is proving to be the most puzzling mystery of the age was

(*Continued on page* 168)



Doctor Hackensaw's Secrets

By CLEMENT FEZANDIÉ

No. 17—The Secret of the Walking Radiobile

(Author's Note.—The automobile has accomplished wonders, both for the transportation of passengers and merchandise. Its one great drawback, however, is that it requires good roads. Isn't it about time that our inventors should turn their attention to giving us an auto that could climb over fences and travel through rough fields?)

"ARE you all ready, Silas? We ought to start in about an hour."

"How are you going? By the train?"

"No, I'm going in my 'Walking Radiobile.'"

"A *walking radiobile?* What in the world is that?"

"That's my latest invention. It's an automobile that walks."

"I confess I'm no wiser than before, doctor," said Silas.

Doctor Hackensaw shrugged his shoulders. "The fact is, Silas," said he, "that I have made a new automobile, which I think is destined to be of the greatest value both in peace and in war. I, of course, realize fully how much we are indebted to our present autos, but they all have one very serious defect—they require good roads. Now the majority of roads are bad, and it takes time and money to improve them. What we need, therefore, is an automobile that can travel the poorest road, cut across fields, climb over fences, and wade through small streams."

"Won't a tractor do that?"

"Yes, but a tractor is too slow, too heavy, and too clumsy. Besides, it destroys everything in its path. Now it struck me that a light automobile with four legs would fill a long-felt want, for it could walk over the roughest ground, climb steep mountains, and even step over a high fence with ease. As you are going to ride out to Michigan with me to inspect the timber-lands there that I am about to purchase, you will have a chance to see for yourself how the thing works."

"Why do you call it a *radiobile?*"

"Because it is run by radium. I've already spoken to you about my radio-engine, but you haven't seen it yet. As I told you not long ago, I can manufacture radium in large quantities and very cheaply. Radium is an unstable substance, continually giving off powerful emanations, and eventually disintegrating into lead. One gram of radium, in turning into lead, gives out some three million horse-power hours of energy. Under ordinary circumstances it would take about two thousand years for the radium to change into lead. In other words, one gram of radium could furnish one-sixth of one horse-power, continuously day and night, for two thousand years! But I have found that by heating the radium I can greatly hasten the disintegration. In my radiobile here, I apply heat at will to the tube of radium that runs the machine, and by means of the heat alone, I can regulate the speed of the machine. If not used at all, my radium lasts two thousand years. If I use it to run a 20 horse-power machine six hours per day the machine would run for over seventy-five years, which is about all that any reasonable man could ask."

"You told me that you used the ocean waves to get the heat required for making the radium."

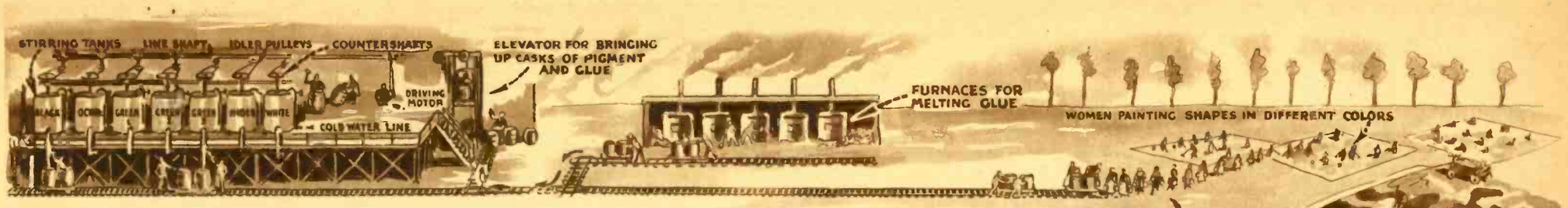
"Yes. You understand, of course, that since a gram of radium in turning into lead, gives off three million horse-power hours of energy, I cannot change a gram of lead into radium without using up *at least* three million horse-power hours of energy. As a matter of fact it takes fifteen million horse-power hours to make a gram of radium. But I consider this very little, as the ocean waves furnish the practically unlimited power."

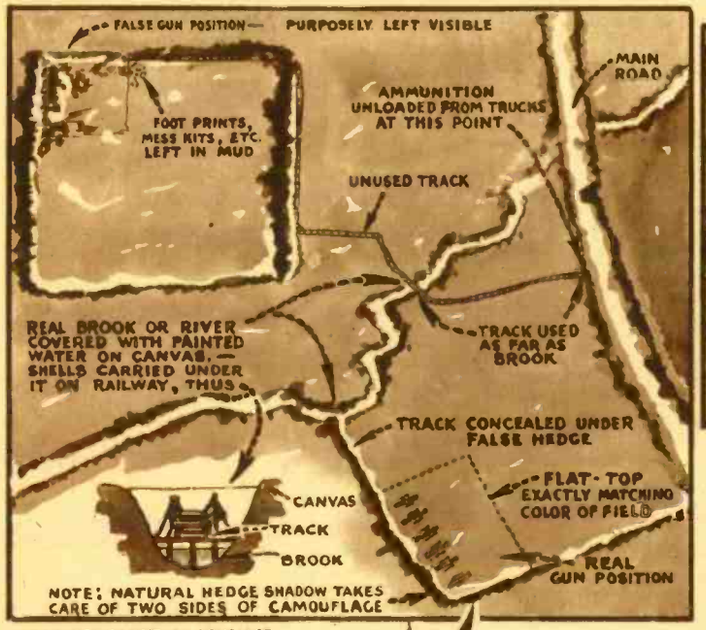
"Only twenty per cent efficiency!" exclaimed Silas. "That seems very little."

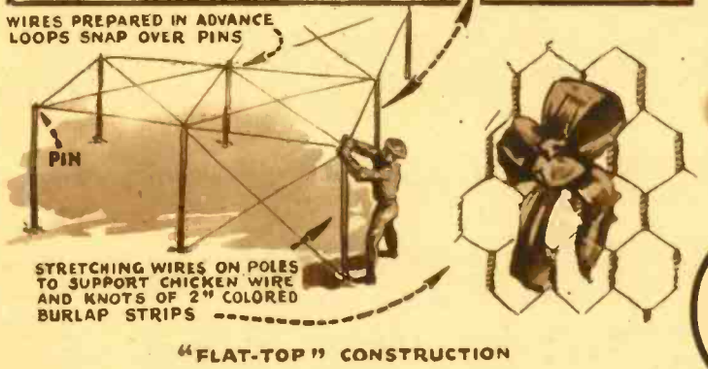
"On the contrary it is a remarkable show-

(*Continued on page* 166)

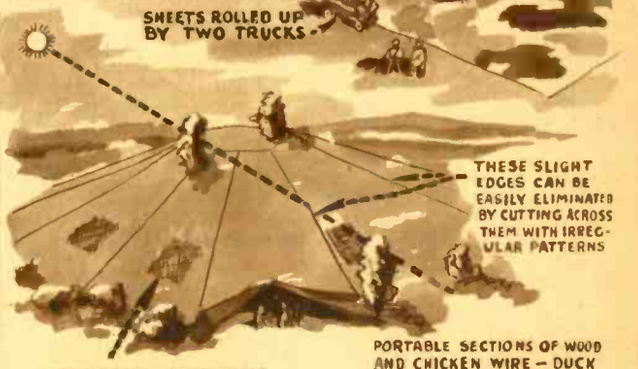
"The Machine Left the Road and Approached the Fence That Bounded the Woods. A Quick Shift of a Lever Transferred a Weight To the Rear of the Car, and Lifted the Front Legs of the Machine Over the Fence. Another Shift and Down They Came On the Other Side. A Reverse Operation Brought the Hind Legs Over."



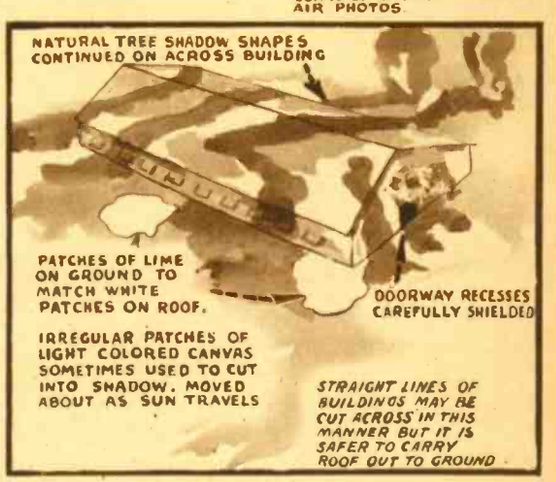




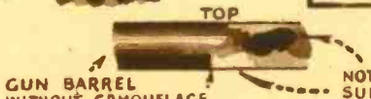
"FLAT-TOP" CONSTRUCTION



PUZZLE—FIND HIM IN THE PICTURE BELOW



FLY SCREEN PEEP HOLE IN O.P. COVERS RECESS WHICH WOULD OTHERWISE BE PLAINLY VISIBLE — PATTERNS PAINTED TO CUT ACROSS OUTLINE OF HOLE



Mystery, With a Capital "M," Surrounded the Majority of the Operations Carried Out By the Camouflage Section of the U. S. Army In France, and Our Readers Will Be No Doubt Greatly Enlightened and Entertained By Reading This Interestingly Told Story On Camouflaging With the A. E. F. Overseas, Written By One of the Boys Who Helped To Do the Trick. The Picture Herewith Shows At the Top How the Paint Was Ground and Mixed In Giant Machines Erected Under War Conditions, French Women Doing a Lot of the Painting Under the Directions of Experts. The Other Illustrations Are Explained By The Captions Accompanying Them, and Show How False Gun Positions Were Outlined For the Benefit of Enemy Airplane Cameras; How Camouflaged Uniforms For Snipers Were Made; Why Colored spots Were Used On Cannon Barrels, and How Edgeless Corners On Buildings Were Effected All With the Aid of Paint, Wire, Cloth and Colors Scientifically Mixed and Applied.

Camouflaging In France

By NED WESLEY

LATE OF U. S. ARMY CAMOUFLAGE SECTION

FANTASTIC misconceptions concerning camouflage were rampant during the war. Clever and original tricks were, of course, successful in isolated cases, but, on the whole, the *land camouflage* of modern war resolves itself in the last analysis into the systematic planning and handling of bulk materials and delivery of camouflage material to front lines and strategic points in enormous quantities.

The main problem of camouflage is to hide army material and the movement and work of troops from enemy observers and expert analysts of aerial photographs.

Photographs are taken daily all along the lines, usually from a height of 10,000 feet, a height out of range of anti-aircraft guns. These views are checked up from day to day and the slightest variation in color spots shows the nature of the operations, which have taken place in such places during the night. The expert reads buildings, guns, piles of ammunition, tanks, troops, etc., by the shadows they cast. So the primary object is to eliminate shadows or to change the shape of shadows by breaking through with light colored shapes.

The *Bigoncy Top* was a purely American contribution to the science, and was used to hide batteries of guns and the like. It could be set up in a few hours at night—completely concealed a battery of guns, was wind-proof, sun-proof, cast no shadow, was unaffected by rain and, if properly colored, photographed exactly the same as the ground did before the guns were moved in. It consisted of chicken wire stretched horizontally on top of rods, with knots of varicolored burlap tied in bows, thick directly over the guns and thinned out to nothing toward the edges. The shadow of each knot was relatively so small as to be invisible to the lens, yet collectively these knots afforded ample screen for the objects to be concealed. The same general idea was used for extending trenches, working on railroads, etc.

Roads were camouflaged with vertical fish-net screens, strung for miles on poles placed on the enemy side of the road if it paralleled the lines, or with screens hung across the road if it ran toward the enemy. Railroad track was often covered with burlap or raffia during the day and operated at night. Where tracks were known by the enemy to exist it was often found advisable to lay a false track parallel to the real one to draw his fire.

Shadowless buildings are an important phase of camouflage work. Tents are not sufficiently rigid; they flop in the wind and no matter how you stretch duck it will sag enough to cast billow shadows, especially when photographed in a low sun. The *U. S. Army Camouflage Section* developed a quickly set up type of building with sides slanted at about 30° to the ground, with thoroughly hidden windows, and rounded in shape to look like a small hill. It was made of dun-colored duck stretched over sections of chicken wire on frames. These buildings proved practicable in service and are invaluable for carrying on important army workmanship, where machinery has to be installed, within bombing distance of the enemy. They are also available for ammunition dumps, hospitals, etc.

Hundreds of women were employed by the U. S. Army in two different plants in France; some engaged in stripping and dyeing streamers of burlap; some in sewing duck or burlap together into gigantic sheets 100 to 200 feet square which were afterward spread out in the fields and swabbed with cold water paint, in irregular shapes and colors, myrtle green, buff, black and cream, by other gangs of women under the direction of army sergeants. Motor trucks folded and rolled these sheets into cylinders in which form they were shipped to the lines where they were used for covering army material and ammunition. The colors used varied with the season and locality.

Color, as the camouflager knows it, is important. It must be furnished in such quantity that an ordinary pigment supply seems ridiculously inadequate. In future warfare color will be extracted directly from the soil and minerals near the field of operations. The U. S. Army had an excellent formula for producing a cheap cold-water paint that was sun-fast and waterproof. However, there is room for considerable experimental research in the extraction of pigment right at the scene of operations.

For instance, brick-red earth mixed with yellow earth give a good orange; a little lamp black or chimney soot added will give a good brown shadow color. Yellow earth, lamp black and chalky earth will give a fairly good light green. Prussian blue and ashes yield a cheap blue which can be used to dye yellow earth into brilliant green. Many natural earths and minerals are abundantly available to mix with artificial pigments, and must be sifted to remove gravel.

There are several binders available for making these earths stick to any desired surface all of which can be manufactured in the field, provided such raw materials as casein, lime, sodium bichromate and cheap glue are available.

Discarded *Corned Willie* cans were revamped into paint cans at Camouflage Headquarters where raw pigment was stirred and ground and made up into officially numbered shades of oil paint and distributed as called for by camouflage details at work with the artillery and at tank and truck headquarters.

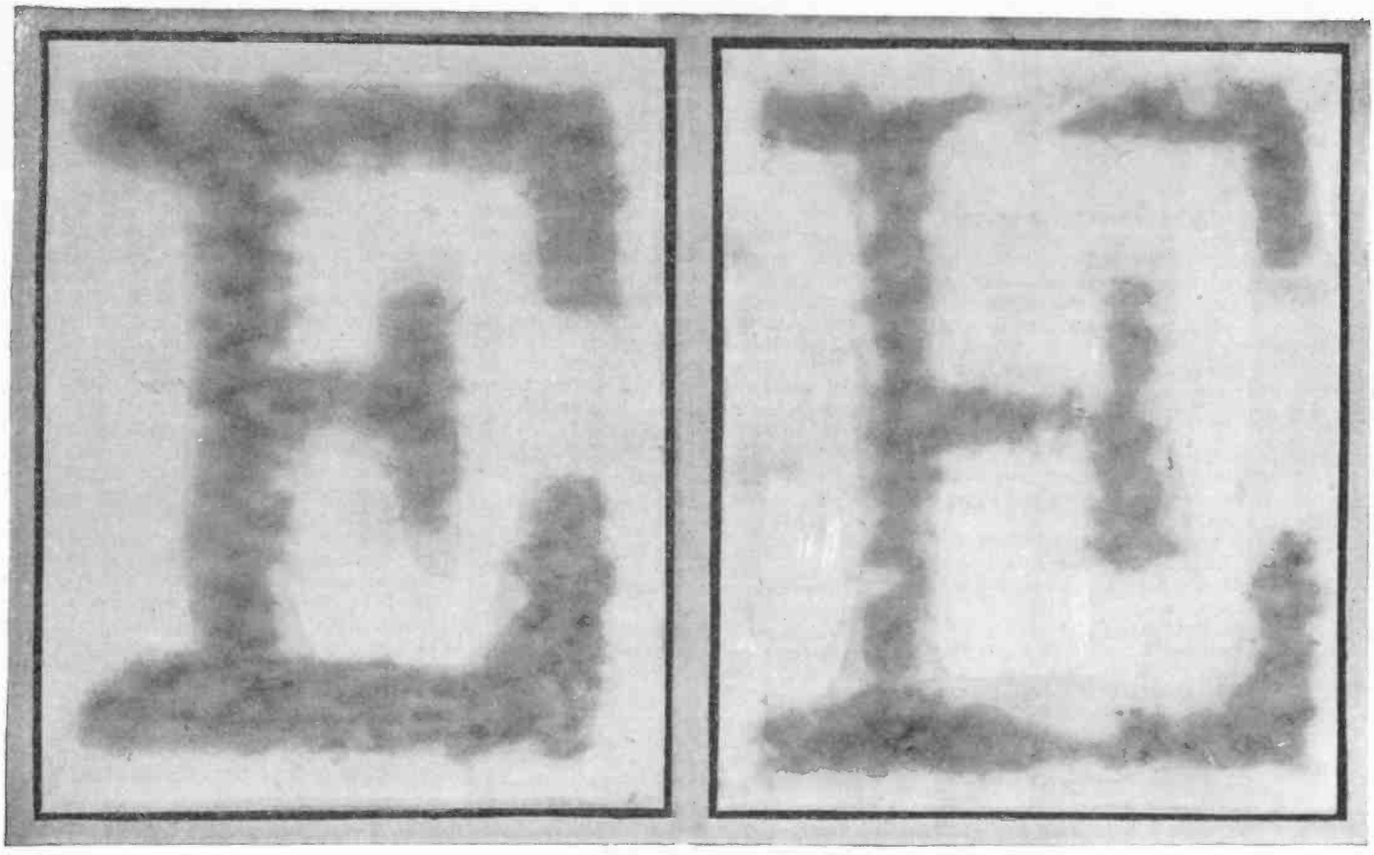
The colors used most for guns, tanks, etc., were yellow ochre, raw umber, yellow-green, blue-green, violet and black.

The painting of guns, trucks, railway equipment, tanks, etc., is a matter of more individual refinement as to arrangement and color scheme, than is the larger *whole countryside* camouflaging. Such coloring calls for a knowledge of the actinic value of colors and tints. A gun may nestle away on the outskirts of a small wood, daubed over with various colors by an enthusiastic amateur camoufleur. His mates stand off a hundred yards or so and pat him on the back saying, "the devil himself couldn't find it." Yet "Jerry" comes over and clicks the camera and there is the gun out in bleak, bare nudity.

"How is it possible?" you ask. Well, blue looked blue to the comrades a hundred yards away, but it looks white to the camera. Yellow looked to the eye exactly the same as the sunlight glinting off the seared leaves in the background, but the camera sees yellow and red as dark gray and black. If the captured German gun down in front of the American Legion has some blotches of blue tint on the lower half of the gun barrel you will know that "Jerry" put them there to lighten the shadow, thereby flattening the roundness. Green must be blue-green to photograph gray. Yellow-green photographs practically black.

The old color law, based on red, yellow and blue as primaries and green, purple and orange as secondaries has been discarded in favor of red, green and violet as primaries. Camouflage painting, based on the latter, stands up under photography, thereby bearing out the spectrum theory of Young, Helmholtz and Tyndall.

Future warfare will involve bigger and more intensive camouflage than has ever been dreamed of heretofore. It will stand at the forefront among defensive and protective measures. The ever present airplane menace will lay bare to the enemy all military strategy except as protected by camouflage. Surprise projects and even the operation of entire campaigns will have to hide behind and underneath shifting, illusive and disconcerting camouflage, well planned and applied on a broadcast scale.



Letter E Written on a New Typewriter of a Certain Make, Enlarged Many Times to Aid in Tracing a Document to Ascertain What Machine it Was Written On.

Every Typewriter Gives Impressions Distinctly Its Own; This Becomes Evident from the Letter E Shown Above, Which is From an Older Machine of Exactly the Same Make.

Scientific Tools of Modern Detectives

By FERI FELIX WEISS

AUTHOR OF "THE SIEVE," "THE TWENTIETH CENTURY DETECTIVE," ETC.

NO detective can aspire nowadays to the title of *expert investigator* unless he is familiar with the tools which science has placed at his disposal during the last half century. The ultimate aim of every detective is to gather evidence sufficiently strong to lead to the arrest of the guilty parties in the first place, and to their conviction in the last; incidentally, he may help in the elimination of innocent suspects. It is with these ends in view that he takes advantage of any and all aids offered him.

The remarkable thing about the application of scientific methods to the detection of crime is not that it has at last broken prejudice, but that it has taken so long to do so; and as the battle is still going on, we may regard this new science as in its infancy.

In a Certain Murder Case a Scientific Detective Examined a Towel Found in the Room Where the Crime Was Committed, and Under a Powerful Microscope He Saw Some Short Red Hairs Caught in the Fabric of the Towel. With This Evidence as a Starting Point, the Criminal Was Finally Traced and Indicted.

Ever since man came down from the treetops, walked erect instead of on his hands and feet, and vanquished the giant mastadon and saber-toothed tiger by his better brain, has he striven to improve his implements of warfare in the struggle for existence.

The detective of today, slow to keep pace with the spirit of an age of invention and progress, has been perhaps among the last to take advantage of modern developments in his use of automobile, airship, submarine, wireless, and the scientific discoveries in the laboratory. Is this reluctance due to a sense of superiority, a "swelled head"? It may be so.

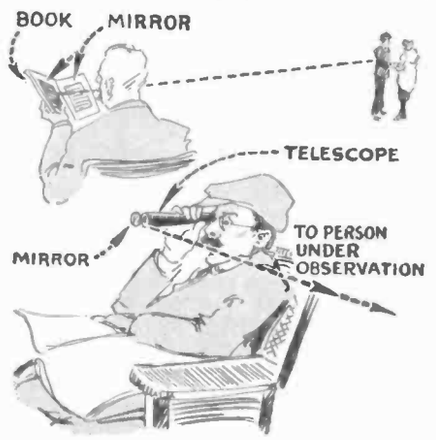
Sometimes I think the comic papers have had something to do with it. They have laughed to scorn the finger-print, the dictograph, the detective himself, and both the official and private detective has been cautious about accepting innovations which may make him appear ridiculous in the public eye.

This may be the reason, too, why in America, even more than in France, Germany, Italy and Austria, the awakening of the scientific detective has been so long delayed.

While the writer of detective stories sends his "Raffles," "Arsène Lupin," his "Sherlock Holmes" chasing, either as scientific crook or scientific detective, from one adventure to another with lightning-like rapidity, using all kinds of impossible means to unravel the threads of an imaginary crime plot; while the old-fashioned detective in real life plods along like a good old work horse—the *scientific investigator* delves neither into the absurd nor follows the usual, but breaks open new paths for rational advancement in methods of defeating the criminal.

Even abroad few cities can boast these highly-trained, well-educated men who have created a new profession, second to none in the halls of learning—a profession by no means purely theoretical, but on the contrary, thoroughly practical.

The great difference, it seems to me, between our methods and the more advanced ones in Europe is that, here the expert with university training is called in only when the case goes to trial in the open court, while there he is employed from the very



The Book-Mirror Shown at Top of Illustration. Has Frequently Been Used by Detectives to Watch the Actions of People Behind or to One Side of Them, While the Small Telescope with a Mirror at One End, Shown Below, Has Proven its Worth in Many Instances.

beginning—when the trail is hot and the clues are not yet lost in fog or wiped out completely. To illustrate:

A woman was found murdered in her little apartment in Berlin. The only clue

Opera or Field Glasses Have Frequently Been Used as in This Case to Spy on Persons Across an Alleyway or Street, the Detective in This Instance Looking Through Small Holes in the Shade Inside a Darkened Room.

to the murderer were bloody marks on the wall and on a towel on which he had apparently wiped his hands after having committed the horrible deed. No one in the neighborhood seemed to know anything of the murdered woman's past or of her recent acquaintances, and as the finger-prints on the wall could not be identified when compared with those in their files, the police were totally at a loss where to look for the murderer.

In this puzzling situation, the university professor, expert in criminology and detective science, was sent for *one hour* after the discovery of the murder. The policemen and detectives, acting under general instructions, had known enough not to touch anything, and when the professor arrived on the scene, the room, the woman's body, etc., were just as had been discovered. Having made a careful and minute examination, he gave the detectives this astonishing bit of instruction:

"Look for a left-handed, red-haired butcher, about six feet tall!"

Of course this was not much of a clue in a city like Berlin with its two million souls, but it was sufficient for the detectives to round up every red-headed butcher in that district, until within a day or two they had discovered one who was left-handed and in addition could not give a good alibi. A "third degree" administered with ruthless Prussian emphasis made him admit his guilt.

How did the professor know that a red-haired, left-handed butcher, about six feet tall had committed that murder?

His knowledge of *anatomy* told him that a man reaching as high as the man who had wiped his bloody hands on the wall must be about six feet tall. This was fact *number one.*

His knowledge of *surgery* taught him that the wounds on the woman's body were made by a butcher's cleaver. Fact *number two* was settled: the murderer was either a butcher himself or had used a butcher's implement.

From the marks on her throat, he observed that the murderer had held her with the right hand while swinging the cleaver with the left: fact *number three.*

The microscope showed the scientist that red hair from beard, head or arm had been rubbed into the rough cloth of the blood-stained towel and the towel having been clean otherwise, that is, newly hung on the rack, this fact, *number four,* pertained probably to the murderer. At least, it was safe to take a chance on the deduction that his hair was red.

USEFUL INSTRUMENTS

Another case where success was due to the use of the microscope was one in which a man in a boarding-house had been robbed of his savings. A thorough search of the premises led to the discovery that the money had been hidden in a pot and buried in a mushroom bed in the cellar. All the boarders and the landlady were examined and a microscopic test taken of the dirt under their finger-nails, whereupon the thief confessed.

The *telescope* or field-glass is another important instrument. I have used one many times in watching suspected persons, while I was hidden in a hotel room across the street from the house or apartment under surveillance, and have had success, where, without this aid, positive failure would have been the outcome.

Special *night-glasses* like those used by army or navy officers are particularly valuable for such work at night, permitting observation at a long distance up and down a street, over housetops, across a river, provided, of course, the room under observation is lighted.

During the war I carried also a tiny *pocket-telescope,* which made it possible for me to recognize persons long before they came near enough to recognize me so that I could make a "get-away." This little pocket glass was very valuable for reading inscriptions or headlines of newspapers which the suspect may have held in his hand at some distance from me.

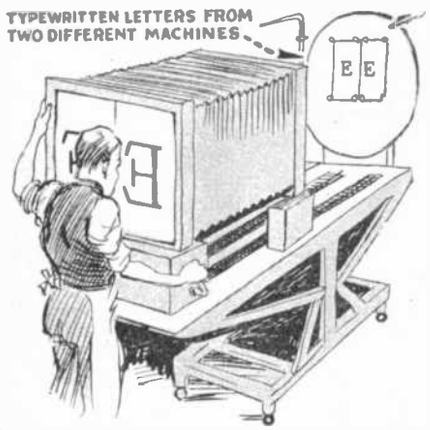
I always carry a little oblong metal hand mirror like those used by our doughboys. I can conceal this easily in my hand and on a train, in a hall or theater, can observe what goes on behind me without needing to turn and expose my face to the audience, some among whom might recognize me. This requires some skill in manipulating in order not to get caught.

Recently a *reflex-telescope* has been invented which, concealed in a book in which the detective is apparently absorbed, enables him to watch anything going on behind him at some distance.

A much greater aid than any of these is, of course, the camera. The smallest and "handiest" is the *watch-camera,* small as a good-sized watch, nickel-plated and shaped like a watch. This takes pictures through a lens which is located where the stem-winder of a watch is usually found. A little view-finder can be attached in a second and just as easily taken off. This is about as perfect a little jewel of its kind as can be found and may be bought for the low cost of three dollars. The picture it takes is only about the size of a postage stamp, it is true, but so clear that it can be enlarged with satisfactory results.

The Detective's Pocket Watch-Camera Containing Lens, Shutter and Film Magazine. The Author Describes How He Took Several Pictures in This Way of a British Ambassador on Board Ship Much to His Surprise and Amusement. He Never Knew That He was Being Photographed.

Before I found this watch-camera, I used a *detective-camera,* a weighty little black box just big enough to be secreted in the palm of my hand. This has an automatic shutter working like a curtain and opened



With a Big Enlarging Camera as Here Shown, the Photographer Comes to the Aid of the Detective in Enlarging Letters, Signatures, Checks, etc., for Minute Examinatoin. The Two Highly Magnified Letter E's Shown on the Opposite Page, Were Enlarged in a Manner Similar to This.

with the thumb, making it especially practical as only one hand is needed to manipulate it. I have taken hundreds of pictures with this tiny camera when on board ship, on the dock, and elsewhere of persons who, most of them, never realized that they were being photographed. I remember taking one of the former British Ambassador, Sir Cecil Spring-Rice, while he talked with two of my friends on the S. S. *Laconia.* Not one of the group knew this picture had been taken until I sent him the finished prints, which were 1½"x1", and so clear that I could use them later in my lectures as slides.

It is the *enlargements* which make the camera especially valuable to the detective. I have seen submitted as evidence in a court case a photo-micrograph of a human ear, enlarged to thirty inches in diameter, making the tiny hairs on the outside of the auditory canal very large. The ear covered an extra large sheet of paper. The contention of the defense was that the man whose ear was shown in the photo-micrograph had committed suicide, but the photographer proved by this picture that the tiny hairs were not scorched off and no powder had been left on the skin, showing that the revolver must have been held at some distance from the ear when it was discharged, indicating the case to be one of murder.

In another interesting picture taken by a friend of mine, one of the foremost expert photographers in criminology, a gun barrel was sawn through the middle to show the tiny scratch on the interior of the barrel made by the passage of the last bullet through that gun. Fire-arms makers and experts contend that every bullet leaves in its course a special channel scratched on the inside of the barrel, and this enlarged photograph showed some remarkably clear marks into which the protruding parts of the equally enlarged photograph of the bullet fitted perfectly.

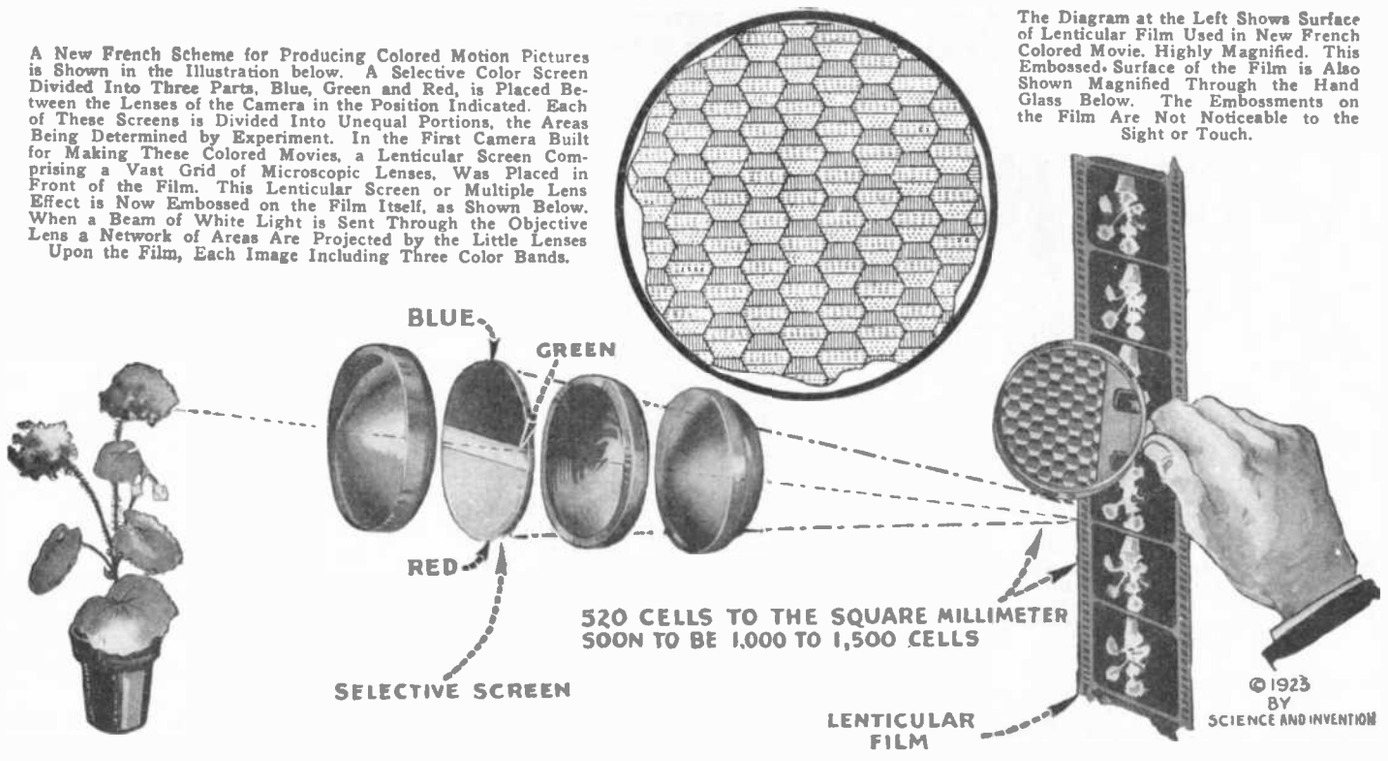
Because these enlargements can be transferred to glass and projected on a screen by a powerful electric light, they are especially valuable before juries in exhibits of disputed writings, documents and the like. No *handwriting expert* can convince a jury so thoroughly of forged writing as the camera.

The detection of erasures in writings, in the so-called *invisible ink* and the reading of *charred documents* are all simple matters to the expert photographer. Many things invisible to the naked eye are brought out

(*Continued on page* 197)

A New French Scheme for Producing Colored Motion Pictures is Shown in the Illustration below. A Selective Color Screen Divided Into Three Parts, Blue, Green and Red, is Placed Between the Lenses of the Camera in the Position Indicated. Each of These Screens is Divided Into Unequal Portions, the Areas Being Determined by Experiment. In the First Camera Built for Making These Colored Movies, a Lenticular Screen Comprising a Vast Grid of Microscopic Lenses, Was Placed in Front of the Film. This Lenticular Screen or Multiple Lens Effect is Now Embossed on the Film Itself, as Shown Below. When a Beam of White Light is Sent Through the Objective Lens a Network of Areas Are Projected by the Little Lenses Upon the Film, Each Image Including Three Color Bands.

The Diagram at the Left Shows Surface of Lenticular Film Used in New French Colored Movie. Highly Magnified. This Embossed Surface of the Film is Also Shown Magnified Through the Hand Glass Below. The Embossments on the Film Are Not Noticeable to the Sight or Touch.



New French Colored Movie Process

ALL devotees of the film know what magnificent results the cinematograph in colors has given. It took long to obtain these results, which have been available since 1920 after numerous experiments. A system pushed to the highest degree of perfection has been developed by M. Gaumont, whose practical application is extremely delicate. By means of an apparatus comprising three objectives with selective screens, and of different colors, the operator takes simultaneously three films, each one of which represents only the parts of an image of the same color. In projecting these films, three screens, of colors identical with those which have been used in taking them, are used. For the three images should be exactly superposed, so as to melt one into the other, or blend perfectly; then the original view, is reproduced with every shade of color. It will be understood that the weak part of the process is: In spite of the small distance intervening between the objectives, the three pictures cannot be rigorously superposed, and to this initial defect there are added others very difficult to avoid during the process of projection. An apparatus of high precision makes these inconveniences practically negligible, but such apparatus costs a great deal; their price and that of the triple film often makes the cinema proprietors hesitate.

On the other hand, the colored prints of autochrome plates sustain very well the enlargement for fixed projections, but they are hardly utilizable for moving pictures. For if we consider the two successive elements of a film these two successive pictures, the distribution of the grains of silver in each are not the same and will not have the same intervals in two corresponding points of successive images; it follows that there is a lack of registration of the shades of color, which is more or less appreciable.

MM. Radolphe Berthon and Albert Keller-Dorian have invented a system of marvelous simplicity, which avoids the difficulties of the present process, permitting the sought for results to be obtained with a single objective and an ordinary apparatus. This system, in view of its realization, is based on two facts well known, but which have never yet been utilized.

Any part of a photographic objective which is properly corrected can be masked without the uncovered portion having its focusing power of producing a complete image interfered with. This happens in the use of the diaphragm. And, if instead of arranging a symmetrical opening before the center of the objective, we cover any part of the lens with a piece of black paper of any shape, the effect remains the same. Every point of the lens, in fact, receives the luminous rays coming from the entire surface of the object, and these rays converge toward the crossing joint whence they spread and diverge, producing the image at the focal plane.

Now if we divide the objective into three zones which we mask with proper selective screens, each zone will produce upon the ground glass a complete image of the subject as far as the unscreened portion of the lens can pass it; the red screen will let the red rays pass, the green screen the green rays, and the blue screen the blue rays. We will form thus three images, each one partial as regards the whole subject, but complete with reference to each of the three fundamental colors of the subject, and these three images brought to the same focal plane are accurately superposed upon the ground glass, where are given an image identical as regards the design and color which the same objectve would give without the use of the color screens.

Such is the mechanism applied to the principle which brings about the power of simultaneous selection of three colors with a single objective.

The problem of printing upon a single sensitized plate the three selective images, in conditions necessary for such plate, to give in projection all the colors of the original, now arises. The problem *a priori* would seem impossible of solution, unless we have resource to the methods of Lippmann. MM. Berthon and Keller-Dorian have solved the problem in a much simpler way by observing and utilizing the following phenomenon:

If, in the interior of a photographic camera in front of the ground glass and very near thereto we place a microscopic lens of negligible focal length compared to that of the objective, this lens will project two images upon the ground glass: 1—The portion of the principal image coming from the objective as far as included within the perimeter of the minute lens. 2—The image of the zone receiving light through the selective screen.

And now the method used by the inventors is to be described:

Between two of the lenses of an objective, a disk of glass divided into three colored bands, red, green, and blue, is to be interposed, each color being divided into unequal proportions, the areas being determined by experiment. Next, almost in the focal plane of the objective, and at a very small distance in front of the ground glass a microscopic lens, or rather a whole group or grating of microscopic lenses, one tangential or in contact with the other, honeycomb fashion, is to be placed. If a beam of white light is sent through the objective, we will find that a network of minute areas projected by the little lenses, appears upon the ground glass, each including three color bands, as shown in one of our figures. Instead of letting a beam of white light pass through the objective, let us place before it any colored object, a bouquet, for example.

In this bouquet let us consider a geranium petal: The red rays reflected by this petal only pass through the red band of the screen. The microscopic lens receiving these rays will illuminate a minute reproduction or focal image of the red colored band, which the same minute lens will project upon the ground glass, as we have just described. The remainder of the original lens

(*Continued on page* 188)

Light Beams Measure Ocean Depths

By EDWARD H. LONDON

A RECENT nautical invention, making it possible for the captain of a vessel to determine the depth of the waters through which he is piloting his ship, has been placed on the English pilot-boat, *Queen of the May*. This vessel is operating off the coast of England, where it awaits the summons of homeward bound liners for pilotage up the Tyne. The system was invented by Captain James Burn of South Shields, England.

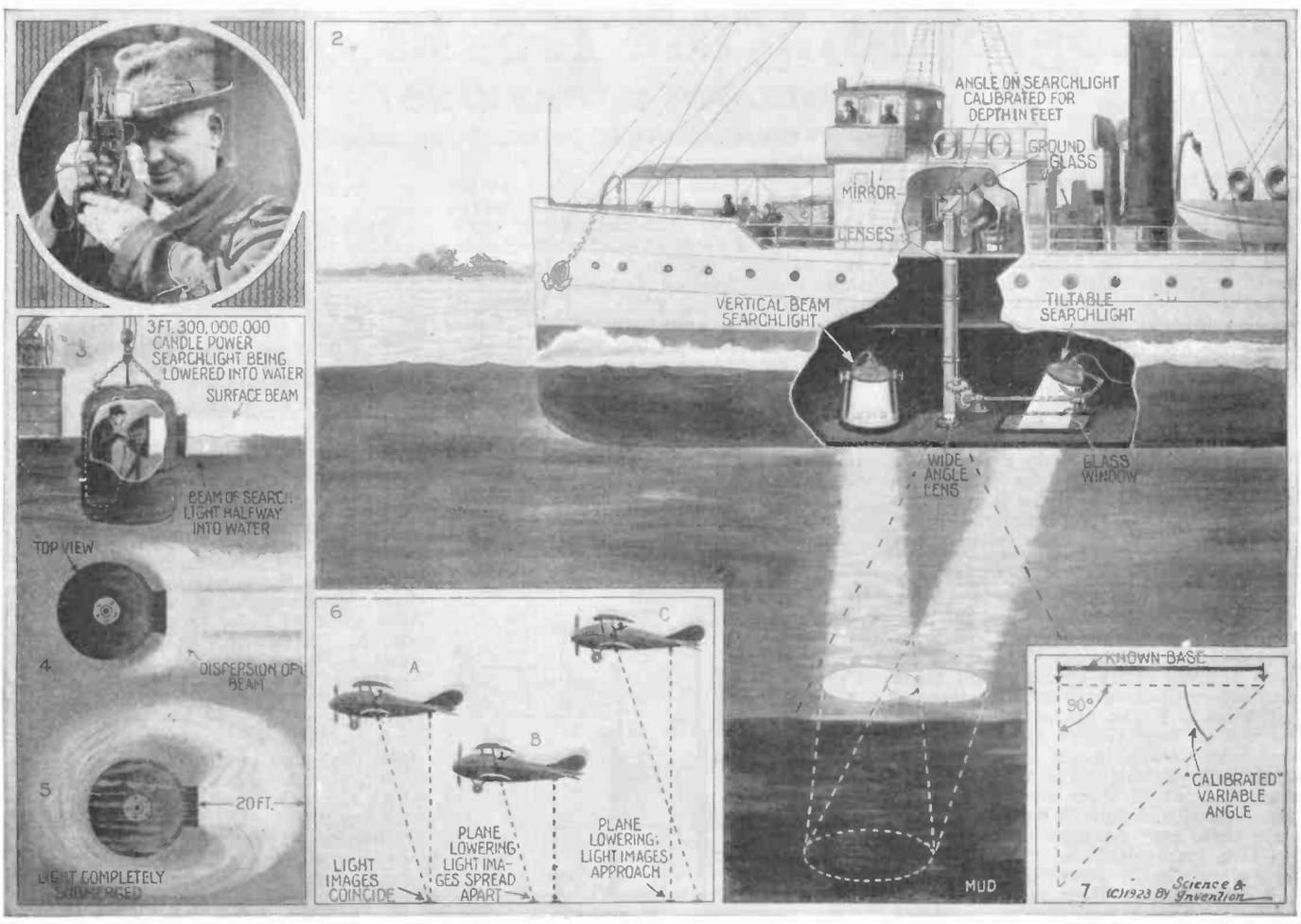
Although this device is considered by some to be of incalculable value, American nautical engineers do not all entertain the same belief. The latter hold that the device may be useful in clear waters, or in shallow waters, but not in deeper seas. Inasmuch as the device was designed for shallow waters, it will be evident that the invention may prove successful. The principle is a well known one.

As will be seen in our illustration, an observation tube extends from the pilot house, vertically downward, through the bottom of the vessel. This is fitted with a system of lenses, terminating in a wide angle lens at the bottom, and in a mirror and ground glass plate at the top. Down in the hold of the vessel and immediately forward of the observation tube, we find a searchlight, sending its beam vertically downward through a large plate glass window, fitted into the hull of the vessel. The circle of light produced by the searchlight may be seen, illuminating the bed of the river, when observed through the tube. A definite distance aft of the tube, another searchlight may be found. This is mounted on its base in such a manner that it may be swung through quite a wide angle. Its beam of light likewise passes through another glass window considerably larger in size, than the forward window. A worm-drive operating a sector on the searchlight, controls the angle of projection of this light beam. This drive is regulated by the pilot of the vessel, who merely turns a knob on a graduated dial, and reads the depth of the water in feet on this dial. The method and reason is quite obvious.

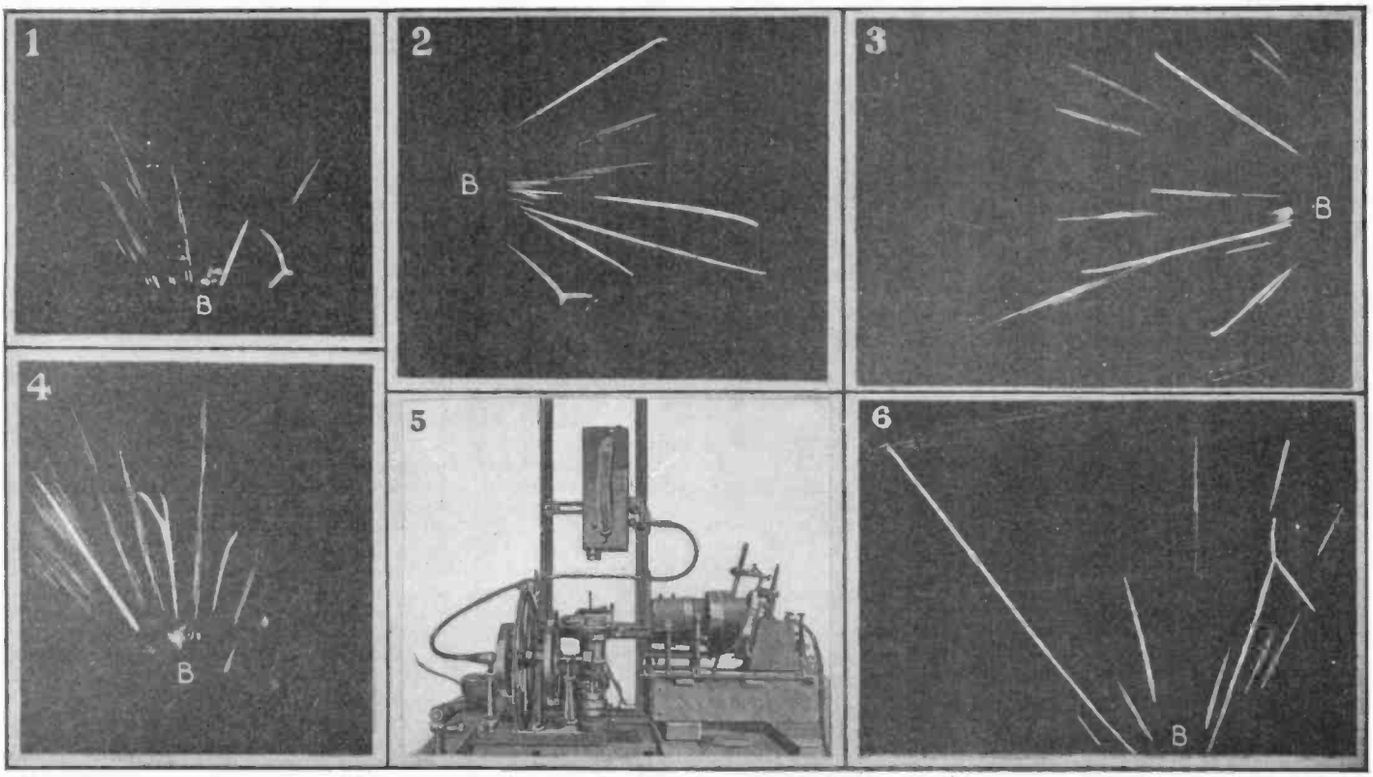
One of the light beams projects vertically downward. The other is shifted until the circle of light it casts on the river bed is superimposed upon that cast by the first mentioned searchlight. By means of simple calculations it is now possible to determine the depth of the water, as we now have a right angled triangle in which the base is known, and one angle is calibrated. An idea similar to this was used by Mr. Jenkins, an American inventor, for night landing of airplanes. For this purpose he projects a beam of light from a small searchlight fitted with an incandescent bulb, vertically downward to earth. Another searchlight, the angle of which may be shifted relative to the airplane, is mounted near the observer's seat. By looking over the side of his airship, the observer can see the two spots of light on the ground. Let us assume now that he has fixed his two spotlights, so that the images will coincide when the airplane has reached a height of twenty-five feet above the ground, and that he has pushed his steering wheel away from him, depressing the elevating rudder and is forcing himself down to the ground. He will see from his position in the airplane that the images are far apart, as shown in C, due to the fact that the beams cross each other. These gradually approach as he continues to travel at reduced speed down to the ground. When they coincide, he can straighten out for landing. On the other hand, if he does not do so, the light images will pass their point of coincidence, and will gradually work themselves further apart. As the opposite effect takes place when the airplane is leaving the ground and ascending to the higher stratas, the aviator can tell his approximate position for the first rise with regard to the earth by means of the two beams of light. So we see that this same principle has been utilized for vessels.

Here, however, we have another difficulty to overcome. We know that it is a relatively simple matter to project a beam of

(*Continued on page* 164)



In the Drawing Above Is Depicted a Method Now Employed In England For Determining the Depth of Water Through Which a Ship Passes. Inasmuch As the Base of the Triangle Is Known, the Oblique Angle Calibrated and the Other a Right Angle, the Depth of the Water Can Easily Be Determined When the Two Circles of Light Coincide. The Same Method Is Used On Airplanes, As Shown In A, B and C. The Searchlight Does Not Have To Be Very Powerful In This Case. At the Extreme Left of the Illustration, the Effects of Submerging a Searchlight Beneath the Waters of New York Bay Is Demonstrated. It May Be Noted That When This Searchlight Is Completely Submerged, the Rays of Light Are So Completely Dispersed That They Engulf the Chamber Housing the Searchlight. Insert Shows Inventor, Captain James Burn.



B Represents the Polonium Speck. 1—Showing an Atomic Collision Near the Source of the Helium Nuclei. 2—Showing Collision Between Atom Nuclei at the Bottom of Photo. 3—Photo. of a Normal Set of Straight Atom Tracks. 4—Shows a Very Peculiar Fork in an Atom Track. 5—Machine for Photographing Tracks of Atoms. 6—Straight Atom Tracks on Left and Atomic Collision on Right. Upward Tracks After the Fork is Due to the Nucleus of a Nitrogen Atom, While the Downward Fork is Due to the Rebounding Helium Nucleus.

Photographing the Tracks of Atoms

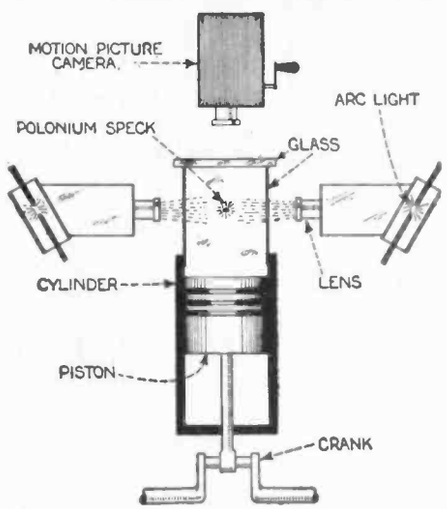
By WILLIAM D. HARKINS

PROFESSOR OF PHYSICAL CHEMISTRY, UNIVERSITY OF CHICAGO

POSSIBLY the greatest triumph of photography is that of securing accurate pictures of the path of flight of single atoms, and also of the collision between an atom traveling twenty-thousand times as fast as the most rapid rifle bullet against one which is comparatively at rest. However, such a collision, as obtained photographically by the use of a universal moving picture machine, is shown in Fig. 1.

An atom is extremely small, so small that it takes 100 million atoms to make a line an inch long. Only a few years ago it was believed that an atom comprised a single particle; now it is known that it is more nearly a miniature solar system, with a central sun, called a nucleus, and a system of planets rotating around it. Each of these planets is a negative electron. Negative electrons escape from all heated wires and are now familiar to all of those who are interested in radio communication, since the electrons are the active agents in all tubes used for rectification or amplification.

The atom tracks are easily visible to the eye as bright lines of light. You simply look down into a small chamber or cylinder through a circular disc of plate glass about three inches in diameter. About half an inch below the glass plate there may be seen the blackened top of a brass piston which fits moderately closely in the glass cylinder. There is a faint diffused light in the cylinder due to the focusing of two powerful arc lights by means of large lenses. The faintness of the light in the cylinder is due to the fact that there is nothing in the cylinder which the light can illuminate, since it contains only perfectly clean moist air. On the back vertical glass wall of the glass cylinder can be seen a very minute white speck (polonium). Suddenly the black piston goes down with a chug, expanding the air in the cylinder. Suddenly, as if by magic, there appear from one to ten lines, usually perfectly straight, white and luminous. Each of these is the path or track of the nucleus of a helium atom which has shot out at a speed of ten thousand miles a second from the white speck at the back of the cylinder. If you are fortunate, or if you wait until this process is repeated often enough, you will see one of the tracks suddenly split into two at the end (as in Fig. 1), in which case you have been so lucky as to view an atomic collision.



Apparatus for Photographing Atom Tracks. Cylinder of Apparatus is Brass Below and Glass Above. Above This is the Moving Picture Machine. Arc Lights Are Used on Right and Left.

The lines of light, which give the exact paths of the helium nuclei, are due to the shining of the arc lights upon many thousand water drops which are deposited in each track. These water drops are deposited upon the wreckage of the atoms of air left by the swift projectile, which, as stated in the first paragraph, shoots through the air with a speed twenty thousand times that of the swiftest rifle bullet.

If you examine many photographs of atom tracks you will see that nearly all of the tracks are perfectly straight lines. This means that the helium nuclei do not turn from their paths when they meet the atoms of the air, but simply shoot straight through them. Thus each nucleus shoots straight through more than one hundred thousand atoms of air before it reaches the end of its path. However, from most of these atoms it tears out one, or sometimes two, negative electrons. These negative electrons are charges of negative electricity, and upon each electron a minute water drop deposits from the moist air whenever the air is suddenly cooled, as it is when the air is expanded by the sudden dropping of the piston. Each atom of air from which an electron is torn is thus charged with positive electricity, and is called a positive ion. Upon each of these positive ions also a minute water drop deposits when the air of the chamber is expanded. Thus about two hundred thousand minute water drops are formed in the track of each atom. Some of these coalesce into larger drops, but altogether there are so many drops that each track gives the appearance of a luminous line.

While the very swift helium nuclei

(*Continued on page* 184)

10 Aviation Records Smashed At Dayton

CLIMAXING a day of superior flying, Lieutenants John A. Macready and Oakley Kelley landed the Fokker monoplane T-2 at 9:45 P. M. on the night of April 17th, establishing a new world's record for sustained flying. They were in the air 36 hours 5 minutes and 20 seconds on a thirty-one and one-eighth mile course. In addition to theirs, nine other records were made.

A record was made when a naval biplane, which, with its own weight, that of its two occupants and the dead weight of 2,422 pounds it carried, weighed approximately 6,000 pounds, piloted by Lieutenant Rutledge Irvine, Anacosta Station, Washington, D. C., gained an altitude of 11,300 feet over McCook Field that afternoon. This is the highest altitude ever gained by a single motored ship carrying this much weight.

Flying under Lieutenants Macready and Kelley during their endurance test, Lieutenant Harold Harris set new speed records for 1,500 and 2,000 kilometers, going almost twice as fast as the former record holder.

Harris maintained an average speed of 114 miles an hour throughout his flight. His time for 1,500 kilometers was 8 hours and 9 minutes and for 2,000 kilometers was 10 hours and 53 minutes. He flew in a De Haviland R-B.

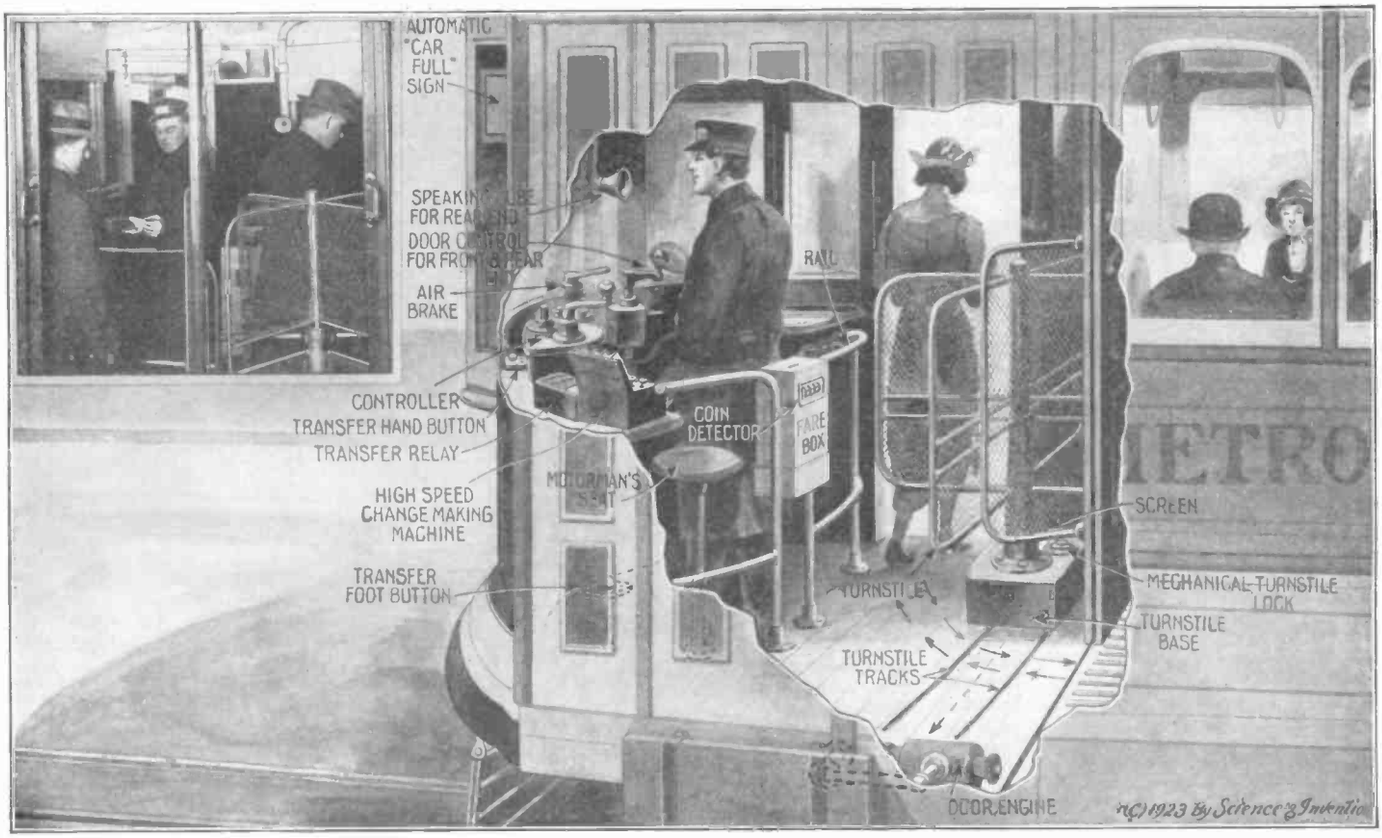
This flight began at 6:28 A. M. on the 17th and was conducted over the 31½-mile triangular course over which Lieutenants John A. Macready and Oakley Kelley flew to set a new endurance record.

Harris landed at 5:21 P. M. and appeared in excellent condition. He also holds the world's speed record for the 1,000-kilometer course, set here in an aerial derby on March 31.

Commander K. F. Smith, naval attaché at McCook Field, tonight said that the biplane which made the record altitude for weight would have gained an altitude of 19,000 feet if it had been equipped with a super-charger.

The deadweight carried included a torpedo weighing 1,650 pounds, shot weighing 600 pounds and additional equipment making up the balance of the weight.

Commander Smith said the ship would be remodeled to capture for the navy the 2,500, 3,000, 3,500, 4,000 kilometer speed records and the distance record.



A Diagrammatic View of One End of the New Pay-as-You-Leave Car is Shown Above. One Side is Partially Cut Away so as to Disclose the Various Parts. These Parts Are All Labeled and Their Relative Positions Indicated. It Will Be Seen That the Motorman is Greatly Assisted by Various Mechanical Devices. The Insert in the Upper Left Corner is a Photograph Showing the Operator Making Change.

Pay As You Leave Street Car

THE traffic situation in New York City has become so troublesome due to congestion and delays in handling the patrons of the surface lines that the New York Railways Company have been casting around for a solution. The main cause of the delays was found to be in the loading and unloading of passengers. Immediately the engineers of the transit company began to contend with the problem and the result of their effort is shown, in part, in the accompanying illustration.

This pay-as-you-leave car takes two operators to run it and arrangements are made so that passengers will be taken on and discharged at both ends. The patrons pay as they leave, thereby allowing them more time to find the necessary *jitney* which they are to give for their fare, without causing the familiar congestion when entering. Everyone knows and loves (?) the person who, when entering a pay-as-you-enter car, misplaces his pocketbook or drops his change on the floor in an endeavor to hurry. All this is eliminated in the new car.

As will be seen in the illustration, there is a turnstile at each end of the vehicle. (For simplicity, only one of the ends is shown herewith). These turnstiles are so arranged that they automatically count the number of passengers entering, and then lock so that when the car is full no more can be taken on until someone leaves. This prevents overloading with its attendant discomfort to the patrons.

As the turnstile locks, a *car full* sign is displayed. Now as passengers leave, they deposit their fares in a coin box which releases the turnstile so that they may leave the car. If they do not have the exact fare, the operator at each end of the car is provided with a quick-action money changing box so that a minimum of time will be lost in the operation of giving change. If the passenger is traveling on a transfer, the carman collects it and releases the turnstile.

All these improvements tend toward greater speed in handling traffic; safety for the patron, and greater comfort when traveling. It is estimated that the time consumed in loading and unloading the car will be reduced by one-half with this latest improvement in the city's transportation system.

Einstein Theory Explained In Movie

IN an attempt to clarify the mysteries of the Einstein Theory, a film has recently been made from which the photos on these pages are taken. This film, produced by Edwin Miles Fadman, and animated by Max Fleischer of "Out of the Ink Well" fame, was exhibited at a private showing in the Rivoli Theater in New York City.

The introduction of the film is for the purpose of increasing man's credulity. It puts the patrons of the theater into receptive moods, so that they will be prepared to accept what follows, without having to yield to preconceived bias of mind against the possibility of accepting the Einstein idea, due perhaps to their having but a smattering of knowledge of the theory.

In this introduction the audience see, projected on the screen, pictures of the first airplane and then of the modern machine. Following this, the telephone, automobile, battleship and other modern inventions and improvements are exhibited, as well as their historic ancestors. Reference is made to what now seems simple yet was once a marvelous invention. Having put you into the mood for accepting this theory, the Newtonian laws of motion are graphically

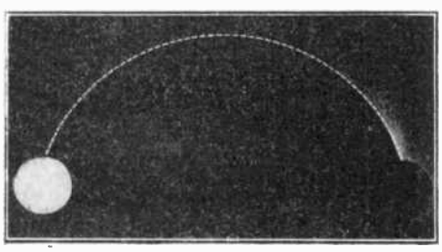
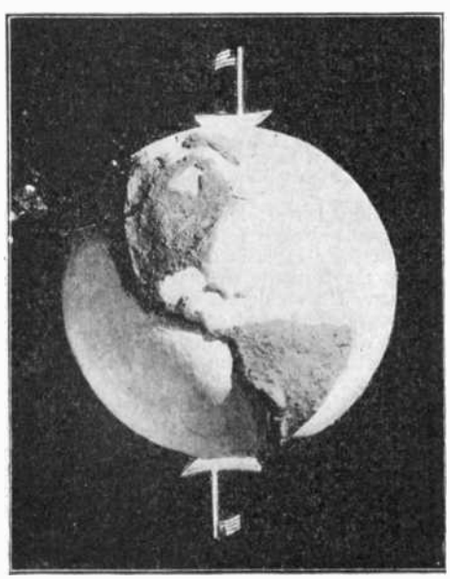


Fig. 2. Direction is Relative. But to an Observer Out in Space a Cannon Ball Would Describe an Arc, Leaving the Earth at the Right and Returning to the Earth at the Left After It had Sped Through Space.

illustrated, following which Einstein's concept of the same effects are shown.

In Fig. 1 we have a cannon mounted on the earth, in what to us here on earth appears to be a vertical position. The cannon is fired, and the shell passes upward into the air, stops and falls again into the nozzle of the cannon. To any of us here on earth, the cannon ball's flight would be marked by two straight lines, the one



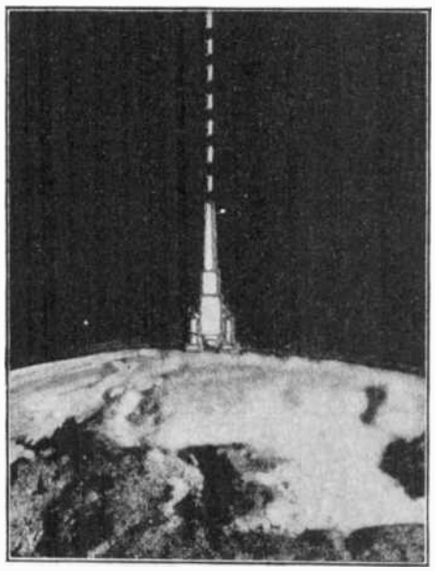


Fig. 1. To An Observer on Earth, a Cannon Ball Fired Straight Up Would Mark Two Lines; Straight Up and Straight Down.

straight up, the other straight down. We now change our position flying out into space at a speed faster than the speed of light, which is constant and definite, namely, 186,500 miles per second. As we pass from this planet to our position in space, we overtake the rays of light of yesterday, then those of the day before. Our acceleration increases, and 1922 slips by and we are looking at scenes which occurred in the year 1921. And so on decade after decade is passed. We stop, turn our superpowerful telescopes to the earth and we observe the same cannon firing a ball in exactly the same position. Strange to say, the cannon ball does not move straight up or down, but viewed from out in space its passage describes an arc, leaving the earth at its right, as shown in the illustration, Fig. 2, and returning to the earth after it has sped through space. The inference is that direction is relative.

Let us take another example of the same phase of motion. In Fig. 3 there are two ships, one located at the North Pole and the other at the South Pole. Flags are raised on both ships. To the captain at the North Pole, the flag on the ship at the South Pole went down, while that on his own ship went up, and vice versa. To an observer out in space at the axis of the earth, the flags move outward from the center, one to the right and the other to the left, and both captains describing the action as up and down would be wrong (Fig. 4). Here are three different versions of one phenomenon and many more could be found. Direction, therefore, is relative.

The scene changes to what appears to be an immense boulder. It is titled, "How Large is This Rock?" (Fig. 5). We ponder for a moment and then exclaim, "About twelve feet high," but someone else's guess is just as good as our own, for, with the rock still in the same position, the camera is drawn back, the size of the slab upon which the boulder rests is then completely brought to view and to our chagrin, we find both the slab and the boulder neatly nested in the palm of the hand (Fig. 6). Size is also relative.

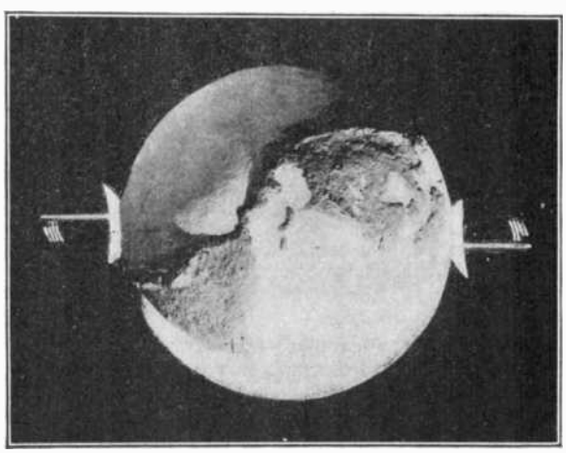
Two chronometers are shown in Fig. 7. The lower one is to indicate a clock held by a man on earth. The one mounted upon the wheel is to indicate a clock on a planet. Both clocks are started at the same moment and are known to keep accurate time. The wheel upon which one of the clocks is mounted is rotated rapidly by an electric motor. It is then brought to a stop, and we find that the clock on the wheel has lost several seconds. Time, therefore, is

Fig. 5. How Large is This Rock? Eleven Feet High? Guess Again, and Then Take a Look at the Next Figure Showing a Photograph of the Same Rock Taken from a Different Position.

relative. The faster the planet rotates, the slower is its time. This mechanical demonstration is purely theoretical. Thus, if we had one clock on a planet and an observer on earth were viewing the clock on the planet, that clock would appear to go slower than the one in the observer's hand, because

Fig. 3.—Left—Direction is Relative. Flags Are Raised on Both Ships. To the Captain at the North Pole the Flag at the South Pole Went Down and His Own Went Up and Vice Versa.

Fig. 4.—Right—To an Observer Out in Space at the Axis of the Earth, They Move from Left to Right, and Both Captains "up and Down" Would Be Wrong. You Here Have Three Different Opinions of One Phenomenon.



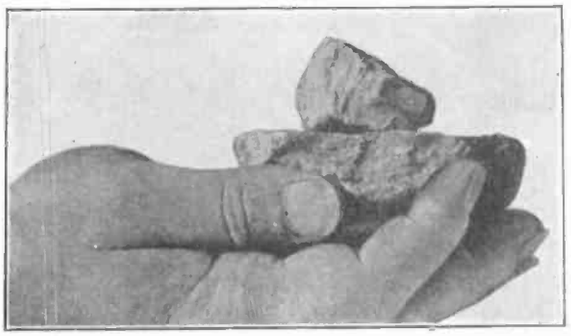


Fig. 6. When We Have Something to Compare the Rock With, it Becomes a Simple Matter to Determine How Large the Rock is. Size is Relative. Of Cource, Even in the Above Photograph We Could Err Slightly, as the Stones May Be Held in the Hand of a Child or by a Powerful Man.

of the fact that it requires a certain amount of time for the light ray carrying the clock's time to pass from the planet to the observer's eye. For this reason we cannot measure time with a light ray.

A dirigible is seen to glide through the air in another of the scenes, passing over one of two lighthouses. Midway between the lighthouses is an observer. Both of the guardians of the night flash their rays of light at the same moment (Fig. 8). The observer in the center would testify to this. The dirigible, however, is closer to one tower than to the other, and an observer there would swear that the tower on the left

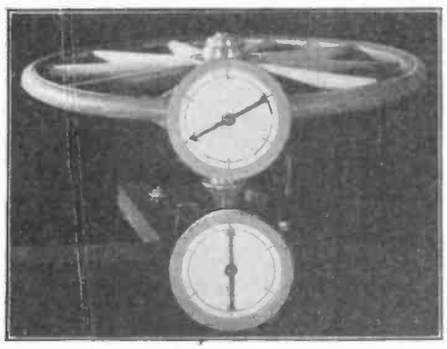
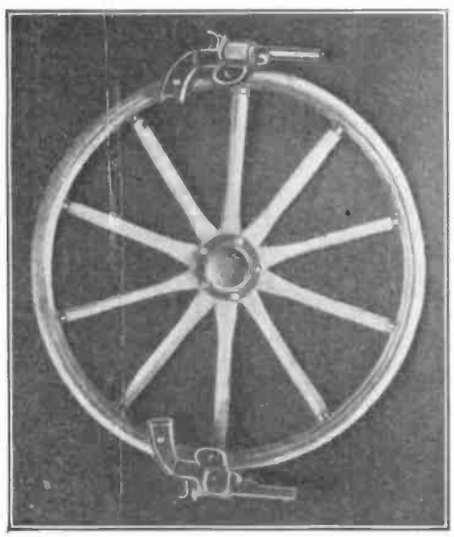


Fig. 7. Above—Measuring Time with a Light Ray. The Greater the Speed of the Planet (Wheel) the Slower its Time. Time is Relative.

Fig. 9.—Below—Revolvers Attached to a Spinning Wheel Are Discharged at the Same Moment. The Bullet from the Upper Gun Fired with the Rotation of the Wheel Flies Faster and Further Than the Bullet from the Lower Gun Fired Against the Direction of the Wheel. The Light Flashes from the Guns are Not Effected by the Rotation of the Wheel, and Travel in Parallel Lines. The Speed of Light is Not Relative. It Always Travels at a Rate of 186,500 Miles per Second.



flashed first. Due to the fact that the speed of light is finite, both observers would be correct, but their positions relative to the source of light emission must be taken into consideration when using the term "correct." The speed of light is not relative.

Let us place two revolvers on the rim of a wheel and rotate this wheel with great rapidity. For the sake of the argument, we may assume that the wheel rotates counter-clockwise, that is, from right to left, on the upper arc (we are now not arguing in Einsteinian terms, but using the words right and left in the manner we had always been taught in our childhood). When the revolvers assume the position shown in the still photograph reproduced in Fig. 9, they are fired simultaneously. Bear in mind however, that the wheel to which they are at-

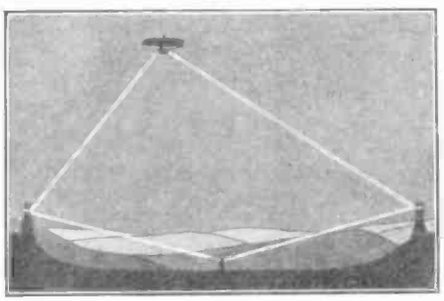


Fig. 8. Two Light Houses Flash Their Beams of Light at the Same Time. An Observer Located Midway Between Them Would Attest to the Truth of the Above Statement. An Observer in a Dirigible Flying Overhead Would Deny the Statement Made by the Man on the Ground, Claiming That the Tower Nearest the Dirigible Flashed First. The Speed of Light is Not Relative.

tached is being rotated rapidly. Both flashes of light leave the revolvers at the same time. They pass forward in the direction in which the revolvers are pointed and impinge upon the target at the same moment. Of course the light rays have passed in every direction, but we are using the target as our fixed point, and considering a few rays only. The speed of light is not relative. Sometime later the bullets strike the target, one above the bull's eye and the other below it, but the one above reachs the target much sooner than the one below, due to the fact that its speed had been accelerated by the revolving wheel, whereas the speed of the ball from the lower revolver had been decreased by the same cause. Speed, therefore, is relative in such cases.

Suppose that there is a train or a planet out in space, and we desire to measure it. We cannot do so by our fixed standards, because, as stated before, size is relative. Let us attempt to measure this train moving in space, which could be a planet or any other object, by means of a light ray. Supposing that the train in Fig. 10 is moving from right to left, a ray of light is started (as shown by the white line immediately below the train) at the tail end of the train, or at the extreme right of our illustration. This white line represents the ray of light leaving at the same moment that the train does. It eventually overtakes the train at the point marked "stop." Suppose that we now put the train back into its former position and measure it from its forward end, the light ray passing from the front of the train toward the rear in a direction from left to right. The train itself moves from right to left at the same speed as before. It is evident, therefore, that the ray of light, the lower right band in the illustration, will be much shorter than the upper one. Con-

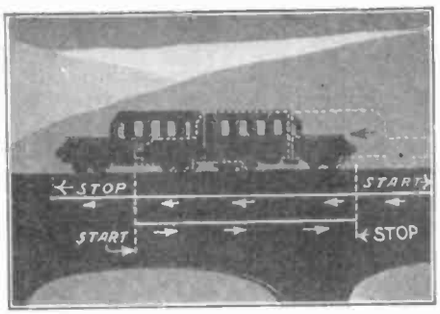


Fig. 10. Let Us Assume that a Train Out in Space is Moving Rapidly and We Desire to Measure its Size by Means of a Ray of Light. If the Train is Moving from Right to Left, as Shown in the Illustration Above, and We Start to Measure It by Means of a Light Ray Traveling in the Same Direction, the Size of the Train Would Be Indicated by the Upper White Line. If We Place the Train Back Into its Former Position, and Measure Its Size from the Forward End, with the Train Moving from Right to Left and the Light Beam Moving from Left to Right, the Size of the Train Would Be as Indicated by the Lower White Line.

sequently, size is relative and a light ray cannot be used to measure a moving object.

According to Einstein, light rays can be bent. A ray of light from the star at the left is turned in its course as it passes the sun (Fig. 11). Observers on earth at the right, calculating only in straight lines, believe the star is elsewhere, not allowing for its bent light ray. Einstein calculated the position of stars as they would appear in the field of a telescope during an eclipse. The calculated positions, according to other existing theories, were found by actual experience to be incorrect. The positions determined by Einstein were so accurate that their variation from the actual photographed positions were of no practical consequence.

The British Royal Academy of Science of England found confirmation of Einstein's theory of bent space in photographs taken during eclipses, such as this one of 1919 (Fig. 12).—*Photos Courtesy of Edwin Miles Fadman (Premier Productions).*

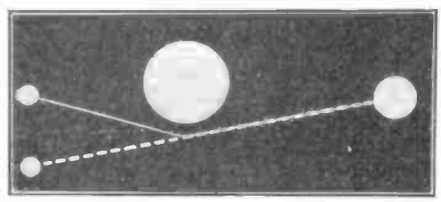


Fig. 11. Do Stars Peep Around Corners? The Course of Light Rays Are Bent According to Einstein. A Ray of Light from the Star at the Left is Turned in Its Course as it Passes the Sun. Observers on Earth (at the Right) Calculating Only in Straight Lines, Believe the Star is Elsewhere, Not Allowing for its Bent Light Ray.

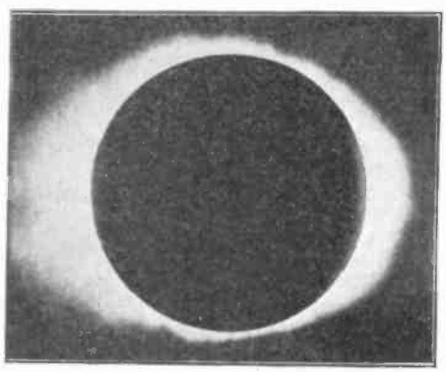
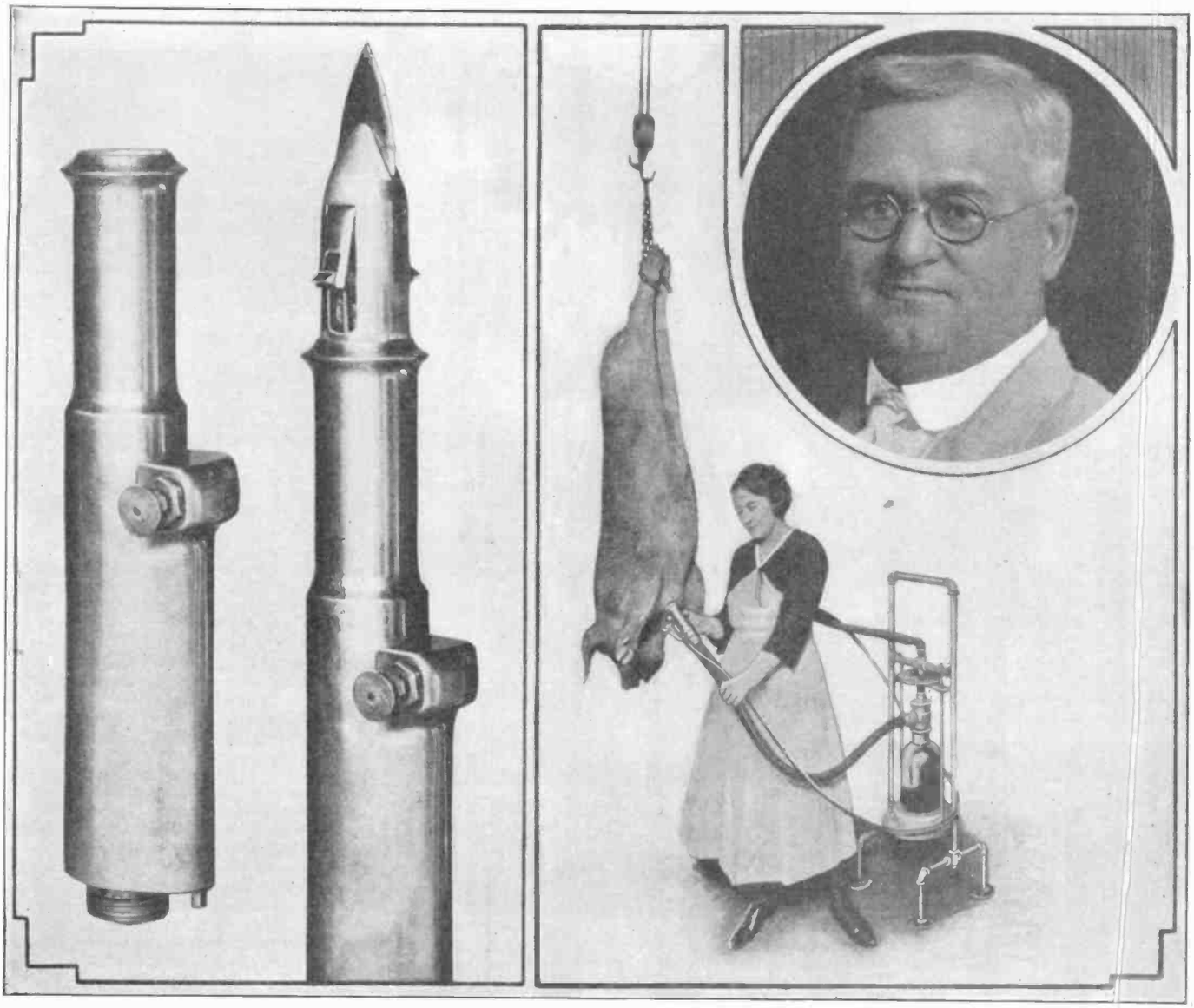


Fig. 12. The 1919 Eclipse. The British Royal Academy of Science of England Found Confirmation of Einstein's Theory of Bent Space in Photographs Taken During Eclipses Like This.



The Illustrations Above Show Mr. John A. Wilson and the "Child of His Brain"—the Wilson Slaughtering Knife—In Actual Operation. The Photo At the Left Shows the Knife With Blade Retracted, and Also With the Blade Extended, Control Being Effected By Pressure On the Single Button Shown. The Lady At the Right Is Shown In the Act of Using the Wilson Individual Slaughtering Machine, the Blood Being Sucked From the Animal By a Motor Driven Vacuum Pump, Thus Bleeding the Animal More Thoroughly and More Quickly Than Was Ever Possible Heretofore.

Money for Your Ideas No. 1

Editor's Note:

This is the first of our announced articles on inventors and their inventions, entitled "Money For Your Ideas."

The following story has to do with a man who had been a practical failure until he was almost sixty years old. Then, suddenly, an idea struck him, an idea that will, in time, revolutionize the entire killing processes as used in our slaughtering houses today.

Mr. Wilson, the inventor of this device, not only knew how to perfect an entirely new invention that is basic, but knew how to finance it and put it across as well. After the invention had been made and patented, costly plants were erected in Missouri, and they are now in operation.

INVENTION experience of the writer has been the result of sudden and very impressive impulse rather than of tedious thought and deliberation. Consequently, my greatest accomplishments have been very foreign in nature to my previous line of work.

HOW I INVENTED THE "WILSON SLAUGHTERING DEVICE"

By JOHN A. WILSON

A Failure at 60!

and

How a Novel Idea Made the Inventor Independent and Sent Him on the Road to Success and Wealth!

This is the romance of a man who had an idea and set himself to the task of working it out. An idea so big that it will revolutionize the killing of cattle and hogs in slaughterhouses the world over. It is the human story of a man with an idea who persisted in the face of discouragements, even from his own family, and who won. A story every inventor should read and re-read—and profit thereby!

I was born in Ross County, Ohio, January 21st, 1863, and was taken to Indiana three years later, where I grew up in idleness on a farm. I was one of a family of eight children, and as my parents were in moderate circumstances, I only obtained a very limited education. At the age of eighteen I lost my mother and as my father died when I was eleven I went to Nebraska, where I spent fourteen uneventful years.

There I was married at the age of twenty-two, having worked only on a farm up to this time, so that until about two years later I had neither trade nor profession. However I had a great desire to make my mark in the world and do something good, and I want to express here my kind regards to a great Statesman of Nebraska, with whom I made my home three years previous to my marriage. It was in the home of this good man, Mr. C. H. Morrill, that I saw the better things of life, and was surrounded with the influence that developed my mind.

After I was married and the father of two children I commenced to study at night. I read law for a number of years which has been the greatest help in protecting my

rights in this work. Always that infinite something seemed to drive me on. The droughts of 1890 to 1895 wrought my financial ruin and I came to Kansas City. Then as my family kept getting larger and my purse smaller, I saw that I must study harder to get ahead. For years I worked and struggled and studied nights. I took up the building trades and while working with my hands by day I worked with my brain at night. I applied myself to a Correspondence Course in Architecture and Engineering, and many a night the small hours found me working over my drafting boards. For about fifteen years I was a Contracting Architect in this city, and was engaged in the building business when the World War came on and forced out so many builders. In the year 1918, at the age of fifty-five I found myself once more down and out.

Sad and discouraged and with my good wife and three dependent children to support, I started working in the mechanical department of a large packing plant, as a draftsman. It is said, "That the Lord helps those who help themselves" and surely this seemingly great punishment was a blessing in disguise. The second week I was there I was sent to the killing floor to take measurements and make a drawing. Unused, as I was to the horrid sights and sounds,—two hundred men cutting and slashing with knives and cleavers, the lowing of the cattle as they were hastened to their death, the thud of the hammer on their heads, the blood like a crimson bog, I was so upset that I could not sleep that night, and as I lay half awake and half asleep, it seemed I could see blood running everywhere, large streams from the cattle's necks running all over the floor, and men wading around in rubber boots. Then, all at once, I saw just as plainly as I ever saw anything in my life —a knife with a hollow stem, a rubber hose attached to the stem conveying the blood away. After that it seemed so clean, so calm and peaceful, I slept so soundly, that the alarm-clock awoke me with a start. Thus the Inspiration was perfect on which to work out a great invention. I say great for it has been proven that I was the first man in the world to conceive the idea of any control of the blood in slaughtering.

Now, like many others, I had an "Idea" but how was I to develop and protect it? To be sure, I could have gone to the machine shops of the Company and by the help of the machinists there, constructed a machine and have given it a thorough trial in the plant, and gained for myself perhaps a raise of a dollar per week on my meager salary. By this course the company would have owned the invention. Instead, I wrote to a good firm of patent attorneys, whose name I will gladly furnish, and by their advice, I did all of my work at home, making only drawings. A model was never constructed until after the Patent was applied for.

Then began the struggle of my life. To raise the money necessary for the advancement of the patent was hard. It was the same old story, no one, not even my own sons, would believe that my invention was worth a dime, but I kept on. By hard application to my work for the company, I was placed in charge of the drafting room, and had to estimate the cost of installing new machinery and changes necessary in the building. This put to use all I had learned of architecture and engineering, and in this way I learned the things necessary to know to perfect my process and machine.

Then came the place where so many inventors are delayed, baffled, discouraged and oftimes are impelled to abandon their work, the financing. I really believe that no one is capable of putting a new article on the market except the inventor himself. With this idea in view and with the help of a friend I organized the Wilson Slaughtering Device Company in such a way that I kept absolute control. Not by retaining fifty-one per cent of the capital, but in a way that is fair and equitable. I have managed this company with no other thought or object in my mind but to make it a great success—believing that right will conquer. Now I have 800 satisfied shareholders.

I have applied for another patent on a process and apparatus to deliver the animals to the shackling floor in an unconscious condition and eliminate the great suffering of our dumb animals as they give up their lives to furnish us food. I feel that this last machine will meet the requirements of the Society for "The Prevention of Cruelty to Animals," who have offered a prize of $10,000 to the inventor.

HOW THE MACHINE WORKS

A technical description of the apparatus and other information may not be amiss here, for the benefit of the reader:

The apparatus consists of a controlled knife, with a hollow stem, and other parts, which removes the blood from animals, in the process of slaughtering, by vacuum. In operation it is swift, humane, safe, sanitary and economical. It is the first and only apparatus that has ever been invented which will remove the blood by force. And it represents an *entirely new idea*—a method of killing animals by inflicting a wound and forcibly withdrawing the blood from the animal's body by external means.

The illustrations show the knife open and closed, and at the bottom can be seen the screw nozzle to which the vacuum hose is attached.

The device is an apparatus comprising a knife with a hollow stem and with a mechanical means for holding the knife in the wound and for holding the wound open, an air tank, and a pump for removing the air from this tank, thereby creating a vacuum which causes the blood quickly to flow from the animal's body. In addition, there are, of course, the necessary connecting and minor parts. The knife is automatic in operation and makes a quick, clean wound in the throat of the animal. The actual bleeding time in hog slaughtering is only 43 seconds, as compared to from two to five minutes bleeding time required by existing methods.

The slaughtering of meat animals in the United States is an industry so extensive that the mind scarcely can grasp its magnitude from a mere statement of figures. In this country, each year, about thirteen and one-half million cattle, nine million calves and seventy-one million swine are killed for food—a total of ninety-three and one-half millions.

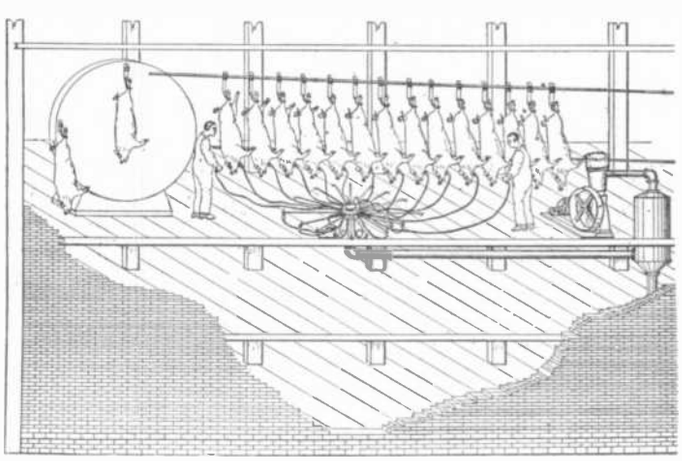
In addition to the meat and other by-products obtained from these 93,500,000 animals, blood to the value of many millions of dollars is procured. Some of this is used for edible purposes, as in the manufacture of blood sausage; some is treated to extract albumen for use in the dye and sugar industries; while some is dried and used in the manufacture of fertilizer, stock food and poultry feeds.

The present practice of slaughtering hogs in serum factories is to cut the throats of suspended hogs, allowing the blood to flow into containers. There is no way at present to prevent bacteria from the atmosphere or dust from finding lodgement in the exposed blood, which is a medium in which germs multiply with the utmost rapidity.

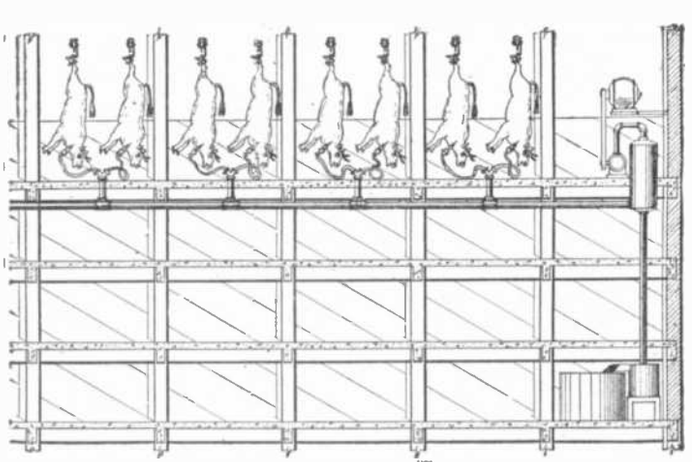
The Wilson device, as applied to serum production, prevents the blood from coming in contact with the outer flesh of the animal at the mouth of the wound. It also carries the blood directly from the arteries and veins of the animal to sealed containers and prevents, entirely, any possibility of bacteria from the air or dust entering the blood.

The device was patented Sept. 12, 1922. Patent No. 1,428,672.

In conclusion let me say, the inventor must first have a real inspiration of something *really new*. He must secure good legal advice, and with such guidance, work out the details of his device. *Never listen to discouraging words from anyone.* After the patent is allowed or at such times as his attorneys advise, make arrangements to put the article on the market, always keeping the control.



The Diagram Above Shows the Wilson Slaughtering Device As Adapted To the Killing of Hogs. The Man At the Right Has Just Removed One Knife, Which Will Be Returned To the Sticker By the Revolving Frame. Ten Knives Are Working All the Time, Removing the Blood From Ten Hogs In Less Than One Minute—Over Six Hundred Per Hour.



This Picture Shows Mr. Wilson's Cattle Slaughtering Machine. The Blood Is Drawn From the Animals and Delivered To the Large Blood Tank Situated Below the Killing Floor. The Cleanliness, Safety and Economy of This New Method of Slaughtering Is At Once Realized. It Will Effect a Revolution In the Operation of Abattoirs.

Popular Astronomy

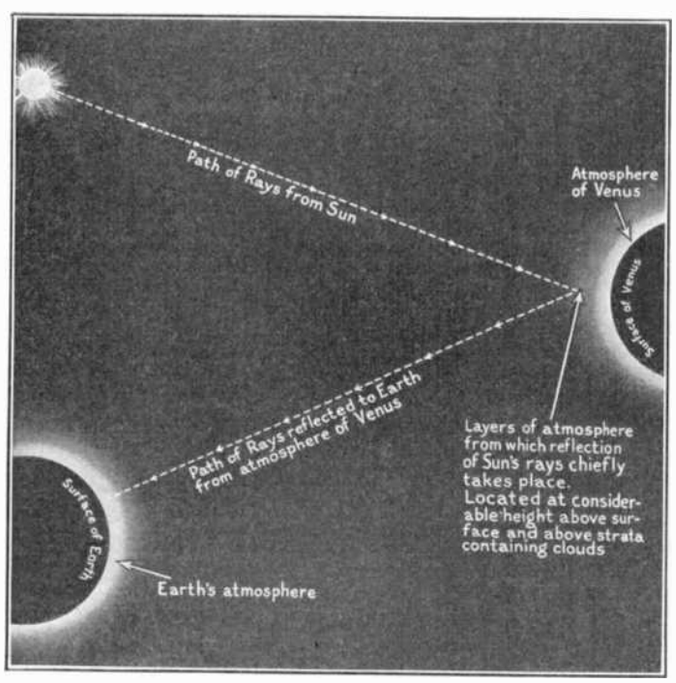
By ISABEL M. LEWIS, M. A.
Of U. S. Naval Observatory, Washington, D. C.

VENUS—The Planet of Mystery

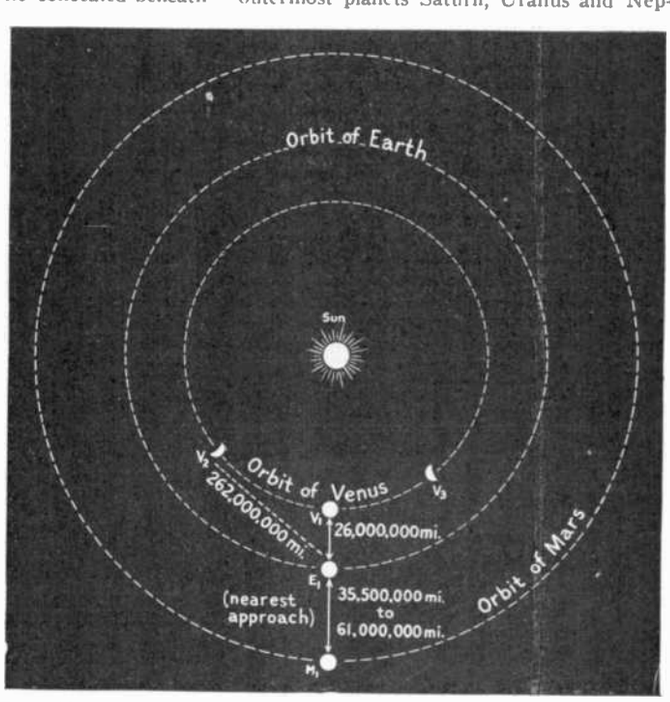
TO most of us, Mars, with its peculiar surface markings thinly veiled by a rare atmosphere, its polar caps and splatches of color changing in hue with the Martian seasons, its drifting clouds or mists temporarily concealing familiar outlines, is the most fascinating and mysterious planet of the solar system. Our interest in the ruddy planet is augmented by the fact that it may be the abode of beings who equal or even surpass ourselves in intelligence. Yet between our own planet and the sun and at its closest approach coming nearer to us than any other celestial body with the exception of the moon and an occasional comet, lies our sister-planet Venus, the most dazzlingly brilliant and beautiful of all the planets, which is quite as likely as Mars to be a world inhabited, and which in size, density and, probably, atmospheric conditions, more closely resembles the earth than our next nearest neighbor, Mars.

Certain astronomers, who do not believe that Mars is an inhabited world, have called attention to the fact that the dense atmosphere of Venus and its favorable position with respect to the sun causing it to receive about twice the amount of light and heat that falls upon our own planet, are strong points in favor of its habitability. Certainly if Mars is an inhabited world it is more than likely that Venus is also. Why, then, is it that Mars, rather than Venus, comes in for the lion's share of popular interest? Chiefly because Venus keeps her fair face permanently hidden from view behind a mask of dense atmospheric vapors. In all probability no human eye has ever gazed upon the surface of Venus. Though a few observers maintain that they have detected faint markings upon the planet, these markings are probably atmospheric in their origin, for they are so vague that the rotation period of the planet cannot be determined from them. The length of the Martian day, on the other hand, which is about equal to our own, is known accurately to a fraction of a second, owing to the clearness with which many definite surface markings can be observed, as they are carried across the visible disk by the planet's rotation on its axis.

Since we can see nothing of the planet Venus except the dazzling brilliancy of the upper reflecting layers of its atmosphere, we cannot feel as keen an interest in this neighboring world as we feel for the smaller and more distant planet Mars, with its permanent markings more or less easily discernible and the continual seasonal changes passing over its disk and giving to the planet a different aspect at each return to opposition. Moreover, though Venus comes nearer to us than Mars, it can never be seen to as good advantage because when it is nearest to the earth, at inferior injunction, its unilluminated surface is turned toward us and the planet is between us and the sun as in the case of the moon when it is *new*. By the time Venus, in its crescent phase, is far enough to either side of the sun to be seen to advantage from the earth its distance from us is as great as that of Mars at an average opposition. Yet as we gaze upon the impenetrable atmospheric screen of this, our sister-planet, we cannot but feel a thrill of interest at the thought of the mysteries of life that may lie concealed beneath it. One of the greatest puzzles that is still to be solved in the case of this planet is that of its rotation period. There have been times when it has been very definitely announced that all evidence points to a rotation period equal in length to that of the planet's revolution around the sun. But so scanty is the evidence upon which these conclusions are based that they cannot be accepted without question. If the period of rotation and revolution were equal the planet would always keep the same face turned toward the sun. One side would experience perpetual day, the other perpetual night. Strong atmospheric currents would blow continuously from the hot to the cold side of the planet. Its temperature would be one of great extremes. It has been said that all the moisture would be carried from the day side of the planet by atmospheric currents and deposited in the form of snow on the night side, but this is by no means certain. It is very probable that a condensation of moisture would take place before the currents carrying this moisture had passed beyond the boundary between the day and night sides. Though the theory of a long rotation period for Venus has been very generally favored in the past it may be said that the evidence now seems rather to be against it. In this connection a recent paper by Mr. H. Kaul in which an empirical formula is given for computing the rotation periods of the planets is of particular interest. This formula gives values for the rotation periods that agree very closely with the known periods for the earth, Mars and Jupiter and with less certainty for the three outermost planets Saturn, Uranus and Nep-



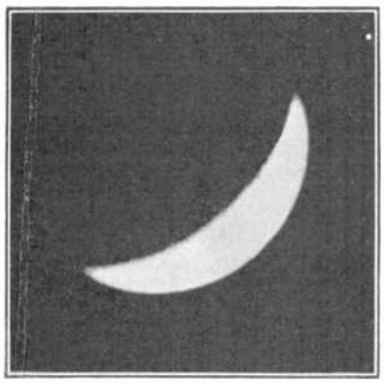
A Ray of Sunlight Reflected To the Earth From Venus Passes Twice Through That Part of the Atmosphere of Venus Lying Above the Reflecting Layers of Its Atmosphere, and Once Through the Earth's Atmosphere. The Spectrum of Venus Is For This Reason the Same As That of Direct Sunlight, Plus Lines Due To Absorption By Elements In the Atmosphere of Venus and the Atmosphere of the Earth As Well. As No Evidence Is Found of the Existence of Water Vapor, Oxygen Or Other Substances In the Atmosphere of Venus, Reflecting Must Take Place From the Upper Strata of the Planet's Atmosphere, Or Possibly From Particles of Volcanic Dust With Which the Atmosphere of the Planet May Be Filled. Finely Divided Volcanic Dust Particles Act As Almost Perfect Reflectors of Short Wave-Length Radiations From the Sun. Two Reasons Why We Are More Interested In Mars Than Venus, Though Both Worlds Are Possibly Inhabited: Compare the Photograph of Venus (On Opposite Page),



Favorably Placed For Observation, and Mars When Nearest the Earth. Note Absolute Lack of Any Detail On Venus, Showing Light Is Reflected From the Atmosphere, and Not the Surface of the Planet, and Compare With Interesting Detail Visible On Surface of Mars, Due To Rareness of Atmosphere.

When Venus Is In Position V1 It Is Only 26,000,000 Miles From the Earth, But It Is In Line With the Sun and Invisible To Us. Between V1 and V2, Or V1 and V3, It Is In the Crescent Phase; At V2 and V3 It Has the Phase of a Half Moon. In These Two Latter Positions, When Half of the Surface Turned Toward Us Is Illuminated the Distance of the Planet Is As Great As That of Mars At a Most Unfavorable Opposition. When Mars, On the Contrary, Is In Position M1 Its Surface Is Fully Illuminated and It Is Most Favorably Placed For Observation.

tune, whose period are not so accurately known. It also gives as the rotation period of Venus 26h 28m 53s, which does not differ greatly from that of the earth and Mars. This question of the rotation period of Venus is one of great interest, for, without any knowledge of the length of the planet's day, we cannot form much of an idea of the conditions that would exist upon its surface.



Not the Moon, But Venus, Photographed By Barnard With 40-Inch Yerkes Telescope. This Is How Venus Appears In the Telescope, and When She Is Most Favorable For Observation.

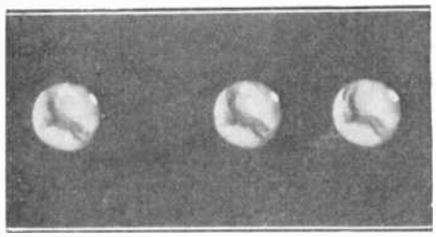
The greatest mystery that we have to solve in the case of Venus at the present time has to do with the nature of the atmosphere of the planet and of the reflecting surface from which the rays of sunlight are turned back to space. Until quite recently it was assumed that, since the albedo of Venus (the ratio of the light which it receives to that which it reflects) is about the same as that of the clouds in our own atmosphere, the reflecting surface of Venus must consist of dense and impenetrable clouds enveloping the surface of the planet with scarce a rift or break. We pictured the inhabitants of Venus deprived of the joy of gazing upon the sun's face by day or upon the starry heavens by night, owing to the presence of a perpetual canopy of clouds. Possibly our first hint to the effect that this might not represent the true state of affairs upon this sister world of ours was the observation of Director Evershed of the Kodaikanal Observatory in India, where Venus has always been a special object of study, to the effect, some few years ago, that the albedo of Venus would be just about what it has been observed to be, if its atmosphere were dust-filled instead of cloud-filled.

Following upon this there came the announcement from Mt. Wilson last year that by an ingenious method of separating the spectral lines originating in the atmosphere of Venus, from those due to elements in our own atmosphere, through which, of course, the light from Venus must pass, the discovery had been made by Drs. St. John and Nicholson that water vapor and oxygen do not exist in the atmosphere of Venus in quantities sufficient to be detected. This was a decided shock to those who had firmly believed that our twin among the planets was shrouded in a veil of dense clouds similar to those that drift across our own skies.

That further evidence to the same effect might not be lacking there were the independent studies of the atmosphere of Venus made by Director V. M. Slipher in 1908 and again in 1921. Photographs of many spectra of Venus were compared with spectra of the sun taken at the same altitude and on the same days at times when the water vapor in the earth's atmosphere was at a minimum at the place of observation. Since lines due to the presence of water vapor in our own atmosphere would appear in both the spectra of the sun and of Venus, it was hoped that the presence of water vapor in the atmosphere of Venus would be shown by an increase in the intensity of these lines in the Venus spectra. Yet not the slightest sign of any accentuation of the lines of water vapor or oxygen in any of the Venus spectra could be observed. Dr. Silpher concluded, then, as a result of his observations, that "this study shows no evidence that by oxygen, water vapor or other substances does the atmosphere of Venus selectively absorb the sunlight she reflects us, and so it leaves this remarkable planet a challenge to further study."

Quite recently also Dr. W. W. Coblentz, of the Bureau of Standards at Washington, D. C., who has been measuring the radiations of the planets by the same method employed in measuring the radiations of the stars, has found that only five per cent of the radiations that come to us from the planet Venus are radiations from the surface of the planet or from its lower atmosphere. The remaining ninety-five per cent of the radiations that we receive from the planet are due entirely to reflected sunlight. Yet Venus receives from the sun almost twice the amount of solar energy that our own planet receives, and it would be expected that its surface and lower atmospheric layers would be heated to a much greater extent if the solar energy is transmitted by the atmosphere of Venus in the same manner that it is by our own atmosphere. It is interesting to remember in this connection that the outgoing radiations from the surface of our own planet at sea level on clear nights is only about ten per cent of the intensity of the solar radiation at the surface and on cloudy nights this is reduced to zero. Also forty per cent of the incoming radiations from the sun, it has been estimated, are reflected away to space from the earth's upper atmosphere without having any heating effect upon the lower atmosphere or the earth's surface. This raises a question as to how our own planet would appear from a neighboring world. Would the dense atmosphere of the earth and the strong reflection of the sun's rays from its upper strata mask the surface features of the earth and the lower strata of the atmosphere in which float our terrestrial clouds as completely as the surface markings of Venus, and probably the lower strata of its atmosphere, are masked by the reflection of sunlight from its upper strata?

In his "Physics of the Air," Prof. W. J. Humphreys has shown that volcanic dust in the atmosphere has a powerful effect on the incoming rays from the sun, being almost as effective as a mirror in turning back to space the rays of shorter wave-length, while permitting the long wave-length outgoing radiations from the earth's surface to escape. He attributes to this fact the noticeable drops in the earth's surface temperature, that follow periods of exceptionally great volcanic activity, such as the eruption of Krakatoa in 1881 and of Katmai in 1912. It is a possibility not to be entirely overlooked that volcanic activity may be far more intense upon the planet of Venus than it is upon the earth. Even upon our own planet volcanic activity, it is generally conceded, has been much more intense in the past than it is today, and it is probable that Venus is not as far advanced in evolution as our own planet, though there may be little difference between the two in this respect. The fact that Venus receives a greater intensity of radiation from the sun than our own planet receives would probably be conducive to volcanic activity also. If great volcanic activity existed upon the planet its atmosphere would doubtless be permeated with volcanic dust to a great distance above its surface, as has been the case with our own planet at times of exceptional eruptions. The finely divided particles of volcanic dust would act the part of a screen in turning back a considerable proportion of the incoming rays from the sun. As a result most of the radiation that reaches our eyes would come from this reflecting layer, and the lower strata of the planet's atmosphere would be largely hidden from view. An effect of the presence of this volcanic dust in the planet's atmosphere would also be to lower the surface temperature of the planet by shutting out much of the solar radiation. Without reference to the possible effect of the composition of the atmosphere upon surface temperatures and taking into account simply the relative distances of the earth and Venus from the sun, it has been calculated that the surface temperature of Venus is 69 degrees C. (156 degrees F.) as compared with 17 degrees C. (63 degrees F.) for the earth. In estimating the probable surface temperature of a planet, however, the composition of the atmosphere is a most vital consideration. Such heat absorbing substances as water vapor, ozone and carbon dioxide in the atmosphere are of the greatest importance in their effect upon the surface temperature of the planet and it is the qualitative, rather than the quantitative content of the atmosphere, that determines the habitability of the globe that lies beneath it. Though one would expect the temperature of Mars to be considerably lower than that of the earth, owing to its greater distance from the sun, it is essential to consider the composition of its atmosphere before making any estimate of its surface temperature, and the same is true in the case of Venus. It is not the intensity of the solar radiation that reaches the *outer* atmosphere of a planet that determines its surface temperature, but the amount that is absorbed by its atmosphere and transmitted to its surface and this depends upon the nature of the gases and substances that make up the content of its atmosphere.



Contrary To Venus, the Three Views Above Show Mars and the Markings of Its Lands. On Venus, Due To Its Atmosphere, We Cannot Get a Glimpse of the Underlying Lands At All. (Photo By Barnard, With 40-Inch Yerkes Telescope.)

It was, indeed, a great surprise to astronomers to find that there exists no trace either of water vapor or oxygen in the radiations that come to us from Venus, but it does not seem essential to assume that for this reason water vapor and oxygen do not exist in the atmosphere of this planet. The reflecting strata of the planet's atmosphere may lie, for some reason, far above its surface and low-lying clouds may be masked by these upper reflecting layers. In the case of our own planet practically all clouds lie within seven miles of the surface though the atmosphere extends in appreciable quantities to an elevation of at least one hundred miles and we know that a considerable proportion of the sun's rays are reflected directly back to space from these upper layers of the atmosphere. If the atmosphere of Venus were permeated with volcanic dust, for instance, and this is by no means improbable, then the principal reflection of the sun's rays would be from the upper strata of the atmosphere carrying these particles.

We have have seen that Venus, the planet that lies nearest to the earth, and that is believed to more closely resemble it than any other planet of the solar system, is in some ways a more mysterious object than

(*Continued on page* 181)

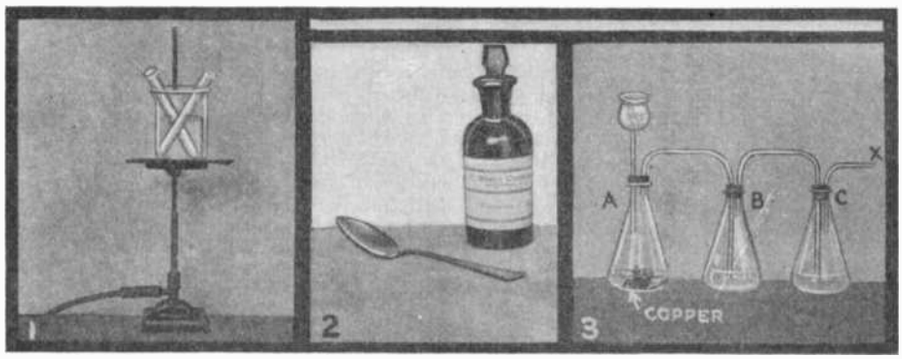
Practical Chemical Experiments

By RAYMOND B. WAILES

No. 3—PHOTOGRAPHY SIMPLIFIED

THE march of science overwhelms us. A silver spoon crossed with a late lethal war gas, bromine, is capable of producing faithfully, lifelike resemblances of friends, objects and places. This can all be accomplished through the aid of *photography*.

A photographic film or plate is composed of a film of celluloid or a piece of flat glass coated with an emulsion of gelatin and a silver chemical compound. Silver bromide, the compound which could be obtained from a silver spoon and the lethal bromine, is employed in suspension with gelatin to coat the film of celluloid or sheet of glass in order that the light reflected towards the focused camera can be converted into visible images faithfully following the contour and lines of the original subject.



1—Simple Water Bath for Preventing Substances to be Heated, from Attaining Temperatures Higher Than 100° C. 2—Photograph of Chemicals Used in Manufacturing Photographic Film. A Silver Spoon and Bromine Gas May Be Combined to Do This. 3—Apparatus for Making Hypo in the Form of Large Crystals.

Many substances become active when under the influence of light. Hydrogen and chlorine gas, another lethal substance, will combine chemically and explosively with each other, when light is allowed to fall upon the mixture of the two. Chlorine and carbon monoxide—a deadly constituent of automobile-exhaust gas and of illuminating gas—will also combine when mixed and exposed to a source of light.

Silver bromide has these same light-active characteristics. Light changes it into other substances, as can be seen by adding several cc. of silver nitrate solution to a solution of potassium bromide and exposing the resulting precipitate of yellowish silver bromide to a strong light. It darkens in color. The reaction for the formation of this precipitate is:

$$AgNO_3 + KBr = AgBr + KNO_3.$$

The latter substances, saltpeter or potassium nitrate, goes into solution.

If now this light-affected silver bromide be treated with a photographic *developing* solution called the *developer*, an interesting change can be perceived. The precipitate assumes a dark grey color, for a precipitated metallic silver has been formed. This metallic formation of silver is due to the active principles of the developer taking away the bromine from the light-affected silver bromide, leaving the silver free, or uncombined. A tube of "M-Q" developer obtained from a photographer for a few cents will serve as a developer. The directions furnished with the tube should be followed.

Now if the tube containing the precipitated silver precipitate from above be treated with a solution of sodium thiosulphate, commonly called the *fixer*, or "*hypo*," any silver bromide which escaped actinic, or light change, when the precipitate was exposed to the light, as in the case of shadows in actual photography, will be dissolved out so that nothing but minute particles of metallic silver will remain.

This is the state of affairs of negatives of photographs. They are nothing but glass or celluloid coated with an irregularly distributed layer of finely divided metallic silver.

If a tube containing silver bromide, prepared as before, but not exposed to the light, being kept in a dark room, is treated with a developing solution, the liquid then poured off and hypo or fixing solution added, little, if any, silver bromide will remain behind. Hypo dissolves silver bromide which has not been exposed to the light.

MAKING A GELATIN PLATE

In actual practice, the silver bromide is suspended in a gelatin composition, the result being the formation of a bromide emulsion. This is coated upon celluloid or upon glass.

Just how these plates or films are made can be easily demonstrated by the chemical experimenter. Prepare a dilute solution of silver nitrate in a test tube as before, and also a tube of potassium bromide solution. Add several pinches of powdered "dessert" gelatin to the tube of potassium bromide. Both of the tubes should then be placed in a water bath, a suitable bath being made from ordinary laboratory apparatus as shown in Fig. 1. The beaker contains water, and the two tubes are immersed in it. The burner from below heats the water in the beaker and soon brings it to a boil. In this manner the substance in the tubes never becomes heated to a temperature higher than 100 degrees Centigrade.

When the gelatin has passed into solution, remove the tubes while still hot and pour the contents of one into the other. A precipitate of silver bromide will form, but will not fall to the bottom of the tube as was the case when the gelatin was not present as in the previous experiment. The gelatin forms an *emulsion* with the precipitate. If the resulting emulsion be allowed to spread, by flowing, over a sheet of cleaned glass and dried, a photographic *dry plate* will result. The above operations should be performed in a dark room.

Exposure of the plate, covered by a suitable design cut from stiff paper, to the light, will produce a darkening as with the original silver bromide. Development, followed by immersion, after washing with water, in hypo solution will remove the light-unaffected portions of the silver bromide.

URANIUM PRINTS

If a card of paper be dipped into a solution of 10 per cent uranium nitrate solution and the paper then dried in the dark, it will have become *sensitized*. Covered with a design and exposed to a strong light for several minutes will *expose* the paper, and if it is then removed to the dark room and brushed with or dipped into a solution of potassium ferricyanide, the image will be clearly produced by *development*.

MANUFACTURE OF "HYPO"

Hypo or sodium thiosulphate is a product of the interaction between sodium carbonate and sulphur compounds. The substance can be prepared and obtained as large beautiful crystals in the experimenter's laboratory.

For the preparation, which is not at all difficult, take 50 grams of sodium carbonate, Na_2CO_3, and dissolve in 150 cc. of water. Boil so as to bring the chemical into solution, and then divide the solution into two parts. Reserve one part for future use and divide the remaining half portion into portions of 60 cc. and 15 cc. each.

Connect the apparatus as shown in Fig. 3 and put the 60 cc. portions of sodium carbonate solution in flask B, and the 15 cc. portion in flask C. Flask A is used to generate sulphur dioxide gas and contains copper scraps. Strong sulphuric acid previously gently warmed is poured into the thistle tube, whereupon the liberation of sulphur dioxide gas commences. Heating the flask A will hasten the reaction. Weak sulphuric acid can be used instead of the strong sulphuric acid, and the copper substituted by a sulphite, such as sodium sulphite, if desired. This is a much safer method and should be adopted by the beginner.

The sulphur dioxide gas forms sodium sulphite with the sodium carbonate, as the gas bubbles through the two flasks. Carbon dioxide is also disengaged from the carbonate, as can be seen by a frothing of the liquids in the flasks. When the exit tube, X, delivers a steady stream of sulphur dioxide gas, the reaction is complete, and sodium sulphite remains in B and C. Unite the two solutions and add the 75 cc. of sodium carbonate solution which was held in reserve to them. Flowers of sulphur should now be added and the whole boiled for about an hour. About ten grams of sulphur flowers will be sufficient. After the required boiling time, filter, and concentrate the liquid somewhat, and allow the solution obtained to cool. Crystals of sodium thiosulphate (or sodium hyposulphite) will form and should be collected. The mother liquid from these crystals can also be concentrated by heating, and another crop of crystals obtained.

This reaction ensues when the sulphite is boiled with sulphur:

$$Na_2SO_3 + S = Na_2S_2O_3$$

EXTRACTION OF SILVER FROM A SILVER COIN

A silver coin is composed of 90 per cent silver and 10 per cent copper. The two metals can be separated, and the silver obtained in the form of silver nitrate for use in the preceding experiments by the following process:

Dissolve the coin in nitric acid, heating if necessary. This operation, as well as that of defacing a coin is not unlawful, if the coin is not recirculated. The solution obtained when the coin has been dissolved contains silver and copper nitrates, the latter imparting a bluish color to the solution. If a solution of sodium chloride (in large amount) be added to the warm acid solution, silver chloride, white and curdy, will be precipi-

(*Continued on page* 164)

Experimental Electro-Chemistry

By RAYMOND B. WAILES

PART 11—PREPARATION OF THE INFLAMMABLE GASES ETHANE AND HYDROGEN BY ELECTROLYSIS; POLARITY TESTERS; NEWLY BORN OR NASCENT ATOMS.

ETHANE AND HYDROGEN FROM SODIUM ACETATE

ETHANE is a gas having the chemical formula, C_2H_6. It is colorless, odorless and tasteless, burning with a faintly luminous blue flame. It exists in small amounts in illuminating gas. Ethane and hydrogen can be simultaneously prepared by the electrolysis of sodium acetate. Sodium acetate could be said to be formed from caustic soda and vinegar, or acetic acid.

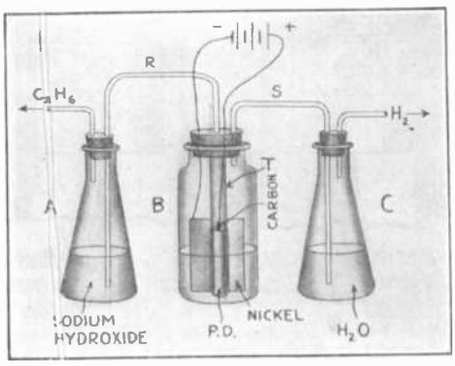


Fig. 1—Preparing Hydrogen and Ethane Simultaneously. Carbon Dioxide Gas is Also Formed During the Electrolysis, and is Absorbed in Flask A, So as Not to Dilute the Inflammable Ethane.

The apparatus used for generating and washing the gases is shown in Fig. 1. The two flasks A and C contain sodium hydroxide and water respectively. A 10 per cent solution of sodium hydroxide, (NaOH), ten grams of the solid dissolved in a small amount of water and then diluted with water to 100 cc. is sufficient. Bottle B has its stopper centrally perforated for a test tube cut off a quarter of an inch from its closed end, thus making a large-sized tube. A thickness of white blotting paper about three inches wide is tied by thread to the lower end of the test tube, forming the porous diaphragm P.D. as shown. This allows current to pass, but tends to keep the gases formed during electrolysis from mixing.

The anode consists of a rod of carbon previously heated to burn off any paraffin present. Its lateral area should be measured by the formula $L = 2\pi R H$, where R is the radius, H the length and L the area. For every ten square centimeters of area of the carbon anode, one ampere should be passed through the cell during the experiment. The voltage should be about six or eight volts.

The cathode should be of nickel. This electrode is not shown in the photo for sake of clearness. The electrolyte consists of a saturated solution of sodium or potassium acetate in water. The whole should be kept cool during the electrolysis, since a "run" with a high temperature results in low "yields" of gas. Immersion of the whole cell in water containing some ice is sufficient.

Flask A contains sodium or potassium hydroxide. This absorbs the carbon dioxide gas which is generated during the electrolysis as shown by equations 3 and 4 below. Ethane, C_2H_6, and carbon dioxide are both formed at the anode, but the hydroxide solution allows only the ethane to pass through the outlet tube, where it may be collected after running the electrolysis after a while, by allowing it to bubble up through an inverted test tube filled with water. It is inflammable and gives a bright flame.

Hydrogen gas is liberated at the cathode and can be collected and burned, or exploded in small quantities after mixing with air.

The equations showing the electrolysis are as follows:

(1) $2Na + 2H_2O = 2NaOH + 2H$

(2) $2CH_3COO + H_2O = 2CH_3.COOH + O$

(3) $2CH_3.COOH + O = C_2H_6 + 2CO_2 + H_2O$

(4) $CH_3.COOH + 4O = 2CO_2 + 2H_2O$

Equation (1) shows the interaction of the sodium atom set free from the sodium acetate at the cathode reacting with water to produce hydrogen. It is this gas which passes through tube S and out of the flask C.

The second equation shows the liberation of oxygen by the interaction between water and the radical of the sodium acetate after the sodium has left it. This oxygen is never obtained free from one of the tubes during the experiment, for it reacts as in equations (3) and (4), the first substances in the equations being acetic acid, the active ingredient in vinegar. The carbon dioxide which is absorbed by the hydroxide or alkali in flask A is evolved from the fourth equation, and being absorbed by the caustic alkali, it does not pass on and mix with or contaminate the ethane.

ELECTROLYSIS OF SULPHUROUS ACID

Sulphurous acid, H_2SO_3, has one less oxygen atom than sulphuric acid, which has the formula H_2SO_4. Sulphurous acid can be prepared by passing sulphur dioxide gas, SO_2, into cold water. The sulphur dioxide gas can be made by burning sulphur and sucking the gas from it into the water by means of suitable apparatus, or more conveniently by the action of sulphuric acid on sodium sulphite. This can be done in a simple gas generator made from a test tube with a one-holed stopper through which a tube passes.

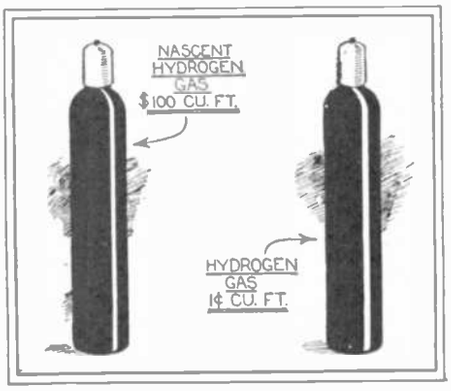
When an electric current is passed through sulphurous acid solution (for this experiment pass sulphur dioxide gas into weak sulphuric acid and use the resulting solution), containing sulphuric acid, the gases hydrogen and oxygen are liberated, as has been before explained in a previous paper. These two gases are produced from the sulphuric acid, very little gas, if any, is performed with sulphurous acid and the sulphuric acid, very little, if any, gas is formed. Instead, a white cloud of sulphur emanates at the negative pole or cathode.

The hydrogen at the moment of liberation at the cathode is said to be in a *nascent* state; that is, newly born. When in this condition, the hydrogen reduces the sulphurous acid, forming water and free or uncombined sulphur. The oxygen liberated at the anode is also in the *nascent* state when liberated and oxidizes the sulphurous acid to sulphuric acid. This is accomplished by simply adding one oxygen atom to sulphurous acid, H_2SO_3, forming H_2SO_4, sulphuric acid. In other words, as fast as hydrogen and oxygen are formed, they are used up.

It must not be thought, however, that the sulphur of today is obtained in this manner, or that sulphuric acid is produced from easily obtained sulphurous acid by electrolysis. The action of the *nascent* hydrogen and oxygen should be contrasted with the "ordinary" or atomic hydrogen and oxygen, for the two gases bubbled through sulphurous and sulphuric acid will not cause conditions as in the above experiment. However, *nascent* substances will quickly convert themselves into atomic, or "ordinary," forms, but a small fraction of a second being required.

POLARITY TEST PAPER

Another experiment which is somewhat similar to the previous and shows the difference between combined and uncombined elements and at the same time shows electrical polarity can be performed with starch and potassium iodide. This latter substance is used in medicine and photography, and no trouble will be experienced in procuring it.



If Nascent Hydrogen Gas Could Be Compressed Into Cylinders as Here Indicated, One Hundred Times as Much Gas as Ordinary or Atomic Hydrogen, Could Be Compressed Into the Same Sized Cylinder.

Potassium iodide has the formula KI, and consists of potassium and iodine. Free iodine, or iodine which is not chemically combined with other elements, will cause a blue color to form when brought into contact with starch. This can readily be seen by diluting several drops of tincture of iodine with considerable water and allowing the mixture to fall upon several drops of starch water or a freshly cut potato (which contains starch). A blue color will immediately form. If, however, a solution of potassium iodide is brought into contact with starch water no color will form. The iodine in potassium iodide is chemically *combined* with the potassium.

The electrical current will liberate iodine from potassium iodide, and the liberated or free iodine will cause a blue color with starch. To a hot solution of starch water add a few crystals of potassium iodide and soak white porous paper in the solution obtained. After drying, the paper should then be cut into strips of a convenient size. In order to show the chemical effects of the electrical current at hand, simply wet a piece of the prepared iodo-starch paper and press the terminals of the current-carrying wires upon it. The positive wire will produce a blue spot upon the paper at its contact.

Iodine, being negatively charged when in solution (when the paper was moistened), was attracted to the positive pole (anode), and there liberated, whence it reacted with the starch present on the paper to produce the blue color.

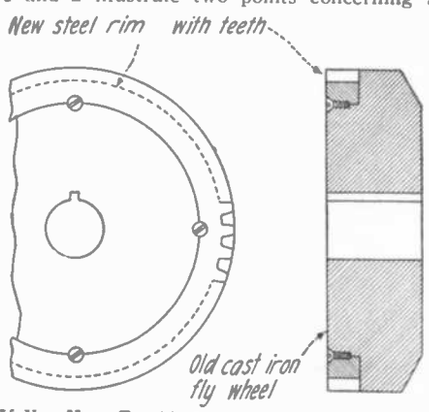
There are many other substances which could be employed in the making of test papers for determining the polarity of the terminals of current carrying wires, and the experimenter will undoubtedly stumble upon some of these himself. Phenolphthalein, for instance, causes a very marked indication if it is in solution. The experimenter can saturate blotting paper with this solution and try it.

Practical Motor Hints

FIRST OF A NEW SERIES OF ARTICLES, EACH COMPLETE IN ITSELF.

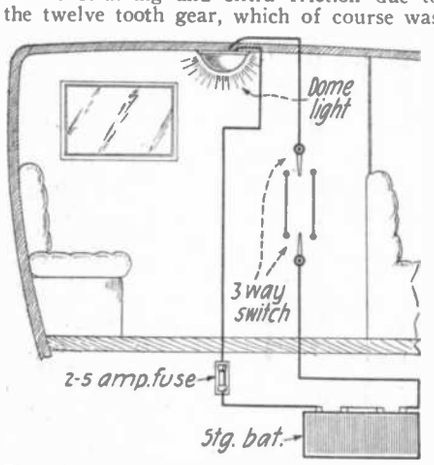
By H. WINFIELD SECOR

IN the following paragraphs the writer has endeavored to describe a few practical hints suggested by his many experiences with cars, and which may be of value to other motorists. Figs. 1 and 2 illustrate two points concerning a particular starter motor and flywheel trouble, which cost the writer over $100 before the trouble was finally remedied.



If You Have Trouble In Knocking Out Teeth On a Cast Iron Flywheel of a Motor Car, a Good Solution of the Problem Is To Have a Machinist Turn Out a Groove On the Flywheel, As Shown In the Drawing Herewith; Then Insert a Steel Rim With the Teeth Cut Into It.

The start of this story was initiated by an incompetent service station mechanic, who replaced a broken Bendix starter gear with another gear having the wrong number of teeth on the pinion which meshed with the fly-wheel. The pinion should have had eleven teeth, but a twelve toothed pinion was substituted unknown to the writer, and there was always more or less trouble with the starter, a noticeable grinding noise invariably being present when using the starter motor; and in the course of a few months a number of teeth were knocked out of the cast iron fly-wheel. It was shortly necessary to replace the fly-wheel with a new one which cost about $40.00, and this had already happened once before. When the last overhaul job was made the garageman was intelligent enough to check up the starter motor, and the number of teeth on the Bendix gear with the specifications of the car in question, and found that an eleven tooth pinion was the proper one. Incidentally, he found on close examination that the shaft of the starter motor was bent, due to the straining and extra friction due to the twelve tooth gear, which of course was of larger diameter than the eleven tooth pinion, so he straightened the shaft of the starter motor for one thing.



The Diagram Above Shows How To Hook Up Two 3-Way Or Simply Two 2-Point Battery Switches, To Control a Dome Or Other Light In the Car, So That It Can Be Switched On Or Off From Two Positions.

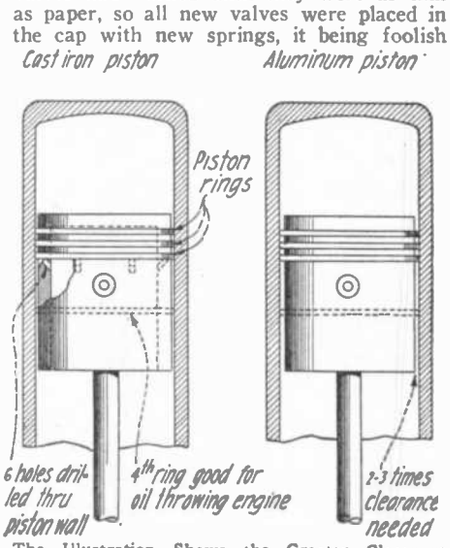
The next job he performed was to turn off all of the remaining teeth on the cast iron fly-wheel after it was removed from the car, and in this recess, as shown in Fig. 1, a steel toothed ring or crown-gear was carefully fitted and secured in place by several tap bolts, in the manner indicated. Of course, there are numerous ways in which to secure the steel rim. The idea of the steel tooth rim replacement was to avoid any further possibility of knocking out the teeth on the new cast iron fly-wheel, which are of course very weak compared to steel; and it is cheaper to replace a broken Bendix gear costing about $7.00, than it is to take chances in replacing another fly-wheel costing originally about $40.00 and involving the expense and trouble of removing and replacing the transmission, etc. The motto to be learned here is always to keep a watch on any changes or replacements on your car, especially around the engine or gears, and be sure to check up the number of teeth.

ALUMINUM VERSUS CAST IRON PISTONS

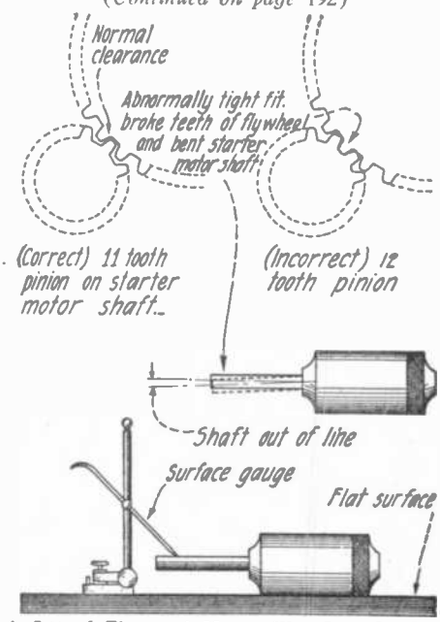
The story of the aluminum versus the cast iron pistons is as follows: About a year previous to last July, the car was purchased with aluminum pistons and a well-known form of patent piston rings, and everything went well for some twelve months, and then the engine suddenly lost compression, and became so weak that it could hardly climb a five per cent grade. Tests were made by an automobile expert with a standard compression gauge, and the best of the cylinders showed very poor compression, and as the valves were in fair condition, it was concluded that it must be the pistons and piston rings that were giving trouble and causing the loss of compression, allowing the compressed mixture to leak past the pistons and rings during the compression stroke.

The car was put in the garage, the bottom of the crank case was removed, and all the pistons were taken out. One or two rings were found broken and the others had burned fast to the aluminum pistons, and it was the final advice of the automobile engineer who supervised the job that new aluminum pistons would have to be fitted. In view of the fact that these had to have a much greater clearance in the cylinders than cast iron, owing to the coefficient of expansion being about two and a half times that of iron, it appeared to be more satisfactory to put light weight cast iron pistons in the engine. Hence six light weight cast iron pistons of the reenforced ribbed type of the correct size to allow about one and a half thousandths of an inch clearance were purchased, and the proper piston rings, determined from micrometer measurements of the cylinders by the engineer, were obtained for the job. The pistons were then lapped in and also the rings. Some of the old valves had burned until they were as thin as paper, so all new valves were placed in the cap with new springs, it being foolish to do an overhaul job like this and still retain the old valve springs as a few weak springs will cause irregular closing of the valves, and part of the power in certain cylinders will therefore be lost. Another important thing that experience has taught the writer, is that the valve rocker arms should not be adjusted absolutely tight, but there should be a few thousandths of an inch clearance, even as much as six to seven thousandths of an inch, between the end of the rocker arm and the tops of the valve stems. In one case after a regrinding and carbon cleaning job, the garage mechanic thought he had the engine tuned up in fine shape, and had tightened the valve rods and rocker arms so that there was no play at

(Continued on page 192)



The Illustration Shows the Greater Clearance Required In Fitting Aluminum Pistons Instead of Cast Iron Pistons, and Also Shows a Couple of Tricks To Help Oil Throwing Engines.



A Lot of Time and Money Was Lost In One Case In the Writer's Experience, All Because a Garage Mechanic, In Repairing a Bendix Starter Gear, Used a Pinion Having Twelve Teeth Instead of Eleven, Which Caused the Bendix Gear To Bind Tightly With the Flywheel. This Shortly Caused Teeth To Be Knocked Out of the Flywheel and Also Bent the Shaft of the Starter Motor, Which Had To Be Straightened.

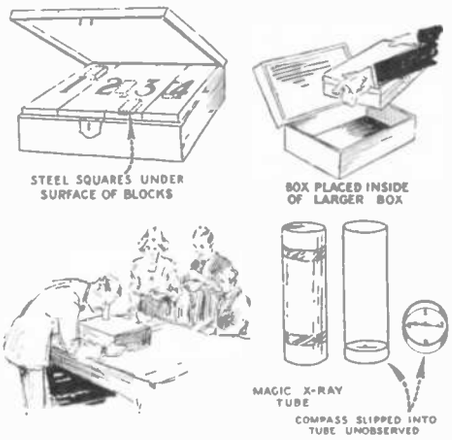
Magic For Everybody

By PROF. JOSEPH DUNNINGER

NO. 3 OF A SERIES

THE HINDU BLOCK MYSTERY

The effect which I am about to describe is perhaps one of the most puzzling and mysterious parlor tricks ever created. It has its advantages over many tricks of a similar nature inasmuch as it is one that will bear repeating over and over again without any possible danger of its secret being detected.



Four Blocks of Wood Are Placed in Any Order in a Box, Which Box Is Locked. This Box Is Again Placed Into a Still Larger One, Which Is Likewise Locked. The Performer Enters the Room and by Peering Through an Open Tube Tells His Audience the Order in Which the Blocks Appear. The Compass and Steel Plates Do the Trick.

THE EFFECT: Two small boxes are passed for thorough inspection. They are so constructed that one will nest conveniently into the other. In the smaller of these chests are found four small blocks of wood, each individually numbered with digits from one to four. The closest inspection of this apparatus is invited, but nothing can possibly be found to arouse the slightest suspicion as to any concealed trickery or mechanism. A small metal tube about two inches long and one-half inch in diameter is also exhibited and freely passed around. The magician explains that he possesses a weird power of concentration, and by the assistance of this tube can place himself in a cataleptic state by which he acquires the power of X-ray sight, and is able to look through solid objects. In order to demonstrate his marvelous power he explains that during his absence from the room the spectators may arrange the blocks in any position they desire in the smallest of the boxes. By this arrangement he suggests that the total number of combination possible with an arrangement of four digits are considerable. He further explains that after this box has been locked it is to be placed in the second or larger box and this one also is to be securely locked and the key thereto retained by a member of the audience. The magician is then to re-enter the room, and will, by running the small tube over the top surface of the box, be able to penetrate the covers with his X-ray eyes and at once to state the exact arrangement of the numbers. The magician leaves the room and his skeptical spectators at once go to work to test the ability of the conjurer. The numbers are, we will state for example, arranged so as to indicate 4,132. The wizard re-enters, and as previously stated, mysteriously calls the total of the numbers, apparently doing nothing more than running the small tube or concentration instrument over the surface of the box.

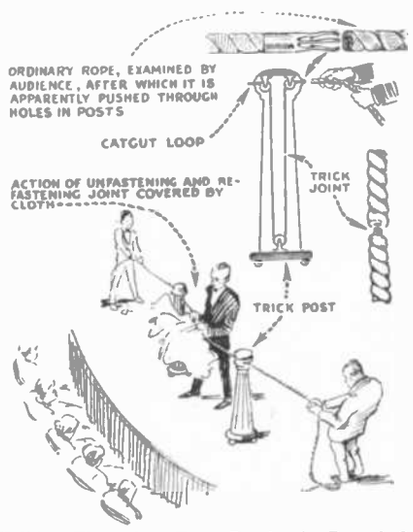
Again and again the numbers are rearranged, and yet the performer states their arrangement with amazing ease and without an error. All of the paraphernalia can be passed for thorough inspection at any period of the trick. Now for the explanation:

A glance at the diagram makes all clear. The boxes are unprepared, but the blocks are not as innocent as their appearance may suggest. It will be found that they are really composed of two layers of wood, between which in each respective block is placed a small piece of magnetized steel in different respective positions, as indicated in the diagram. Unknown to the spectators, the conjurer has secreted in his pocket a small tube, an exact duplicate of which he has passed about for inspection. In the lower end of this cylinder is affixed a compass. The tube otherwise is identical with the one examined. The workings of the trick are practically simple, as my readers will surmise. Regardless of the position of the blocks, the magnetized pieces of steel will register upon the compass point through the upper surfaces of the boxes. As the bars of steel are placed in different positions in the blocks, the indications of the compass will naturally divulge the number. The performer must, of course memorize the four positions, so that he will be in position to locate the individual digits during the test. The prepared tube is secretly exchanged for the one examined during the performer's absence from the room.

WALKING THROUGH A ROPE

This amazing and bewildering illusionary effect has for years baffled large audiences and has deceived magicians and those well up in the studies of the art of deception as well. I have presented this effect for a number of years, and have found it to be one of the most talked of sensational problems in any of my programs.

As the curtain rises, the stage is free from any paraphernalia of an unusual type with the possible exception of two posts, similar in appearance to those illustrated in Fig. 1. Two rows of chairs on either side of the stage and a table complete the stage furniture. The magician enters, clad in a costume of white flannel, the importance of which will afterward be understood. He states that he is about to present a miracle, and, contrary to all natural laws, will demonstrate that it is possible to pass a *solid* through a *solid*. For the objects of his experiment he will use his own body and prove that there is nothing that can obstruct his passage through a solid substance. Upon the table, standing upon the stage, are several lengths of unprepared rope, each about ten yards long. To heighten the effect of



Walking Through a Rope Previously Passed Out for Examination. This is Pushed Through Holes in Both Posts. Two Men Hold the Ends of the Rope While the Performer Covering It in Front of His Body, Passes Right Through It. Note the Rope Concealed in the Post, Which is Fitted with the Trick Joint.

The Method of Reading the Figures on a Bill from a Distance of Thirty or Forty Feet, is Illustrated in the Above Chart. The Performer, if Possible, Maintains an Almost Ceaseless Patter with His Spectators on Either Side. The Medium is Twenty or Thirty Feet Away. By Straightening the Bill Repeatedly, and Changing the Position of His Fingers, the Magician Informs the Medium of the Proper Figures in Their Correct Sequence.

the offering and to further convince his audience that the items of this experiment are absolutely without pre-arrangement, or preparation, he invites a committee from the spectators to go upon the stage, so they might partake in the offering and inspect all that is used.

After the committee has been secured, the ropes are passed for thorough inspection, and one is selected for the purpose of the test. This rope is passed through two holes in the top of the posts as indicated below, and the performer stations himself directly back of the rope at a point midway between these posts. The magician explains that the posts act as an obstruction should he be accused of lifting or lowering the rope at any time during the presentation of the trick. The opposite ends of the rope are held by two assistants, one on either side of the stage. Two attendants now come forth and hold a small cloth two feet wide and three and one-half feet long in front of the performer's body, so as to obstruct the view of the section of rope between the posts and that part of the performer's body from the sight of the audience. The upper part of the performer's body and his legs are in full view at all times. The performer is now seen to mysteriously walk forth and pass through the rope. The cloth is removed and the rope is found intact as before the presentation. The rope is now withdrawn from out the posts and passed for thorough inspection. Nothing can be found to help solve the mystery.

Now for the secret: One of the posts is genuine and entirely unprepared, the other not quite as innocent.

Referring to diagram Fig. 3, it will be seen that in the hollow post is constructed an arrangement composed of a series of three wheels over which passes a duplicate piece of rope which is concealed from view prior to the performance. In a section of this rope is a trick-joint operated similarly to a screw-plug, which can be opened or closed by one or two twists. To one of the free ends of this rope is affixed a bayonet-catch, and to the other end a catgut loop.

(*Continued on page* 164)

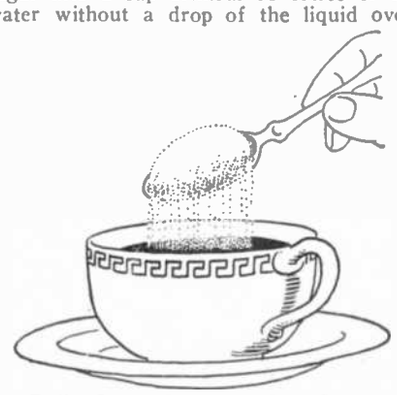
Scientific Problems and Puzzles

By ERNEST K. CHAPIN

NO. 9 OF A SERIES

IMPENETRABILITY

EVERY traffic collision impresses upon us the well known law of impenetrability which states that two or more bodies cannot occupy the same space at the same time. Why, then, is it possible to sprinkle a whole spoonful of sugar into a cup brimful of coffee or hot water without a drop of the liquid over-



Two Bodies Cannot Occupy the Same Space at the Same Time. How Then Would You Account for the Fact That Sugar Dropped Into a Cup of Coffee Does Not Cause the Volume of the Liquid to Increase Appreciably?

spilling the edge? Or, to take another instance, why is it that certain liquids such as water and alcohol can be mixed together with the result that the volume of the mixture is less than the sum of the volumes of its constituents?

COMPARISON OF HEAT QUANTITIES

The great variety of current expressions employed to describe hot objects and hot places has scarcely a counterpart in any other phase of our descriptive vocabulary. "As hot as a Dutch oven," "red hot," "white hot," "boiling hot," "as hot as blazes," we say rather indiscriminately when sometimes we refer to extremes of temperature and sometimes to great quantity of heat—an entirely different thing.

All of which goes to show that our ideas of heat quantity are often confused with those of temperature and are usually rather vague in any case. If anyone is inclined to doubt this statement let him attempt to arrange a number of characteristically hot or cold bodies in order according to the relative amount of heat which he thinks each contains. Let him determine which of the bodies considered would melt the greatest amount of some solid, say mercury at —39° C., which would melt the least, and what would be the order of those intermediate. For example, let him compare the relative amount of heat contained in the following bodies: A pound of red-hot iron, a cubic foot of boiling water, the air in a baking oven at 400° F., the air in a room containing 1,000 cubic feet of air at 90° F., and the ice of known area and thickness on a frozen lake.

A QUESTION OF WEIGHT

Mistakes are often made, too, in comparing the weight of different objects. It is probably not very rash to assert that 90 per cent will fail on answering the following simple question when first confronted with it: Which weighs the most, a pint of milk or a pint of cream?

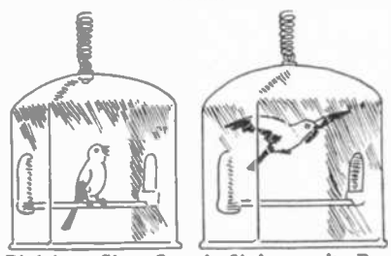
THE FLYING BIRD AND THE FLOATING STICK

Does a bird weigh anything when flying in the air, or a stick weigh anything when floating in water? To make the question more definite, suppose a bird is standing on a perch in a large air-tight case. Will the weight of the case and contents change if the bird leaves the perch and flies around the case at the level of the perch? Or suppose we weigh a stick and a pail of water side by side on the same scale and then weigh them again with the stick floating in the water. Will any difference in weight be found?

THE SLIDING ROPE

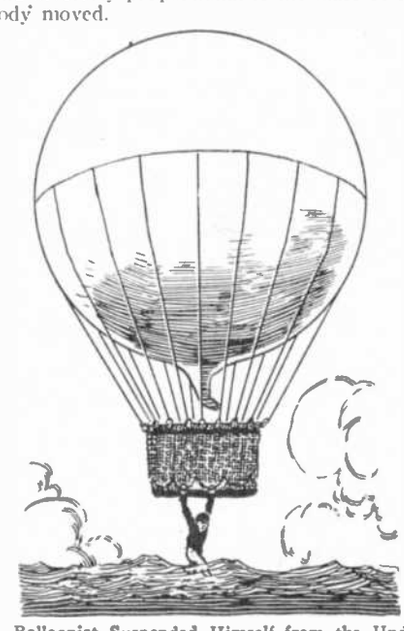
Suppose we have a flexible rope lying out straight on a perfectly level and frictionless surface considerably elevated above the ground. Now let us pull one end of the rope to the edge of the surface and let it hang down over a light pulley at the edge. How will its motion change as the rope slides off? Will the acceleration of the rope be constant, as it is for a freely falling body, or will it increase? If it increases in acceleration will its rate of increase be constant or variable? The whole problem can be solved on the basis of Newton's first law of motion, which states that: The acceleration

Which is Heavier, a Pint of Milk or a Pint of Cream?



A Bird in a Glass Cage is Sitting on its Perch. The Bird and Cage Are Weighed by a Spring Balance. When the Bird Commences to Fly, Does the Weight of the Cage Increase or Decrease?

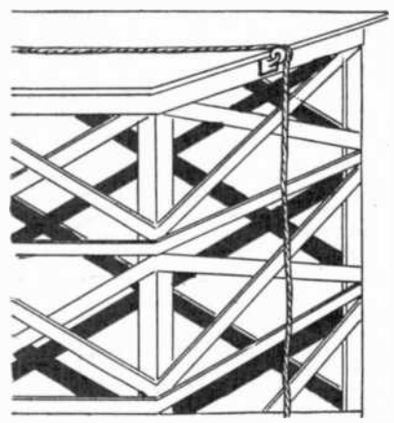
of a body is proportional to the force applied and inversely proportional to the mass of the body moved.



A Balloonist Suspended Himself from the Under Side of the Basket of a Rapidly Falling Balloon. When His Feet Struck the Water, the Descent of the Balloon Was Checked. Why?

THE BALLOONIST

During a balloon race not long ago one of the balloons sprung a leak while crossing a large lake. As the balloon neared the surface of the water the pilot got out of the basket and clung to some ropes from the



A Flexible Rope Lying Out Straight on a Perfectly Level Frictionless Surface is Permitted to Hang Down Over the Pulley. How Will its Motion Change as the Rope Slides Off?

under side so that he might free himself and thus escape being enveloped by the great bag when it struck the water. Strangely enough, as soon as his feet touched the water, the balloon ceased dropping so rapidly and actually supported the pilot until he was rescued. How can you account for its curious behavior?

Answers

IMPENETRABILITY

Sugar, and probably other substances, dissolves in water without producing much change in volume. Other substances such as ammonium chloride on dissolving produce a greater increase in volume. Some liquids, on the other hand, like alcohol and water seem to contract appreciably when mixed. While the theory which completely accounts for these facts has yet to be formulated, it is safe to say that these phenomena are made possible by the relatively large distances which separate adjacent molecules in a liquid. The molecules of the added substance can find room for themselves in the interspaces of the solvent much as a quart of beans might find room for themselves in the interspaces of a bushel of potatoes. In the case of the sugar the molecules by their presence produce little displacement of the water molecules, and hence little change in volume results when they are added. In the case of the ammonium chloride, there is evidently a little more displacement produced with a resultant increase in volume, while in the case of alcohol and water the affinity of the molecules for each other seems to result in bringing them closer together with a consequent diminution of volume of the mixture.

COMPARISON OF HEAT QUANTITIES

The quantity of heat that can be liberated by a certain body on cooling through a given temperature interval can be readily calculated by multiplying the weight of the body by the temperature interval considered and again by a constant called the *specific heat*, a constant which varies widely with different substances. Thus the specific heat of water

(*Continued on page* 164)

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.

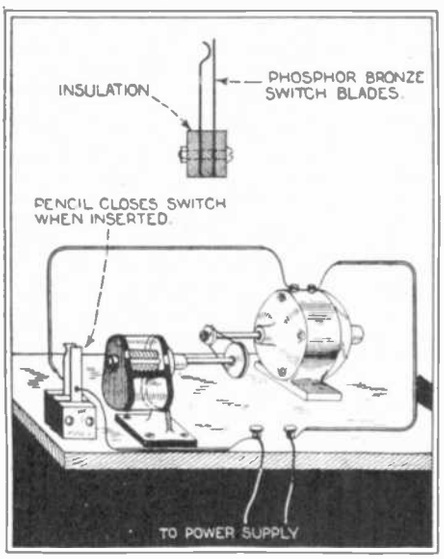
FIRST PRIZE $15.00

PENCIL SHARPENER

In need of a faster pencil sharpener and desiring to do away with the nuisance of always cranking it when a sharp point is needed, I remodeled one as follows:

Two pieces of phosphor bronze ½x¼ inches are arranged as in the diagram. This constitutes the switch. The crank is removed from the pencil sharpener and a 1-inch pulley is put in its place. This is belted to an electric motor. No definite size is given for the base as no two motors take the same floor space. When the pencil is inserted in the sharpener the switch is closed and the motor turns it until the switch is opened as the pencil is withdrawn. A strong battery motor can be used in this sharpener, the pulley in this case should be small.

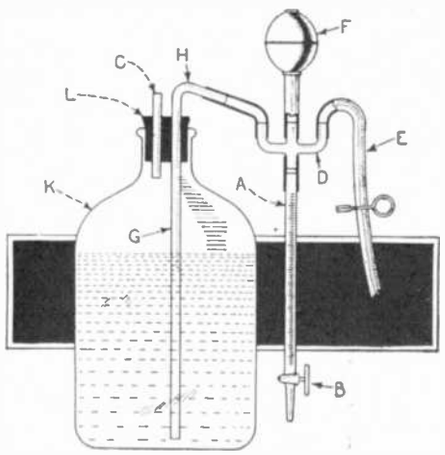
Contributed by HAROLD STRAAT.



A Very Handy Pencil Sharpener is Shown Above, Driven by an Electric Motor, Which is Actuated Upon the Insertion of the Pencil Into the Sharpener.

SECOND PRIZE $10.00
BOTTLE SIPHON

The accompanying picture shows the construction of a burette siphon, suitable for use with reagent bottles. The siphon is so constructed that a measured amount of the liquid may be removed from the bottle without pouring or applying suction by the mouth. We have the burette arm, A, graduated in cubic centimeters from 0 to 25, and a glass tube, G, which is supported in the bottle, K, by the stopper, L. To the upper end of A a three-way connection is fastened and to one of these tubes a rubber bulb, F, of a slightly larger capacity than the burette, is attached. The side tube, D, is provided with a rubber tube, E, and pinch-clamp. The lower end of A is, of course, provided with a stopcock, B. C is a glass plug which must be removed before withdrawing liquid from the bottle. To start the burette, close B, compress bulb F, with E clamped, then release the pressure on F, and the bulb will draw the liquid through G into A. If it is desired to withdraw a large quantity of the liquid from the bottle, let the entire tube fill up to H with liquid. When B is opened the liquid siphons over. To stop the siphoning, close E. If it is desired to measure out a small quantity of the liquid, repeat the directions as given, but before the arm, H, fills with liquid, open E and keep open while adjusting the height of liquid in A by means of the stop cock.



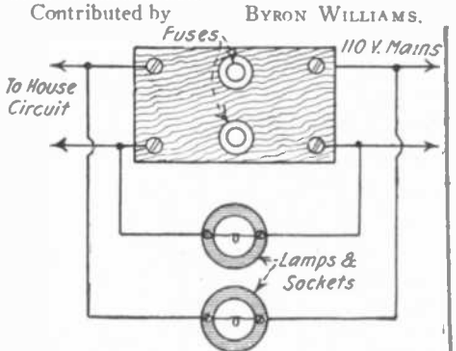
A Siphon Which is Operated by Means of a Rubber Bulb is Shown Above. This May Also be Used to Measure Certain Amounts of Liquids.

Contributed by W. J. DUNMIRE.

THIRD PRIZE $5.00.
A FUSE KINK

In experimental work, fuses are frequently blown out and the room left in total darkness, which often causes the experimenter to get a shock while inserting new fuses. To prevent this, equip two sockets with two 25-watt lamps and cut them in on the circuit, as shown in the diagram. With this arrangement, when the fuses blow the lamps will light dimly. This circuit is very efficient and useful to the average laboratory worker, as it will suggest many other uses for itself after its installation.

Contributed by BYRON WILLIAMS.



A Lamp Indicator for Blown Fuses May Be Made and Connected as Shown Above. This Eliminates the Necessity of Hunting for the Fuse Which Was Blown Out.

ANTIQUE GREEN FINISH FROM BRASS.

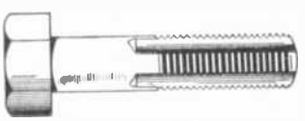
An antique finish may be given to brass articles such as binding posts, switch arms and the like by repeated applications of a dilute solution of acetic acid and exposure to the fumes of ammonia. A similar color can be given to copper by applying a solution of vinegar, blue vitriol and common salt. This mixture is applied with a brush. When the desired color is obtained, the work is washed, dried slowly (with applying heat) and then polished.

Contributed by CHESNEY Q. VOIGT.

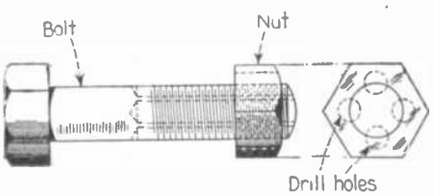
HOME-MADE TAP.

To make the tap, get a bolt on which the threads have not been worn off and place it in a vise. Procure a drill and drill four holes about 2 inches deep in the crack between the nut and bolt proper. Have the holes drilled as evenly apart as possible. Unscrew the nut and you have a tap which will prove nearly as good as one purchased. In this manner you can make taps according to the holes required. Of course, in smaller bolts the holes that are to be drilled are made proportionately smaller. It is good to taper the end of the bolt after drilling the same.

Contributed by MICHAEL B. COHEN.



FINISHED TAP



METHOD OF FLUTING TAP

The Accompanying Drawing Illustrates How to Make a Home-Made Tap from a Bolt. The Threads Can be Hardened if Desired by the Well-Known Case-Hardening Process, Any Blacksmith or Machinist Being Familiar With It.

WATER-GLASS AS A CLEANSER

Of course everyone knows that eggs can be preserved in water-glass, but how many know of the various other uses for it? You can mix this water-glass with boiling water to the consistency of syrup and keep it in a bottle. If very dirty clothes are steeped in water to which some of this "syrup" is added, and they are afterward rinsed out and soaped, they will be much whiter than if washed in soap and water alone. This treatment often removes stubborn stains. Discolored glass dishes and vinegar bottles, etc., may be made brilliantly clear by washing with the solution, as also may stained pottery or enamel ware. Dark stains on marble may often be removed by mixing the "syrup" with whiting, rubbing the place well and then washing off with clean water. Sponges become beautifully clean and fresh if washed in hot water with water-glass in it and afterwards well rinsed. No doubt stone floors could also be cleaned with this mixture.

How To Build A Wind Power Motor

By G. G. McVicker

THE REAR AXLE UNIT OF A SMALL AUTOMOBILE AND A FEW OTHER PARTS COMPLETE THE PLANT FOR HOME OR SHOP POWER.

THE vast amount of wind pressure which sweeps over the earth's surface every twenty-four hours would perform a good part of the tedious jobs about the home or about the shop if in some way it could be harnessed and utilized in belt-power form. The expense of purchasing a power windmill, such as will deliver power to a pulley or belt, is enough to keep most experimenters with wind power from attempting the erection of such a power plant.

With this conviction in mind together with the thought that there are thousands of good mechanical parts discarded from old automobiles every month, caused me to plan some arrangement to make use of the latter and with their use secure the services of the air. The following drawings and explanation will give the reader the idea of a plant which may be erected at but little cost and as can be seen will be a practical wind motor.

With the development of generators and storage batteries for storing wind power, this plant will make an ideal home lighting plant, as the electrical units may be attached at the ground floor in place of being attached at the top of the tower.

At a glance the main part of the plant will be recognized as the rear axle unit of a popular small automobile. The tubings, shafts, bearings, gears and wheels are left intact as they were when in service as an automobile part. The parts not found in an old car from which the unit is taken will be easily constructed without a lathe or machine tools other than a forge and drill press.

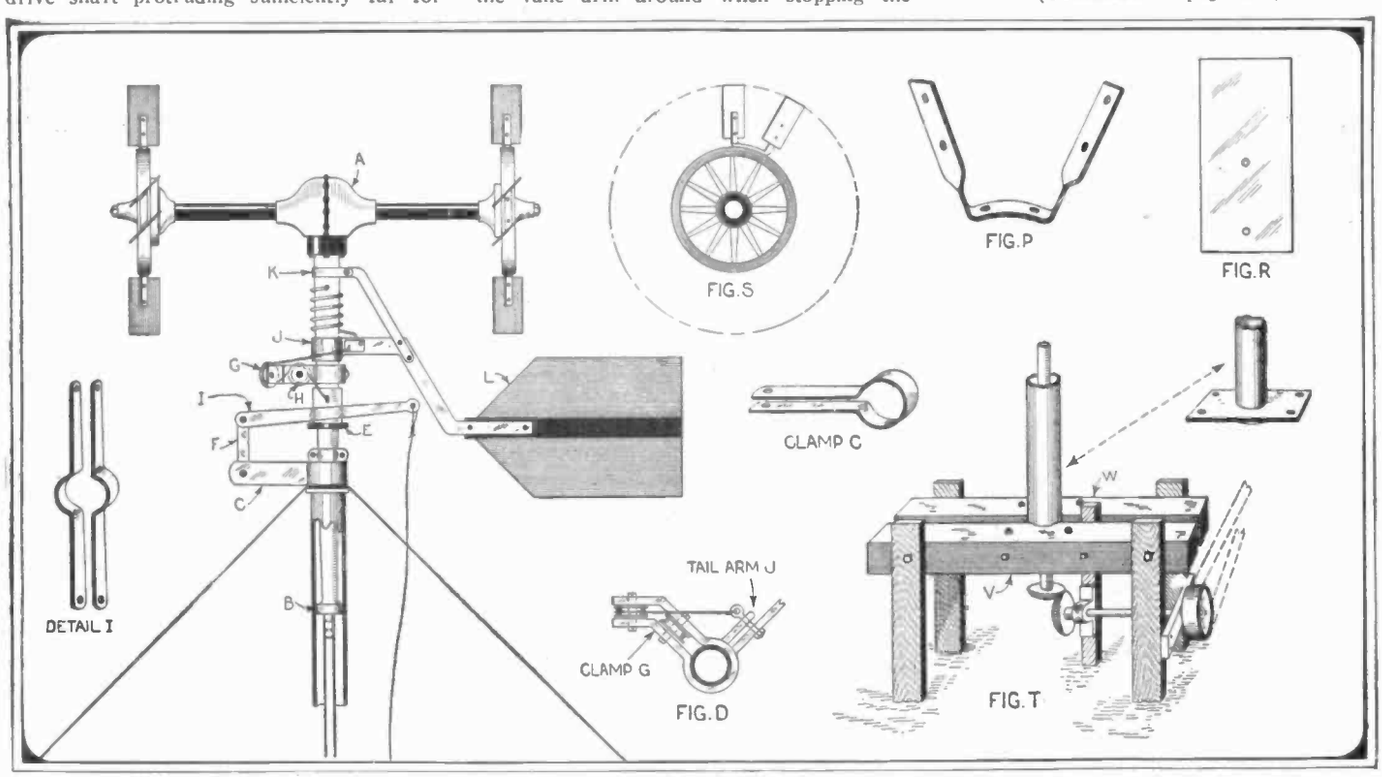
The front end of the torsion tube is sawed off just back of where the radius rod lugs are attached. This leaves the end of the drive shaft protruding sufficiently far for connecting a hollow shaft on the square end of the drive shaft. This also leaves a collar on the part of the tube to be used and makes a bearing for the latter to rest against. It will be seen that the tower for this plant is nothing more than a pipe two and one-half inches in diameter which is held in its upright position by means of four or more guy wires attached at the top of the pipe and well anchored in the ground on several sides of the pipe and well back from it. As the axle tubing is tapering the tower pipe will equal the latter diameter about ⅓ the distance up from the end collar. At this point there is clamped a collar on the tube which will carry the weight of the upper parts and allow these parts to turn freely as the various directions of the wind will demand.

At the top of the tower pipe is attached a clamp arm extending about 8 inches to one side. This to form a support for the link (F) and arms (I) which are operated by a wire from the ground to stop the wheel by turning the edges to the wind. The arm (G), better shown in the small drawing, is clamped to the tube and also has a set screw to prevent it from turning. This piece carries two pulleys both with wide grooves so that the chain will not run off when it has to operate at an angle with the sides of the pulleys. The arms (J) and (K) are formed to fit freely on the tube and both carry the vane which extends to the side to keep the wheels to or from the wind as wanted. A coil spring formed from ⅜ spring steel rod has its lower end attached to the vane arm and the upper end attached to the tube. This is to turn the wheels to the wind and thus hold them when the controlling wire at the ground is released. A chain connected to the swivel collar (E) passing around the pulleys pulls the vane arm around when stopping the mill. This action is better understood by the drawing at Fig. D.

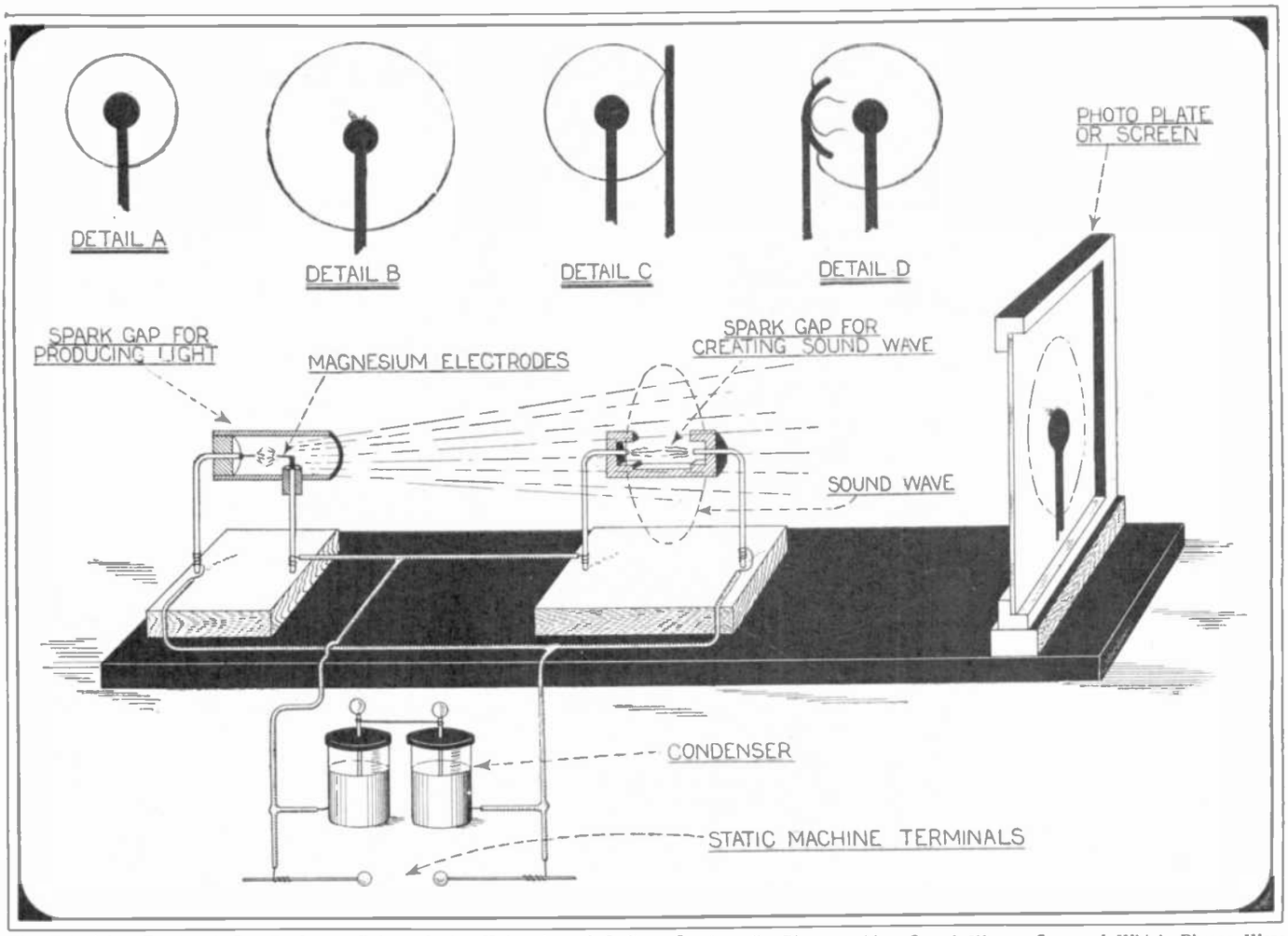
To hold the fans or blades on the wind wheels, irons as at (Fig. P) are bolted to the rims of the wheels, using two bolts between each spoke. Or for more power more blades may be attached by bolting on more of these supporting irons. Each of these are formed from 1⅜ by ⅜ machine steel, and each prong is given a 45 degree twist so that the wind blades will sit in position to receive action from the wind. The blades are each 36 inches long and eight inches wide and made from flat sheet steel of 20 gauge thickness. These are riveted to the supports on the wheel rims.

The base of the pipe tower is clamped between two six by six timbers and rests on a metal plate having a hole large enough for the shaft to pass through but not the pipe which serves as the tower. This plate is bolted to the bottom of the timbers which clamp the pipe, and these timbers are bolted to posts set in the ground which support the whole. The shaft which transmits the power from the end of the automobile drive shaft to the bevel gear at the bottom of the tower may be a piece of 1¼ inch pipe squared at the upper end to fit the drive shaft, and with a piece of shafting of its own inside diameter riveted in the bottom end to pass through a bearing at the bottom of the pipe tower and to receive the bevel gear. A horizontal shaft with gear and pulley may be arranged at the base as conditions best call for. The shaft from the tower may extend on into a well beneath and be connected direct to a rotary gear pump placed therein, if a part of the power is to be used for pumping water. Or a crank may be placed on the belt pulley to operate a stroke pump.

(*Continued on page* 164)



By Removing the Complete Rear End From An Old Automobile, and Fitting the Wheels With Vanes, It Becomes Possible To Develop a Very Efficient Type of Wind Power Motor Which May Be Used For Generating Current and May Be Employed In Various Other Ways, Such As For Running Small Lathes and Pumping Water.



The Principles Employed By Professor Foley of the University of Indiana In Actually Photographing Sound Waves, Some of Which Photos Were Published In An Article In This Magazine Several Years Ago, Are Brought Within the Scope of Experimentation By the Apparatus Here Described By Mr. Kenworthy. A Small Static Machine Is Used To Charge the Condenser, Which Causes a Spark To Jump In Both Gaps, the Electrodes of the Gap At the Left Being Made of Short Pieces of Magnesium Wire, While Copper or Brass Wire Will Serve As the Electrode Material For the Sound Wave Gap At the Right. Detail A Represents the Shadow of the Spark Gap and the Sound Wave Before It Has Progressed Very Far. In B the Wave Is Further Away From the Gap. C Represents a Wave That Has Been Reflected From a Plain Surface, and D, a Wave Reflected From a Concave Surface.

The Instantaneous Photography of Sound Waves

By ALLAN R. KENWORTHY

A NUMBER of years ago Professor Foley of the University of Indiana devised a means of photographing a sound wave in a gaseous medium. The method is thoroughly reliable and practical and is available for the average experimenter, who possesses or is capable of constructing the required apparatus, the one essential being a fairly large static generator, preferably of the Toepler-Holtz or Wimshurst types.

In principle, the method consists of the generation of a sound wave of peculiar shape by an electric discharge in a specially constructed spark gap. By the laws of refraction the sound wave, which is of different density than the medium through which it progresses, is capable of casting a shadow, therefore, by illuminating the sound wave by a properly timed electric spark of great actinic intensity, the shadow may be photographed.

The apparatus required to make this unique experiment consists, essentially, of five parts; a high-voltage condenser, a static generator for charging the condenser, the spark gap at which the sound wave to be observed is produced, the spark gap for illuminating the sound wave, and the photographic plate which may be replaced, if desired, by a screen or a piece of ground glass, should direct visual observation of the progression of the wave be required.

The condenser, from which the necessary electrical energy is taken, should consist of a battery of Leyden jars arranged in a series-parallel connection and adjusted so that when fully charged the potential is just sufficient to break down the resistance of the spark gaps. To charge the condenser, a static generator of the induction type should be employed, preferably a Wimshurst machine. Both condenser and static machine should be placed as near the other apparatus as possible in order that the wiring between the various parts can be kept at a minimum. If necessary, suitable screens should be arranged about the condenser and generator to prevent stray rays of light due to corona, etc., from reaching the photographic plate.

The spark gap at which the sound wave is created should be made of a piece of hard rubber rod approximately .5 inch in diameter and 1.5 inches long. Reference to the illustration will show the manner of its construction, which is such that the sound wave formed, instead of being spherical as is the normal shape of a sound wave generated at a point source, is cylindrical, the contour of compression being parallel with the normal axis of the spark gap. Heavy copper wire is suitable material for the electrodes of this gap.

The spark gap at which the light illuminating the sound wave is produced should be constructed from a piece of fibre or bakelite tubing approximately 1 inch in diameter and 3 to 4 inches long. The electrodes of this gap should be short pieces of magnesium wire arranged in such a manner that they can be conveniently renewed. As the metallic magnesium is usually available in the form of ribbon, the wires forming the electrodes will have to be cut from this material. By using magnesium, the actinic properties of the light from the gap are materially increased.

Both spark gaps should be mounted on suitable supports to permit their ready adjustment. All connections between the spark gaps and the condenser should be made as direct as possible and sharp turns avoided, especially in the connections to the spark gap which supplies the necessary illumination.

While the light furnished by the discharge at the magnesium electrodes is very intense, it lasts but for a very small fraction of a second, therefore, to produce a good photograph of the shadow of the sound wave, the plate used must be very sensitive. Photographic plates of the ultra-rapid type may be employed in the experiments, but specially prepared plates sensitive to ultra-violet radiations or the plates used for X-ray work are to be preferred. The size of the plates used is rather immaterial, although the use of plates smaller than four by five

(*Continued on page* 195)

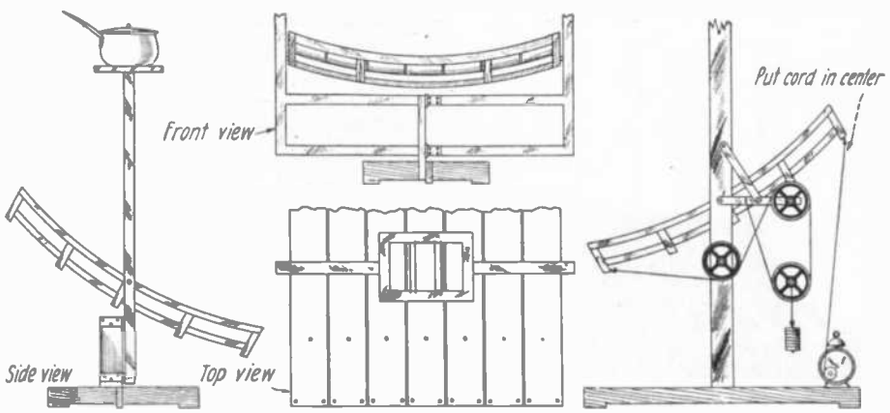
A Solar Stove of Tin Plate

By W. I. GRIPENBERG

LIKE wind power, solar radiation, as available on the surface of the earth, is fitful and uncertain and the flow of power is comparatively weak.

The concave mirror, whose serviceableness for cooking small meals was shown many decades ago, has apparently not yet undergone the requisite simplification as to material and construction.

The writer was some years ago led along a chain of reasoning, that need not be described here, to build a cooking-mirror of tin plate, and this, despite the seeming worthlessness of the material, has proved so useful that he cannot help thinking that a great many people the world over would be most glad to avail themselves of a similar apparatus.



Side, Top and Front View of a Solar Stove Made of Tinplate and a Wooden Frame. For Camping Purposes This Kind of Heat is Very Efficient. The Alarm Clock and Weight System Maintain the Focal Point Directly Under the Pot.

To procure tin plate is easy, but shaping it into a spherical mirror requires special machinery or professional skill. It was therefore cut into seven strips each one meter (3.28 feet) long and fifteen centimeters (5.9 inches) broad and bent by hand into cylindrical mirrors of 1.5 meter (almost 5 feet) radius and then arranged into a frame made of laths so as to form roughly a spherical surface. Obviously, this mirror has also the advantage that it can easily be taken apart and transported or can have parts replaced if damaged. The construction is clearly shown in the figures and needs hardly any description.

The focus covers approximately the bottom (which always must be black) of an average sized cooking vessel. The bottom may be painted with lamp black or covered with soot.

Although the mirror is very inaccurate, the focus, none the less, possesses remarkable power of setting fire to paper, wood, etc., which must be borne in mind when the mirror is set aside after use. It is inclined face downwards and in a northerly (southerly if south of equator) direction, to about 45 degrees and so is also protected against dust.

In the beginning it is almost unavoidable that splotches on the mirror occur. These are removed with a wet sponge several times rinsed in pure water. Touch the mirror surface as seldom as possible.

The frame of the grate, if made of wood, must be protected by means of bright tin plate.

What is the main value of the apparatus described?

It enables all those interested to get practical first hand knowledge of what solar power can do and they will in most cases be agreeably surprised.

Whether the average housewife will take easily to the solar stove is another matter. Necessity can do much, however.

That solar power is independent of social disturbances is perhaps not its least advantage. All other fuels are mainly provided by the grown-up male population, but the solar stove can be tended by the children, a good thing in critical times.

How to Build a Solar Cooker

By DR. C. G. ABBOT

ASSISTANT SECRETARY SMITHSONIAN INSTITUTE

Polly put the kettle on
And we'll all take tea.
—Old Song.

A HOT oven without a fire, a kitchen as cool as the parlor, these are the luxuries that come with a *solar cooker*. There are two ways of making one. The simpler kind is like that which Mr. W. Adams of Bombay made nearly a half century ago and described in the *Scientific American* of June 5, 1878. He built of wood an eight-sided cone which he lined inside with mirror glass and hinged upon a board so it could face the sun. The dish to be cooked was enclosed in a blackened, tightly covered pail hung at the center. A glass cover enclosed the pail to keep away wind. If, now, the cone was kept pointed towards the sun, a lot of its rays would be roughly focused upon the blackened pail, and its contents to be cooked could quickly be brought to boiling or, if no water was present, even hotter. Mr. Adams states that the rations of seven soldiers, consisting of meat and vegetables, were thoroughly cooked by it in a couple of hours, in January, the coldest month of the year in Bombay; and that the men declared the food to be cooked much better than in the ordinary manner. The dish is stewed or baked according as the steam is retained or allowed to escape.

But suppose the sun goes behind a cloud just as one wants to get dinner, and the clouds hangs provokingly in front of the sun for an hour though the rest of the sky remains clear. Such a catastrophe, a few times repeated, would be apt to make the men of the house kick the sun-cooker out into the brush.

To avoid this unreliability in solar cooking, a new scheme designed to keep the food cooking during nights and cloudy weather has been tried on Mount Wilson, California, at the solar observatory of the Smithsonian Institution. Instead of hanging the dish to be cooked directly in focus of the sun-rays, we provided a hot reservoir of oil above the mirror in which were ovens for the cooking. In order to carry heat from the focus of the mirror to the ovens, there was a circuit of oil pipe running up from the mirror focus to the top of the reservoir and back from the bottom of the reservoir underneath the mirror to complete the circuit. This plan is exactly like the gravity water circulation used with cook stoves and furnaces to heat a reservoir of water for the house, only that gas engine oil, instead of water, had to be used for the solar cooker, so that baking temperatures much higher than the boiling point of water would be possible.

In the contrivance as shown in the illustration, the sun-rays are focused by a great concave parabolic sheet of shiny metal upon a *blackened brass tube* containing the oil. The tube must lie so as to point at the polar star, and the metal mirror must rotate around it to follow the sun from east towards west every day.

In order that the solar heat may not be wasted, or the mirror be dimmed by dust, the whole top of it, about 10 feet by 7 feet in area, is covered by 10 sheets of flat window glass, laid on a steel frame work. This glass may be easily cleaned occasionally, so that the sun-rays can pass through it freely and it keeps out the wind currents which would tend to cool the focus-tube. To still further prevent loss of heat, the focus tube, which is about 1½ inches in diameter, is surrounded by a glass tube about twice the diameter. Notwithstanding its two glass protectors, more heat is lost from the focus tube than from all other parts of the apparatus. All the other parts, including the reservoir and connecting tubes, are covered to a thickness of about six inches with layers of asbestos and cotton-batting enclosed by bright steel metal to keep out the rain.

The iron reservoir, $40 \times 40 \times 120$ cm. ($16'' \times 16'' \times 4'$) outside, has approximately 20,000 cm.^{2} (21.5 sq. ft.) area. It is protected from wind by its galvanized iron case, and from heat conduction by 10 cm. (4″) of boxwood and 10 cm. (4″) of cotton wool, moderately compressed, on every side.

The mirror itself, 10 feet long, 7 feet wide, was made up of structural steel in five

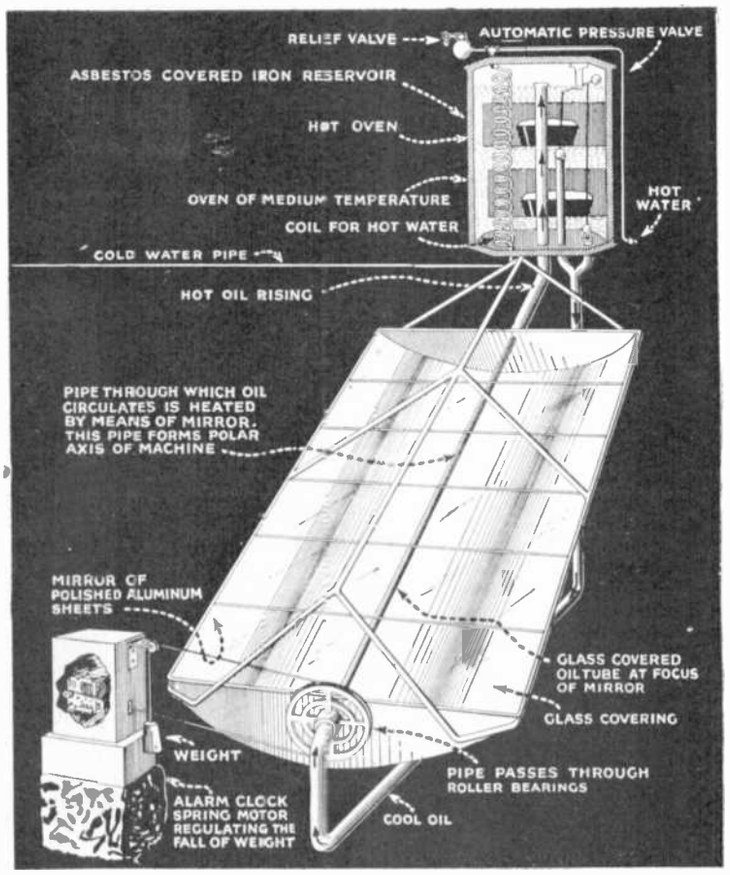
sections each 2 feet in length. Each section was framed by a pair of L-shaped members bent to the form of a parabolic bow and its chord. On the front of each pair of curved L-irons was fastened a thin sheet of smooth steel which itself, if it were polished, would accordingly have formed a mirror, but as this would have been a very poor reflector, it was proposed to cover the steel sheets with sheets of tin-foil and this experiment was first tried. Owing to an unfortunate leakage of oil which occurred at a certain joint in the pipe, the tin-foil became very dirty before the end of the experiments, but this was not the most serious trouble. It was found that no suitable means of fastening the tin-foil to the sheets of steel could be arranged. For as the mirror became heated, as the experiments went on, the tin-foil puffed up in blisters all over the surface and so spoiled the definition of the mirror. Accordingly, the preliminary experiments, although very promising, were not satisfactory, for the reason that no suitable mirror surface had been provided. An order was accordingly given for sheets of polished aluminum, somewhat thicker than the tin-foil to take its place.

The polished aluminum sheets were screwed to the parabolic steel backing to serve as a mirror surface. Their reflecting power was measured by fastening a piece of aluminum sheet to a flat board and attaching it as a mirror to an instrument to reflect sunlight. Two observers then observed the sun's brightness, the one close to and pointed at this mirror, the other pointed directly at the sun. The mean of 5 pointings to different parts of the mirror indicated its average reflecting power as $77.3 + 2.2$ per cent. In several months' use no apparent change appeared in the hot mirror. Some loss of heat occurred by imperfect shape of the aluminum mirror surface, so that a small proportion of the rays reflected shot by on the sides of the oil tube. This proportion, thought it could not be measured accurately, seemed small, perhaps 10 or 15 per cent at most.

Recalling that the mirror was covered by window glass only fairly clean, as it could not be continually kept in the condition of a lens or prism, we may set the transmission of it at 85 per cent. Further recalling that the oil tube was protected by a glass tube, another loss of 15 per cent may be admitted for it. Within this glass was the lampblack-painted tube whose absorption may be set at 95 per cent. Recalling further that no provision was made for the seasonal motion of the sun, so that the mirror was right only on the equinoxes, a small loss occurred at the mirror ends by rays not reaching the mirror surface and reflections not reaching the tube. This diminution of the effective size of the mirror varies with the time of the year. An average value for it is 5 per cent. A great loss, not a feature of the instrument, but of its location, was due to the shade of trees that could not well be removed. This practically cut off all sun rays after 1 o'clock in the afternoon, besides producing a little shade in the early morning, and thus amounted to a loss of about 40 per cent during the day.

Summing up the seven transmissions:

Glass, 85 per cent; aluminum, 77 per cent; glass, 85 per cent; focus, 85 per cent; blackening, 95 per cent; declination, 95 per cent; shade, 60 per cent.; or $85 \times 77 \times 85 \times 85 \times 95 \times 95 \times 60 = 25.6$ per cent.



At the Right Is Shown the Solar Cooker Built By Dr. C. G. Abbot. Polished Aluminum Sheets Serve As the Reflectors. This System Is Today Being Employed.

It thus appears that only about one-fourth of the sun's heat available during the day was collected to warm the oil. Of course, the shade of the trees was absent much of the time. The factor would then rise to 43 per cent. The loss at focus could be avoided by more accurate construction, and perhaps means could be found to keep the glasses clean enough to raise their transmission to 90 per cent. It would be impracticable to substitute silver on front of glass for the aluminum, and silver on back of glass reflects but little better than aluminum, besides being costly, heavy and fragile. Hence we may set the maximum attainable efficiency at

$$90 \times 77 \times 90 \times 95 \times 95 = 56 \text{ per cent.}$$

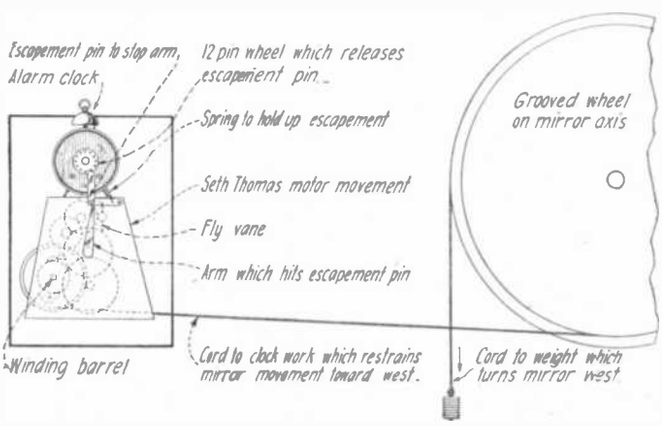
Of this possible maximum efficiency, by neglecting the tree's shading, we attained 77 per cent.

The mirror motion is arranged in a very cheap but effective way. A large grooved wheel attached to the mirror has hung from its outer edge a wire and heavy weight which tends to turn the mirror westward. But on a groove in a second smaller part of the wheel is another wire wound around the wheel in the opposite way, which restrains the turning of the mirror. This second wire ends in a clock-work, so that as the mirror turns westward the clock-work hums along pretty fast. But soon a hand like a clock hand, which it carries, hits a pin, and the motion is stopped. Then the mirror must wait motionless until a little common alarm clock with a 12-pin wheel on its back has ticked off about two minutes and released the catch which held back the mirror. This happens once each five minutes. So the mirror is always within a very small angle of exactly right in its position to focus the sun-rays on the hot tube of oil. A single setting of the mirror to face the east in the morning is all the attention it needs. The clock-work does the rest.

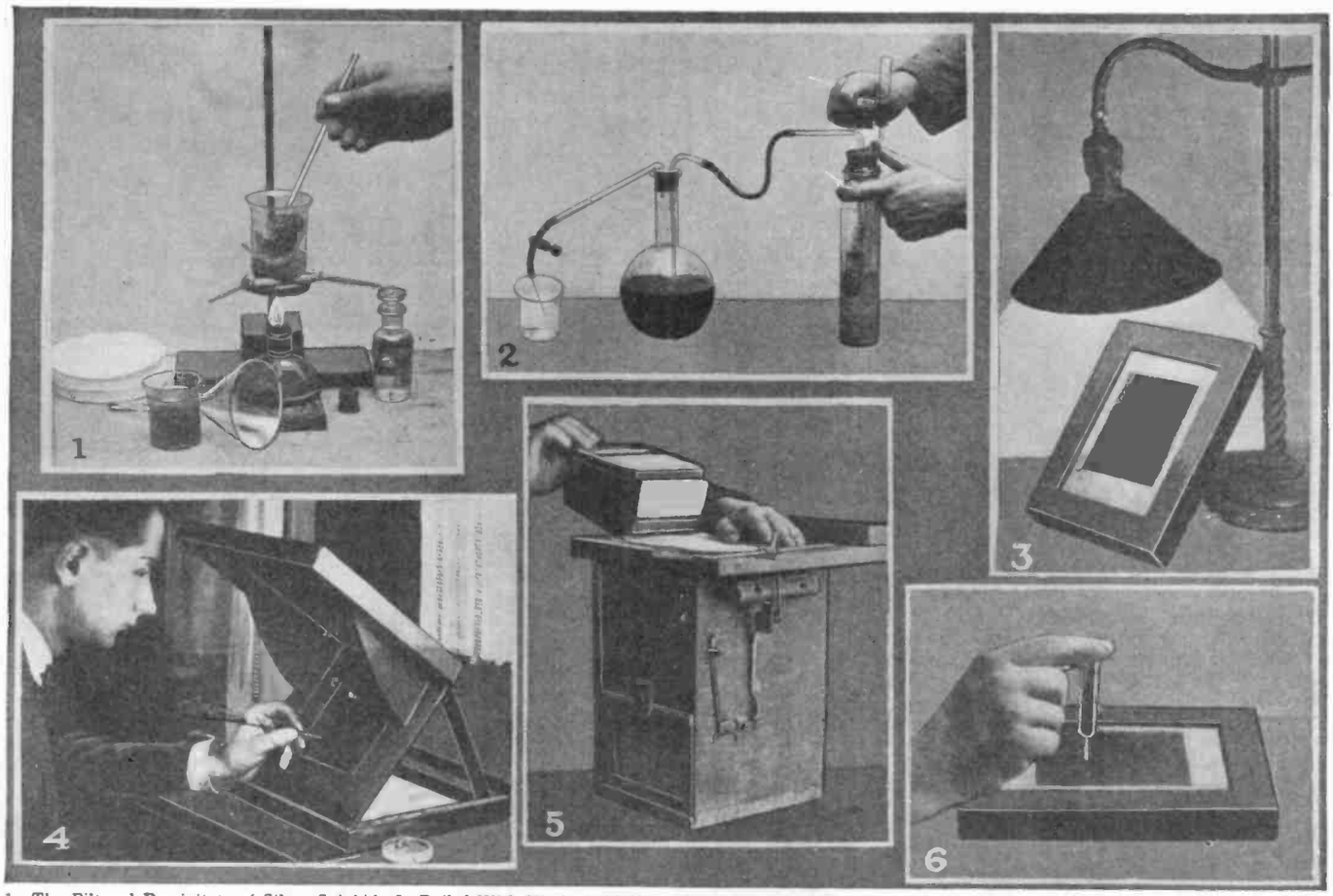
But why does the oil run uphill from the mirror to the top of the reservoir? Because the heating of the oil makes it expand, and become lighter. So the hot oil tends to rise to the top like froth on a boiling kettle. The cooler, heavier oil at the bottom of the reservoir sinks to take the place vacated by the hot oil in the tube. In this way gravity keeps up a continual circulation as long as the sun shines.

There are two ovens inserted, one near the top, the other near the bottom of the reservoir and surrounded on all sides, except where the door opens, with oil. The upper one is always hottest because the hotter oil is lighter and keeps on top. Accordingly, bread-baking must be done in the upper oven, but cooking meat, vegetables, or breakfast foods may be done in the lower one. The upper oven reaches a temperature of more than 310° Fahrenheit during sunny days, and sinks only to about boiling temperature, 212° Fahrenheit, at night.

All kinds of cooking except frying can be done with this range of temperatures. The dishes are prepared in a cool kitchen, and carried just outside the door to be placed in the oven. That there may be no danger of burning anything, a self-regulator of temperature was devised. This is a float on the top of the oil in the reservoir which, when the oil is below a desired temperature, and therefore below a certain level, opens a side pipe about half way up so that the lower half of the oil in the reservoir does not enter the circulation. But if it gets hotter this side pipe is closed by the float, and then all the cooler oil enters into circulation from the bottom. Thus it is safe to leave the dinner to cook without watching.



The Method of Regulating the Mirror Is Indicated In the Drawing At the Left. An Alarm Clock With a Twelve-Pin Wheel Releases An Escapement Pin Secured To a Motor Movement. The Weight Turns the Mirror To the West a Fixed Distance Every Five Minutes.



1—The Filtered Precipitate of Silver Sulphide Is Boiled With Nitric Acid Until It Assumes a Yellow Color. 2—Apparatus For Precipitation of Silver Sulphile From the Hypo Bath. The Flask At the Right Generates Hydrogen Sulphide; the Second Contains the Hypo; and the Third Is a Beaker Containing Caustic Soda. 3—Printing At An Angle, If One Part of the Negative Is Dense and the Other Soft. 4—Spotting Out Holes and Bad Spots On the Negative On a Retouching Table Made of Thin Wood. 5—Special Printing Outfit. The Printing Is Done In Subdued Light, No Dark Room Being Required. 6—Making Clouds With the Aid of a Pocket Flashlight, Whose Lens Is Covered With a Black Sheet of Paper Perforated With a Pin Hole.

How to Use Your Camera

By Dr. ERNEST BADE

NO. 6—THE PRINTING OF THE PICTURE AND THE RECOVERY OF SILVER FROM SOLUTION

THE thoroughly washed and dried negative is seldom ready to be printed. Here and there a few spots will often be found, as well as tiny holes in the silver layer, many of which originate from specks of dust. These must first be removed with Chinese ink, the black ink being placed over the holes. These holes, which are now black, appear as white spots upon the paper print. They can easily be removed, after printing, by painting over with negative ink. Black holes upon the positive can seldom be removed effectively.

Such work is best accomplished upon a so-called retouching frame, which illuminates the negative from the back, so that all faults can readily be seen. It can be built up of either thick cardboard, or thin wood. It is also excellent for opaqueing parts of the negative which are not to be printed.

Daylight printing papers are seldom used now. They do not keep long if they have not been carefully prepared, and many a successful photo on such paper deteriorates rapidly and bleaches.

The modern gas-light papers are far better for general use, and the manipulation of the print, after it has been exposed in the copying frame, is similar to the development of the negative. But the papers are less sensitive to light, and then, too, there are various grades of paper, some for very thin negatives, some for normal negatives, and some for very hard or dense negatives. With this choice of papers, it is a comparatively simple matter to select the correct paper to attain any desired effect and to work well with any density of negative.

Although the hydrochinon developer gives excellent results for the production of negatives, it cannot be used for the development of the print. The best results are always obtained with developers of those special types recommended by the manufacturer of the paper selected. The process of printing is simple. The negative is placed in the printing frame in such a manner that the emulsion side faces the paper which is placed on top of it. The frame is then closed by clamping in the backboard, and exposed to gas or electric light. With a comparatively strong source of illumination, an exposure of about one minute will be sufficient. Never judge the time, always use a watch. If the first print is not satisfactory, make another, but this time lengthen or shorten the period of exposure as the case may be.

Nothing is visible on the exposed paper. It only becomes visible after developing, which does not have to be carried out in a dark room although the light, in which this process is carried out, must be subdued. When the positive is sufficiently dense, it is washed in water and quickly placed in a hypo solution (32 oz. water and 8 oz. of sodium thio-sulphate), where it is fixed. Ten or 15 minutes in this last bath is sufficient, although it may remain longer without injury.

When fixed, the paper positive is to be washed in water, the cork clips being again used for this purpose. After all hypo has been removed by the wash water, the prints are placed, face up, upon news-papers and the surplus water remaining on the print is carefully and gently rubbed off with a soft, clean rag, the prints then being left on the paper until completely dry. The prints are wrinkled and curled. Quickly ironing them with a hot iron on their back makes them perfectly smooth, although they may roll slightly. This last defect is most readily removed by simply pressing them between two books, or otherwise, for 24 hours.

If a few spots were blackened on the negative, these will be visible on the print as white areas. With the aid of black retouching pigment (or Chinese black) the spots are easily removed, care being taken that the tone given equals that of the surroundings. If the print is to be mounted, this slight retouching must wait until this has been accomplished. The "spotting out" of holes is the last thing to which the positive is subjected.

Under certain conditions, a negative must be retouched if certain parts print too dark. Here nothing else can be done than to use a soft pencil, and make these parts slightly denser. Larger areas, which demand extensive drawing, are not to be considered in this way. When a negative, on the other hand, prints unequally, one side being too dark while the other is too light, no retouching is necessary. This fault can be equalized by printing. In such a case the printing frame is held in such a position to the light that the denser parts are strongly illuminated while the softer weaker parts receive less light, and this is accomplished by simply

turning the frame at an angle to the source of illumination.

A process for printing difficult negatives with gas or electric light consists in exposing the paper for a sufficient length of time so that the darkest parts attain the correct shade. The lighter thinner parts are, of course, over-exposed, and this is corrected by treating the print in a solution of bichromate, whose strength is varied according to the degree of softness desired. The solution is first tested with a few pieces of paper before it is used; then, after the paper has been exposed, and before it is developed, the print, whose image is still invisible, is placed in this solution for about 2 minutes. A special developer is not necessary, but cleanliness is essential.

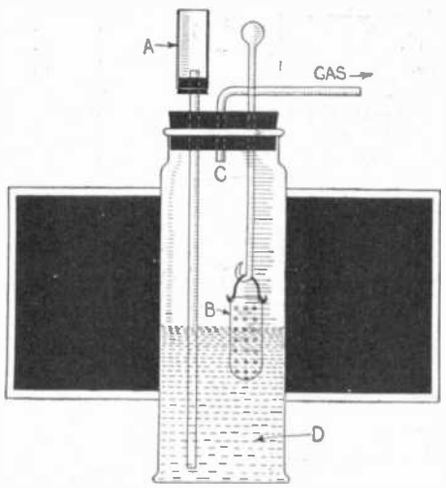
The stock solution consists of

Ammonium bichromate..... 28 gr.
Water .....280 cc.

The salt is dissolved in the water after it has been heated. This stock solution is largely diluted for use, a dilution of 1 part to 1,000 parts of water being approximately correct.

It is quite a venturesome expedient to produce clouds on the print of a landscape with a flashlight whose opening has been reduced to a pin point, although this, as well as smoke from a chimney, can be produced in this manner before the print is developed. Such a trick is sometimes very effective. An acquaintance of mine was unable to print the enlargement of a portrait successfully, although the negative was excellent with the exception of the details of the eye which were flat. Only after he had used a flashlight, after normal exposure, to intensify the light in the eye, was an exceptionally pleasing and artistic print secured.

Clouds can also be printed into a landscape by simply smoking the reverse of the negative with soot from a candle, but the soot should only be deposited where there is sky, otherwise the result will be a failure. In fact, these artificial clouds seldom, if ever, compare favorably with those taken naturally.



Detailed Drawing of the Generating Flask. The Flask Is An Olive Bottle Whose Mouth Is Closed With Three-Holed Stopper. A Is the Safety Manometer, An Ordinary Test Tube Cut Off and Fitted To a Glass Tube By Means of a One-Holed Stopper. B Is a Perforated Glass Basket Containing Iron Sulphide. D Is Hydrochloric Acid Diluted, and C Is the Delivery Tube.

Many amateurs consider glossy paper prints with a certain degree of disfavor, which is quite unnecessary. The gloss gives the prints an apparent depth which is lacking in some other types. This is quite important since depth, even if only apparent, is a necessary qualification for any good photograph. To attain the same effect upon a matt paper requires a negative giving good contrasts, a characteristic lacking in many negatives. For artistic enlargements, only a matt paper is recommended, and then a type which is as rough as it is possible to obtain. This reproduces artistic effects to the best degree.

Since quite a little silver is dissolved in the old fixing baths, both from the negatives and from the prints, it sometimes is advisable to remove it from the solution, the recovered silver being either sold if it is obtained in quantities sufficiently large, or used for experimental purposes. The old hypo baths are collected until a quart, a gallon, or more, as the case may be, is at hand. Then the silver is precipitated from the solution by hydrogen sulphide generated in a safety generator, which consists of an old olive bottle, a long safety tube, and a glass basket containing iron sulphide and which can be raised and lowered. The bottle contains dilute hydrochloric acid. The gas is passed into the large flask of used hypo until the solution is saturated. The silver sulphide precipitate is black in color, and is filtered out, and the precipitate is washed once with water. Then the filter paper with the precipitated silver sulphide on it is placed in strong (not concentrated) nitric acid, and the whole is boiled until of a straw color due to separated sulphur. When yellow, the mass is filtered to remove the sulphur and fibres of the filter paper, after which it is carefully evaporated to dryness, and the silver nitrate is collected and kept separate. When a quantity of this crude silver nitrate has been obtained, it is purified by careful fractional crystallization. On long standing, old hypo solutions decompose, forming hydrogen sulphide, which precipitates some of the silver as silver sulphide on the walls of the vessel. This can usually be recovered by the use of nitric acid. Care must be taken that the potash solution is not drawn back into the flask.

Simple Wood Turning Lathe

The chuck of this home-made wood turning lathe (3) is held by a set screw in a hole bored in any free end of a shaft. Mine is held in the little piece of crank shaft extending from the fly wheel of a 1½ horsepower gasoline engine. The engine, which runs at about 550 r. p. m., furnishes the driving power. The chuck itself is only a ½ inch bolt hammered flat and then filed into the desired shape.

The center, 1, is probably the only thing the amateur will need to have made, unless he happens to have access to a metal turning lathe. The screw, 2, preferably a square threaded one, and hand wheel, 4, can be found almost anywhere. The length of the screw will of course limit the length of material that can be handled in the lathe and therefore it is advisable to have it at least 2 feet in length, which would then allow the lathe to take work up to about 18 inches in length. The center, 1, is held securely by means of a rivet. Before attaching the center, however, the bearing for the screw should be made.

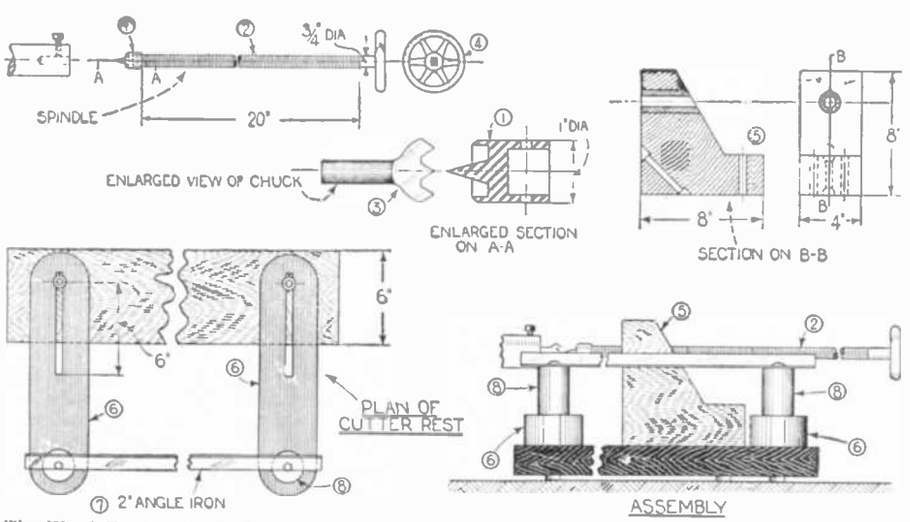
The bearing, 5, shown in end and sectional elevations is a piece of good, sound wood about 8x8x4 inches and cut in the manner shown. A hole 1½ inches in diameter for a ¾ inch screw is drilled; the screw is put into the hole and the hole is poured with babbit metal the same as an ordinary bearing. Care, however, must be taken before pouring the babbit to have the screw centered perfectly in the hole or there may be some difficulty in aligning the lathe later. The best way is to lay the flat side of the block on a smooth surface so the babbit will have no chance to run out and brace both block and screw well prior to pouring. The notches shown cut on each side of the hole are to prevent any possibility of the babbit turning with the screw. The whole is then securely bolted to a heavy plank or bench, as the case may be, facing the shaft end.

The rest for the cutting chisels is fastened to the same base as the bearing block. The 2 × 4's, 6, are slotted to allow their sliding in and out according to the size of work required to be done. The round blocks, 8, may be turned on the lathe before the rest is ready and are made about 2 inches in diameter and 4 inches high. This, however, may vary to suit conditions. The rest, however, should be up about level with the center for best results. The angle iron, 7, for resting the cutting chisels on, should run at least the distance between the end of the shaft and the face of the block.

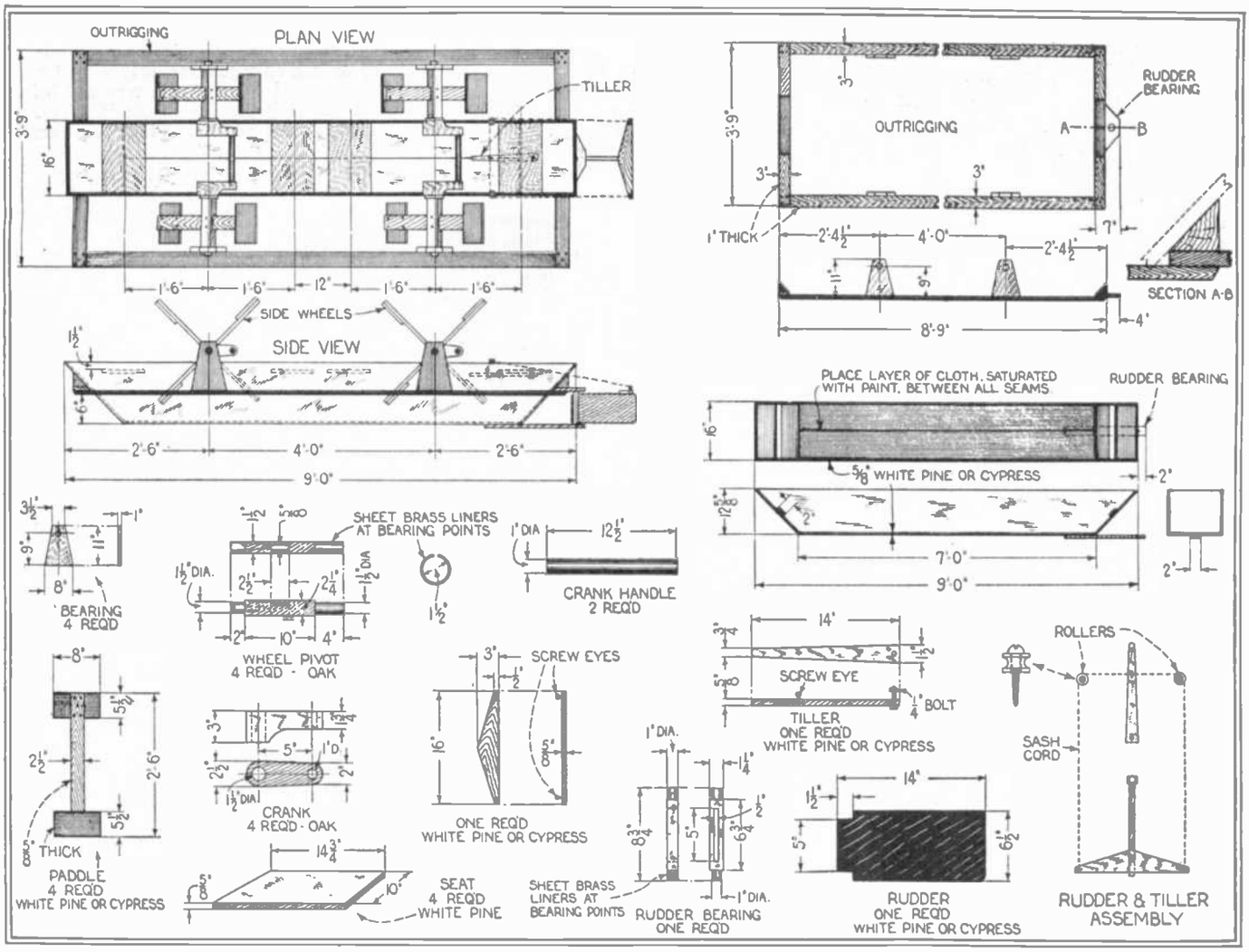
Very good cutting chisels may be ground out from old files of different sizes and shapes.

With a lathe of this nature it becomes possible to construct floor lamps and various larger and really appealing articles of furniture. If the distance between the centers is not great enough to allow for the construction of the floor lamp in one piece, the entire is made up of sections and then coupled together by doweling and gluing.

Contributed by E. V. S.



The Wood Turning Lathe Shown in the Diagram is Made Entirely Out of Material Usually Found in the Experimenter's Labratory. Its Construction is Very Simple and the Time Required to Build the Same Has Been Reduced to a Minimum.



Wherever There Is Available a Small Body of Water, Such As a Lake, Brook or Other Small Stream, Barrels of Fun and Pleasure May Be Obtained By Young Boys or Grown-Ups With This Home-Made Side-Wheel, Flat-Bottom Boat. The Cost Will Vary, Depending Upon Whether the Lumber Can Be Obtained Second-Hand, Or Whether It Has To Be Purchased New, But In Any Case the Cost Will Not Be Excessive. A Small Gasoline Engine, Such As a Motorcycle Engine, Might Be Attached To One of the Paddle Wheels, Preferably Arranging This Paddle Wheel At One End of the Boat. As Pointed Out By the Author, a Short Mast, Boom and a Triangular Sail May Be Added to the Craft, and Advantage Taken of the Wind to Propel the Boat.

Constructing a Side Wheel, Flat Bottom Boat

By GEORGE A. LUERS

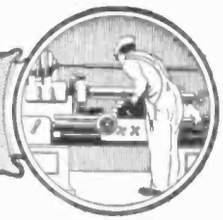
THERE is hardly a stream which cannot be damned up in an hour or so of work with shovels, to provide a half acre of shallow lake of a foot or foot and a half in depth. With this small lake and the side wheel driven boat shown in the attached drawings, four boys can find many an hour of sport and fun, skimming rapidly over the surface, turning wide circles, all the while learning something about navigation and boating. The foremost feature in this type of boat, is that it is perfectly safe. The outriggers prevent it turning over, while the boys will find further that there is considerable more real sport in turning the propelling wheels and feeling it glide away, ever alert to make changes in its course under the guidance of the rudder, than they will in the usual bad practice of trying to find how much tipping or rocking they can get out of it.

The details have been made to involve the least amount of work or materials. Boys who are handy with the saw and hammer will find no difficulty in assembling the parts of this simple flat bottom boat, fitting the outriggers, the rudder and the propelling side wheels. To carry this boat, to and from the lake, the outriggers, provide a most advantageous set of handles, the boat being carried by four boys, one at each corner. Of course the weight of the boat depends upon the material which can be obtained for the construction. White cedar is the best; white pine is usually the most convenient but hard to get. Cypress is very good, but is a somewhat heavy wood. Five-eighth inch white pine, not dressed or planed can very frequently be obtained from the saw mill and will provide a light boat that can be carried for long distances, without tiring those who are carrying it.

The side planking of the boat is made of one piece on each side, while the bottom is of two pieces, with a center strip over the seam. The ends are made of two pieces of wood and a center strip, placed with the grain of the wood crosswise of the boat. The outriggers are continuous strips, with cross fasteners at the extreme ends of the boat. The side wheels are made with crank handles as are shown in the details. In turning the side wheels the boys sit on seats, facing each other. Two boys can of course propel the boat; however, the speed is greater when all hands turn to the work of rotating the side wheels. The rudder is a single part or plank, fitted with a hinge and control cords convenient to a member of the crew, who is facing forward and in a position to control the direction of the boat. The seams of the boat should be securely nailed to prevent them leaking. Before nailing up the seams of the thin sections joining the bottom, strips of doubled cloth or canvas should be placed between the edges of the wood. Saturate this cloth in some old oil paint, put the nails in close together and the finished boat will be kept practically free of water.

Later on it may be desired to add a short mast, boom and a triangular sail, that is after the operation of the boat is learned and the mystery of the sailing boat opens up a field for further experimenting. For this reason it is well to be careful in making up a good tight boat, fitting up the seams tight, and taking care of the boat after it is made. A coat of paint on both inside and outside will keep it in good condition, especially through the winter, when for protection and safety it should be kept under the covering of a barn or other house, where it will not fill with water and freeze.

THE CONSTRUCTOR



How To Build A Motor Swing Whirler

By LAWRENCE B. ROBBINS

AN amusement device that combines the thrill of a giant swing with the exhilaration of a swiftly turning merry-go-round is here described. Furthermore, it is power driven and thus can be made to operate as long as desired and at any predetermined speed and is under the control of the occupant at all times.

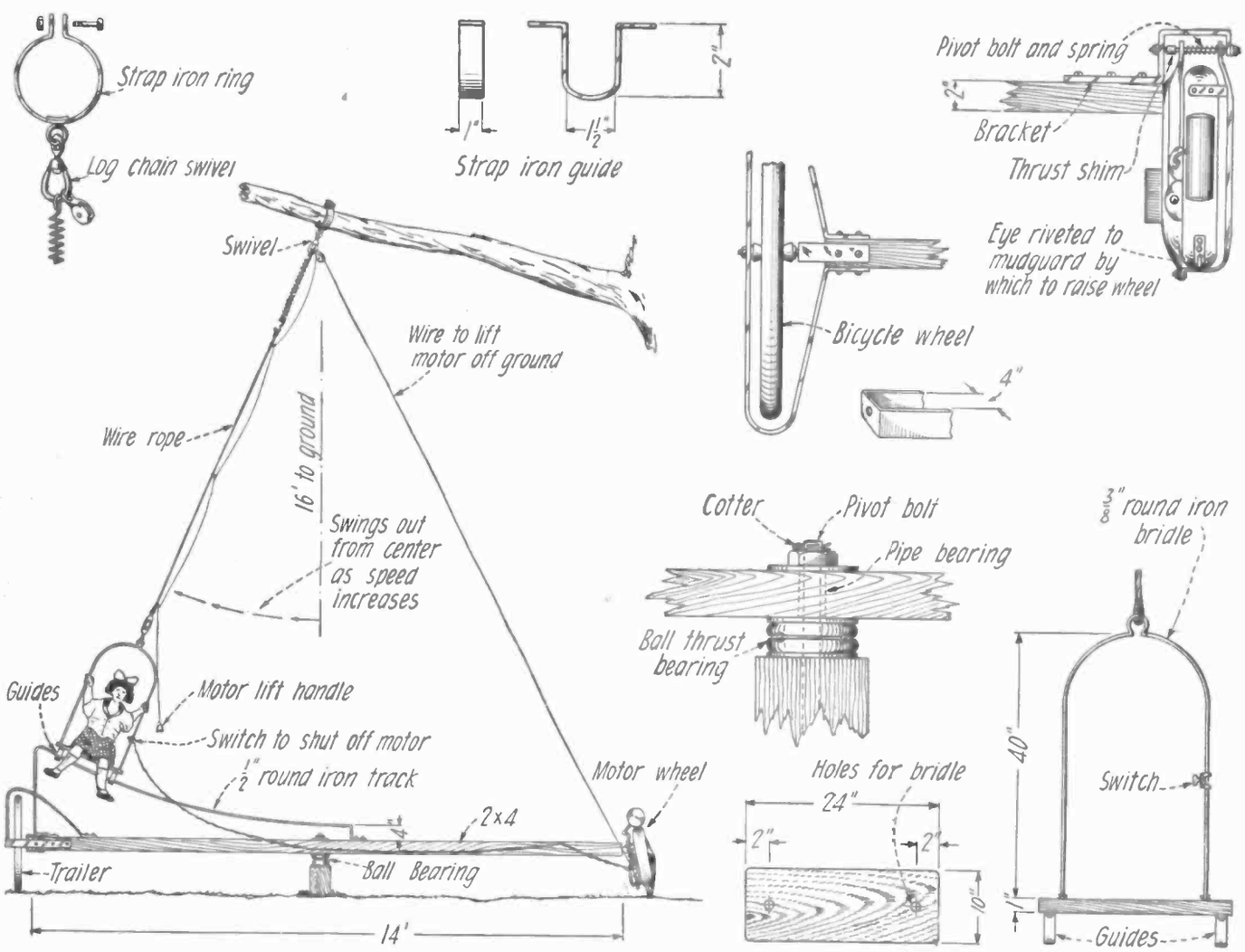
A site should be chosen directly under a strong, horizontal limb of a tree at least 16 ft. from the ground. The ground should be hard and level and all holes or bumps smoothed off. This space should also have a radius of at least 10 ft. from a point determined by dropping a plumb bob from the limb. Twelve feet is better and will give a diameter of 25 ft. for the device to operate in and will allow room for spectators at the sides.

At the point on the limb where the plumb bob was finally held smooth off the bark and make the limb as nearly round as possible without lessening its strength. Then have a "limb ring" made of flat strap iron as shown in the detail sketch. As will be seen, it is provided with ears at one point, drilled with holes to take a bolt and nut. Opposite the ears an eye should be welded into the flat iron with a short, flat base on the inside of the ring to give additional strength. To this eye the small end of a common log-chain swivel should next be firmly attached, and lastly a metal pulley and a large spiral spring about 2 ft. long and 1½ to 2 inches in diameter and sufficiently stiff to withstand a pull of at least 250 lbs. before expanding much should be attached to the large loop of the swivel. The detail sketch shows this assembly plainly. Attach it to the tree and then set the post for the whirler to pivot upon.

This should be of cedar and about 6 in. in diameter and at least 6 ft. long. Set it in the ground exactly in the spot indicated by the plumb bob and bury solidly, using heavy stones at the bottom of the hole to prevent the post from working loose as much as possible. Allow about 12 or 13 in. of the post to project above ground and saw off the top horizontally. This can be determined with a spirit level. Bore a deep, vertical hole in the center of the post and then drive in a long, iron bolt or bar threaded at the top end. It will be advisable to use a heavy wooden mallet to pound with or else protect the threaded end with a bar of brass to receive the blows. Otherwise the threads will be ruined. Let about 10 in. of the bolt project above the top of the post.

The ball bearing can be removed from some discarded automobile part. A thrust bearing should be used if possible and a large iron washer placed above and below to take up the friction on the wooden parts of the device. If the holes in the ball races are larger than the diameter of the pivot bolt make up the difference by slipping a short

(*Continued on page* 182)



In the Illustration and Description Herewith Are Given the Necessary Details For Building a Very Interesting Motor-Driven Swing Whirler. This Whirler May Be Operated With a Gasoline Motor Wheel of a Well Known Type, or Else By a Small Electric Motor.

HEAT INDICATING COMPOUNDS

A German scientist discovered many years ago that the double iodide of copper and mercury could be used as an indicator of a moderate heat. Although normally red, a black modification is produced upon heating to a temperature of 96° Centigrade. If heated water is stirred with a sealed glass tube containing two or three grams of the substance, the color change will occur before the water boils. A piece of paper painted red with a suspension of cuprous mercuric iodide in gum solution turns black when gently warmed. On cooling, the reverse change takes place. The compound is often used as a paint for sensitive bearings, the transition giving warning of overheating.

To prepare a sufficient amount to perform these experiments, first make three solutions as follows:

(1) Dissolve 2.7 grams potassium iodide in 20 cc. of water.

(2) Dissolve 1.1 grams mercuric chloride in 20 cc. of water.

(3) Dissolve 2 grams cupric sulphate in 10 cc. of water.

Then mix (1) and (2). When the precipitate which is first formed dissolves, add (3). Set up a sulphur dioxide generator (sodium sulphite treated with sulphuric acid in an ordinary gas generator) and pass a rapid stream of the gas through the mixture in order to reduce the cupric sulphate. Collect the red precipitate of cuprous mercuric iodide on a filter paper, wash it in cold water and dry.

Since this discovery, several other substances have been obtained which exhibit similar changes. Most of them are mercury compounds. By far the most sensitive of these is silver mercuric iodide, which, at ordinary temperatures is yellow, but when heated to 45° is dark red.

Preparation:

(1) Dissolve 3.3 grams potassium iodide in 25 cc. of water.

(2) Dissolve 1.3 grams mercuric chloride in 25 cc. of water.

(3) Dissolve 1.7 grams silver nitrate in 10 cc. of water.

Mix these solutions as in the preparation of cuprous mercuric iodide, but omit the treatment with sulphur dioxide.

Mercuric iodide is scarlet. When heated to 127° it turns yellow. However, the change is slow to reverse. It is prepared by precipitating a solution of 2.7 grams mercuric chloride in 50 cc. of water with a solution of 3.3 grams potassium iodide in 25 cc. of water.

Mercuric oxide, historically noted because of its relation to the discovery of oxygen, is brick red at ordinary temperatures. When heated it gradually grows darker and just before decomposition is dead black. When it is cooled by liquid air, however, the shade of red gives way to a yellow, similar to the color of sulphur.

Contributed by CHAS. D. TENNEY.

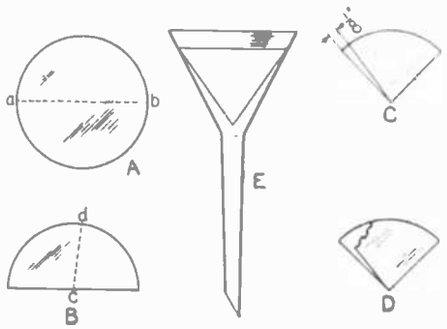
THIS MONTH'S $5.00 PRIZE

RAPID FILTRATION

Filtering as a rule is a slow and tiresome process, unless suction is used. Every chemical experimenter is not blessed with a suction filter and has to watch the filtrate seep through the paper and fall, drop by drop into the beaker or test tube.

If the experimenter will fold his filter paper as described below and follow instructions, he can filter a solution many times as fast as in the usual way. No suction is required and there is no danger of sucking a hole in the paper.

An ordinary glass funnel is used. The size will depend upon the size of the filter paper employed. A funnel about three inches across the top is the best to use for an 11 cm. filter paper. Instead of folding



If Filter Paper is Folded as Shown in the Above Diagram Instead of in the Usual Way, Much More Rapid Filtration Will Be Accomplished.

the paper in the usual way, fold as shown in the illustrations.

First fold filter A on the line, *ab*, as in the usual way. Now instead of folding B at a 90 degree angle as usual, fold along the line, *cd*, so that the fold is about one-eighth of an inch from the edge at the top as shown in C. Now tear off one corner of the filter as shown in D. This permits the filter to fit tightly to the sides of the funnel when wet.

Open the funnel into the customary cone shape and place in the funnel. Wet the paper and press the top edge of the filter tightly to the edge of the funnel. The tip of the cone of filter paper should be exactly in the center of the funnel. The filter will rest in the funnel as shown in E.

If the solution does not flow through fast when poured into the filter, move the filter paper slightly by pressing the thick fold of the paper. When once started, the solution will flow in a steady stream. If air bubbles pass down the stem of the funnel, press to the filter at the folds of the paper.

The reason for this rapid filtration is that you secure more filtering surface by folding the paper this way and the paper fits tightly in the funnel. This prevents air from passing down the stem of the funnel. Once the stream is started it acts as a gravity suction.

Sometimes this suction causes the filter paper to be pulled down into the tip of the funnel, decreasing the filtering surface and slowing filtration. You will find that the better the grade of filter used the less apt this is to occur.

Contributed by G. B. ASHTON.

SOURCE OF TRANSFORMER CORE IRON

Sooner or later every electrical experimenter comes to the place where he needs laminated iron for the core of a transformer.

This source is the so-called tin cans. It might be well for me to correct a too general false impression concerning the supposed-to-be tin cans. They are in reality made of thin sheet iron coated with a layer of tin on each side. The purpose of this coating is to prevent rusting and corroding.

Consequently for core iron save your empty food cans. However, take pains to save cans made of thin metal and affording material of convenient size. This depends largely on the nature of the core desired. I usually use condensed milk cans and those with their ends soldered on because of the greater ease in removing them without spoiling the rest of the material.

Cut the cans to whatever sizes and shapes may be required for the particular job on hand. Tie these strips in a rather loose bundle and place this in a fire, allowing it to come to a red heat and remain thus for about ten minutes. This heating has a three fold purpose. It melts the tin off the surface of the iron making it thinner and increasing its resistance to eddy currents. it oxidizes the surface of the iron further increasing its resistance to eddy currents, and it anneals the iron thus lowering the hysteresis losses.

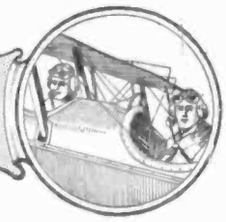
While the iron is heating prepare a bath of air-slaked lime large enough to bury the iron. It is not absolutely necessary that lime be used for this purpose, but whatever is used must have the property of holding heat and must be able to stand a high temperature. I have often used with good success carbide ash which is almost the same as lime. It is best that this be preheated to some extent before the iron is buried so as not to cool it too quickly which would have a tendency to harden it

When the heap of lime has been prepared and the iron has been heated properly, remove the latter from the fire and bury it well in the lime or whatever is used for this purpose. Permit the iron to cool for at least a half a day after which it is ready for use.

Avoid as much as possible hammering the metal at any stage of the work as this greatly reduces the permeability.

Contributed by KENNETH E. MILES.

RADIO DEPARTMENT



Radio for Every Tenant

IN Newark, New Jersey, the *Ritz Apartments* have recently been built, whose owners furnish to the tenants *free radio service* throughout the day and evening. This is accomplished by means of a very selective radio receiving set and suitable amplifiers located in a small house on the roof of the apartment building from which wires are run to each of the seventy-two apartments in the house.

This apparatus was installed by a leading American radio company and is an adaptation of a well-known public address system, which has been used so successfully in many large installations.

In each of the seventy-two suites in this building there is a jack to which is connected, by means of an ordinary telephone plug, a head-set or loud speaker, as may be desired by the listener.

The jack used has three contacts, so arranged that when the plug is inserted therein, it will make contact with two of them, the third remaining idle. When the plug is removed a circuit is closed shunting a non-inductive resistance of 20,000 ohms across the jack. This compensates for the removal of the resistance of the phones or loud speaker, as the case may be, and allows equal reproduction of signals at each of the outlets, in the other apartments. The phones or loud speakers are all connected in parallel and the sound volume for each head-set is practically the same whether one or seventy-two of the instruments be in the circuit.

A noteworthy point of this installation was brought out by the superintendent of the building, when he said that the popularity of this innovation in apartment house service is shown by the fact that comparatively little elevator service is required in the evenings. It has been found that a greater number of the tenants prefer to stay at home and listen to the radio programs, which are selected by the operator.

It will be seen that the latter mentioned personage must needs combined great diplomacy and ability to select and pick up from the air a program that will suit the preferences of all the people in the seventy-two suites. Thus far, however, he has been reasonably successful and not even one complaint has been registered. The owners of the house, however, are figuring on just such an emergency whereupon they will install an additional receiving set to repeat from other broadcasting stations.

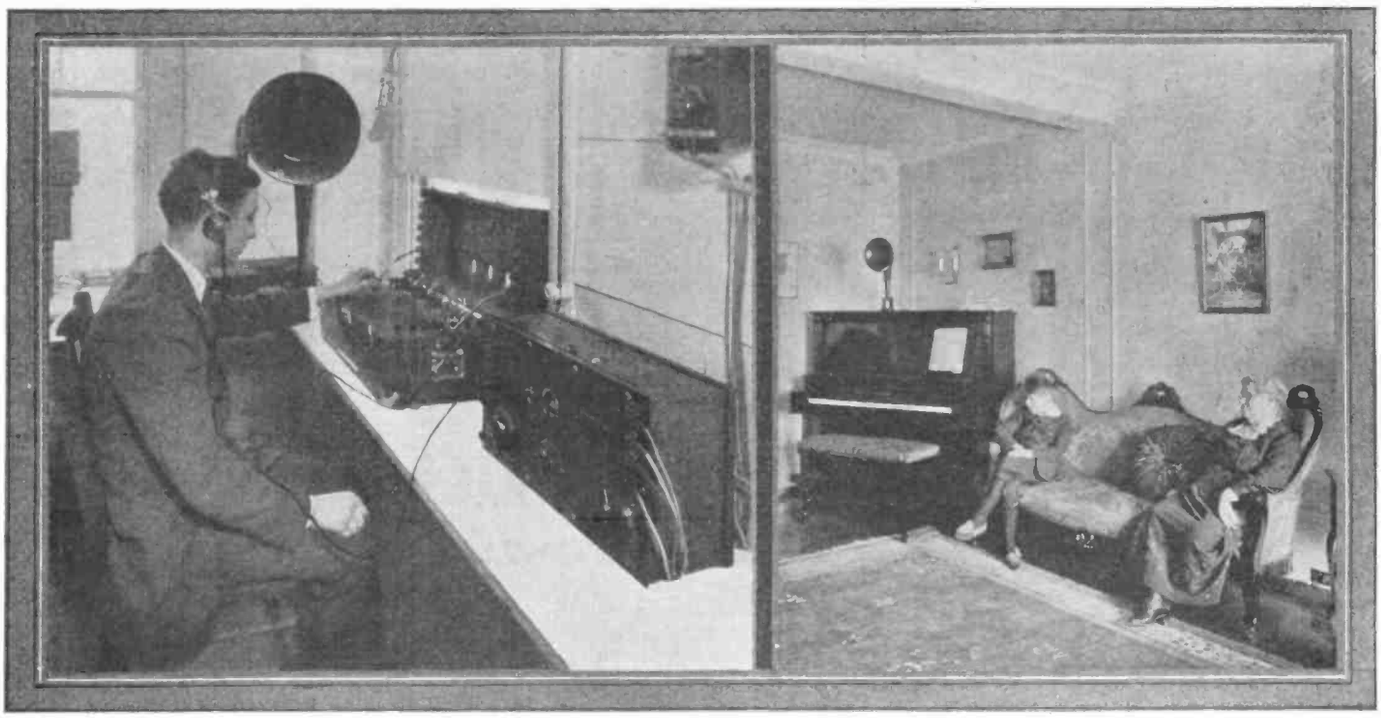
The equipment now used lends itself very well to the work. It consists of an extremely selective receiving set of well known make, used in connection with a high power amplifier. The receiving set proper utilizes four vacuum tubes, giving two stages of radio frequency amplification, a detector and one stage of audio frequency amplification. The tubes used in this set can be operated on dry cells. The output of the audio-frequency amplifying tube is led through a specially designed transformer to the power amplifier, which makes use of four vacuum tubes giving three stages of audio-frequency amplification. The last two tubes are arranged through a push-pull transformer.

With this set the operator has been able to pick up practically every broadcasting station in the United States which has a power of 500 watts or more.

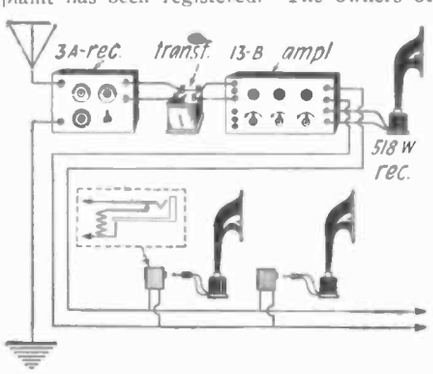
If a particular tenant desires quietness rather than great volume of sound he can plug in his head-set or if on the other hand he desires sufficient music to dance by he can plug in a loud speaker.

The owners of the building have also had installed in the basement of these apartments a loud speaker whereby at intervals during the day, the workers in the boiler room and the janitors are furnished with occasional entertainments. The effect is usually an increased amount of work from those thus entertained.

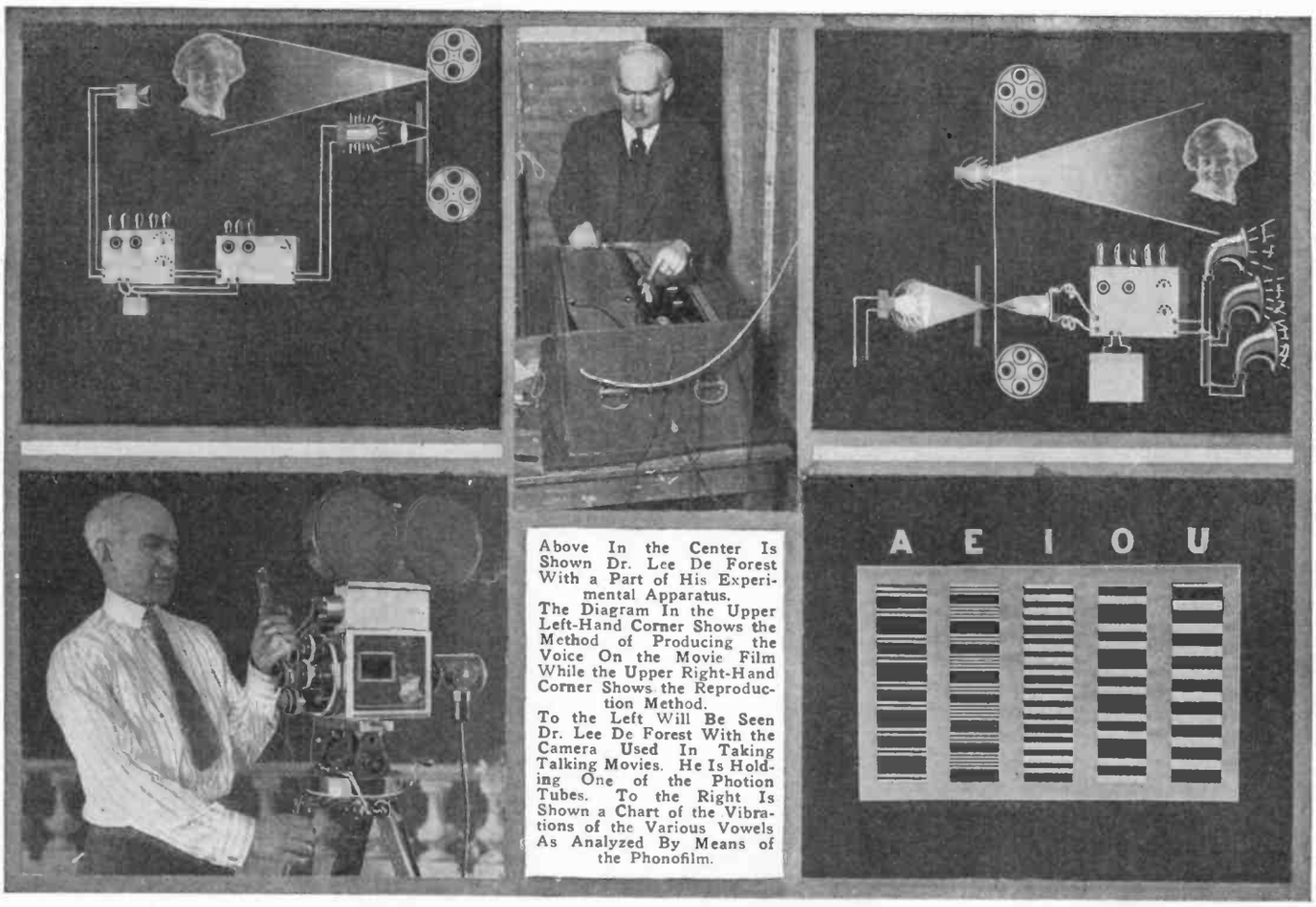
(*Continued on page* 179)



In an Up-to-Date Newark, New Jersey, Apartment House, a Radio Set is Installed, Having an Operator in Attendance at All Hours of the Day. By Simply Inserting a Plug into a Jack in the Wall of the Room, Radio Concerts Are Supplied to the Tenants Without Additional Charge. The Photo at the Left Shows the Very Selective Receiving Set in This Apartment House, and at the Right the Loud-Speaker Located in One of the Apartments.



The Hook-Up of the Apartment House Radio Receiving Station is Given in the Diagram Herewith. The Loud-Talkers in the Various Apartments Are Connected with a Plug and Jack, the Jack Closing the Circuit Through a 20,000 Ohm Non-Inductive Resistance, When the Loud-Talker Is Not Plugged In.



Above In the Center Is Shown Dr. Lee De Forest With a Part of His Experimental Apparatus. The Diagram In the Upper Left-Hand Corner Shows the Method of Producing the Voice On the Movie Film While the Upper Right-Hand Corner Shows the Reproduction Method. To the Left Will Be Seen Dr. Lee De Forest With the Camera Used In Taking Talking Movies. He Is Holding One of the Photion Tubes. To the Right Is Shown a Chart of the Vibrations of the Various Vowels As Analyzed By Means of the Phonofilm.

The Phonofilm—Talking Movie

By DR. LEE DE FOREST*

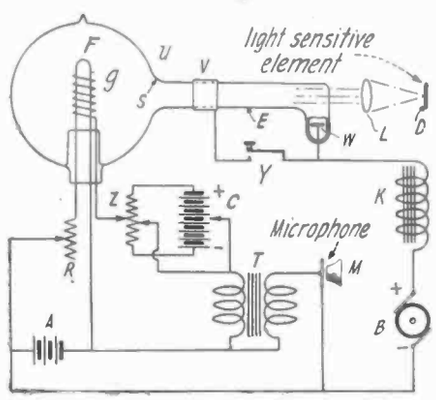
THE Phonofilm, as its name suggests, is combined on the same film with motion pictures, the voice or music being photographically recorded along the margin. Standard cinematograph film is used. The sound record occupies a very narrow strip of the film about $\frac{3}{32}$" wide on one margin, and does not materially reduce the width of the picture.

Recording: "An especially designed gas filled lamp called the Photion light is inserted in the moving picture camera a short distance away from the usual objective lens. The light from this Photion tube passes through an extremely narrow slit and falls directly upon one margin of the film. This margin is screened from the picture itself, so that only the light from the Photion falls upon it. The film is driven continuously at an even speed in front of this narrow slit, but with the usual intermittent step-by-step motion in front of the picture aperture.

"Now the light in the Photion tube is generated by the electric current which is passing through the gas enclosed therein. The intensity of the light depends on the intensity of the electric current. Therefore if a powerful telephonic current is passed through the Photion, the light emitted varies exactly in accordance with the strength of the telephonic current at any instant. This light therefore fluctuates in brightness hundreds or thousands of times a second in perfect rythm with the telephonic current pulses, and varies in strength with the current.

"This telephonic current originates in the first place from the special microphone transmitter which is quite unlike the ordinary telephonic microphone, but serves the same general purpose. This transmitter picks up the sound waves at distances of five to fifteen feet from the source of sound these sound waves producing very weak telephonic currents. The Audion Amplifier is then used to amplify these weak currents 100,000 times, to bring them up to sufficient strength to influence the Photion lamp in the camera. Without the Audion Amplifier the entire arrangement would be utterly impractical because of the weakness of the voice currents.

"Thus we have three ostensible transformations—first sound waves into electric telephonic currents, then the amplification of these currents into light waves, and the registering of these light waves through the narrow slit upon the photographic film.



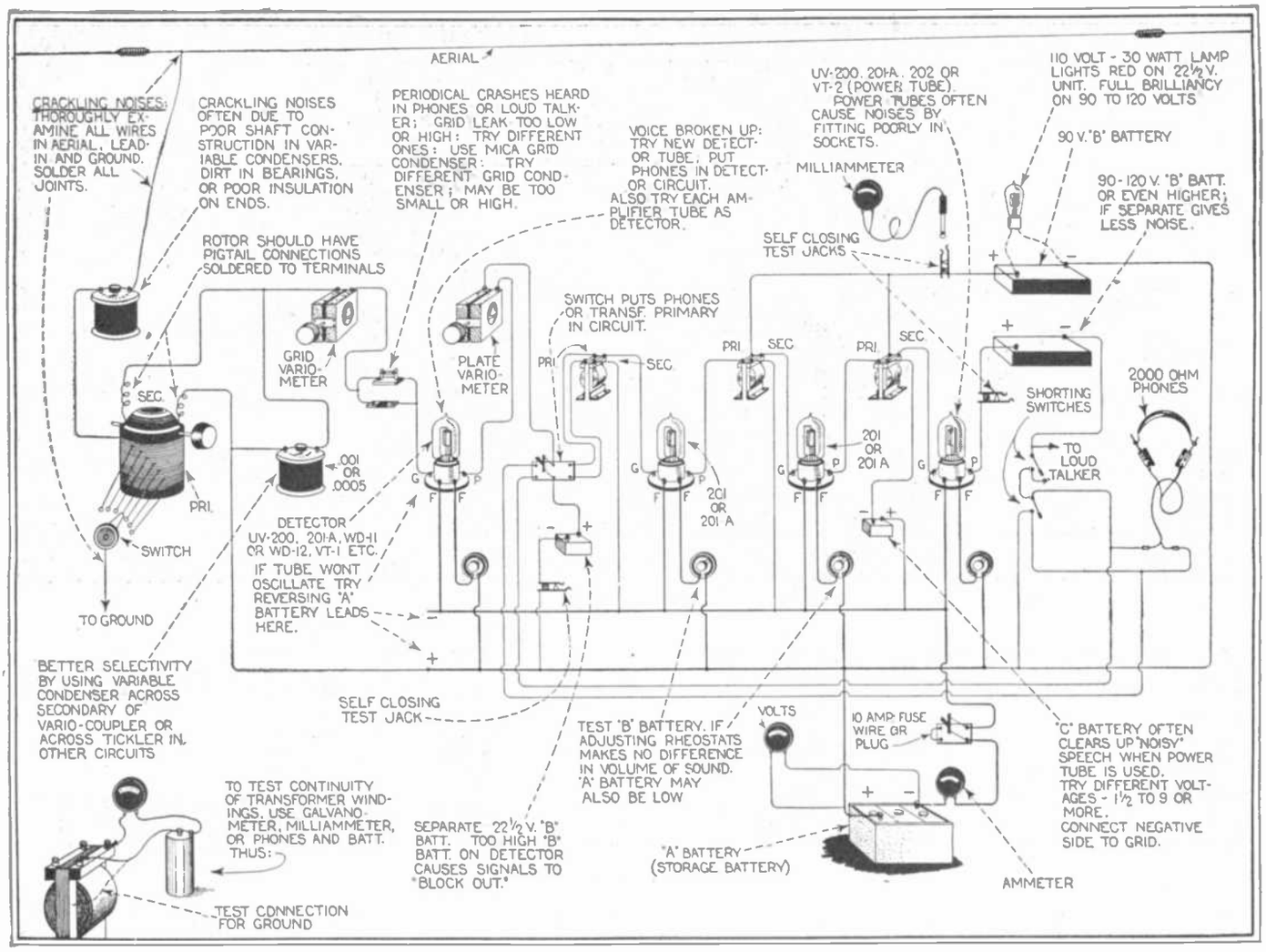
The Circuit Diagram For the Connections of the Photion Tube and Its Attendant Apparatus Is Shown Above.

Reproducing: "The negative film, carrying picture and sound record, is now developed in the usual manner, but using a special developer to bring out the details of the sound record. Positive prints are made through a special printer to give the necessary light values for picture and sound record. This positive print is then run through the moving picture projection machine. This is a standard projection machine such as is found in any moving picture theatre. A small attachment is added to this machine, which attachment in no wise interferes with its ordinary use, and which includes a small incandescent lamp and a highly sensitive photo-electric cell, the latter being the invention of T. W. Case. Between the lamp and the photo-electric cell passes the film as it travels through the projection machine. The light from this incandescent lamp is concentrated upon a tiny slit similar to that above described in the motion picture camera. This light therefore passes through the sound record, which has been photographed on the film, and on into the chamber containing the photo-electric cell. The passage of the sound record therefore, across this narrow slit, controls the intensity of the light falling upon the sensitive cell.

"The photo-electric cell has this peculiar property—its electrical resistance at any instant is determined by the amount of light falling upon it. Therefore, as the film travels across the slit and the light falling

(*Continued on page* 194)

*Abstract of address given before the New York Electrical Society in the auditorium of the Engineering Societies Building, New York City, April 4th.



Hunting Trouble In the Radio Set Is Not the Simplest Thing In the World Nowadays, With the Rapid Advance In the Development and Manufacturing of Multi-Stage Vacuum Tube Receiving Sets, Having Anywhere From Three To Six or More Tubes. It Is Impossible, of Course, To Tell All the Troubles Which May Happen To a Certain Set In a Single Chart Like This One, But If All of the Instructions Given Thereon Are Checked Up When Trouble Is Met With In Operating a Vacuum Tube Set, and Each Suggested Remedy Thoroughly Applied, the Weak and the Strong Points In the Set Will Be Checked Up, and the Trouble Systematically Located In Nine Cases Out of Ten.

Hunting Trouble in the Radio Set

By H. WINFIELD SECOR

"TROUBLE shooting" on radio sets a few years ago was relatively a simple matter. If trouble was experienced in the operation of the simple crystal detector receiving sets of that period, the difficulty was usually found by examining the slider or switch connections to the tuning coil or loose coupler, or possibly the detector crystal was a poor one, or again some poor joints in the aerial or ground circuit were the cause behind the effect. But today the trials and tribulations of the radio trouble hunter have multiplied many fold, due to the advent of multiple stage vacuum tube amplifiers of both radio- and audio-frequency types.

Some of the faults with which the writer has come in contact in operating multiple stage V. T. receiving sets are discussed here, and it is difficult to tell just where to begin, as many of the different troubles may happen at any time, or in conjunction with "one or more complications," as the doctor would say.

VACUUM TUBE TROUBLES

One of the most persistent troubles which was hard to locate in one case which the writer recollects, was that where the voice came in all broken up. Of course, faulty connections were looked for as one of the ostensible reasons for this trouble. New grid leaks and grid condensers in various sizes were tried, as these were suspected of possibly having become defective, but the voice still came in unintelligible. The transformers were tested by means of a galvanometer and battery through both primary and secondary windings to see that the fine wire coils were continuous and not open circuited, and the B batteries were very strongly suspected as a possible cause of this trouble. Complaints are heard every now and then concerning them, a poorly soldered connection having suddenly developed into a high resistance or loose joint, which would be very difficult to locate, except by placing a voltmeter across the battery and watching it for some time to see if any fluctuations occurred. To make this test effective, the meter must be very sensitive, and the battery must be shaken up a little now and then, so as to vibrate the loose connection if present.

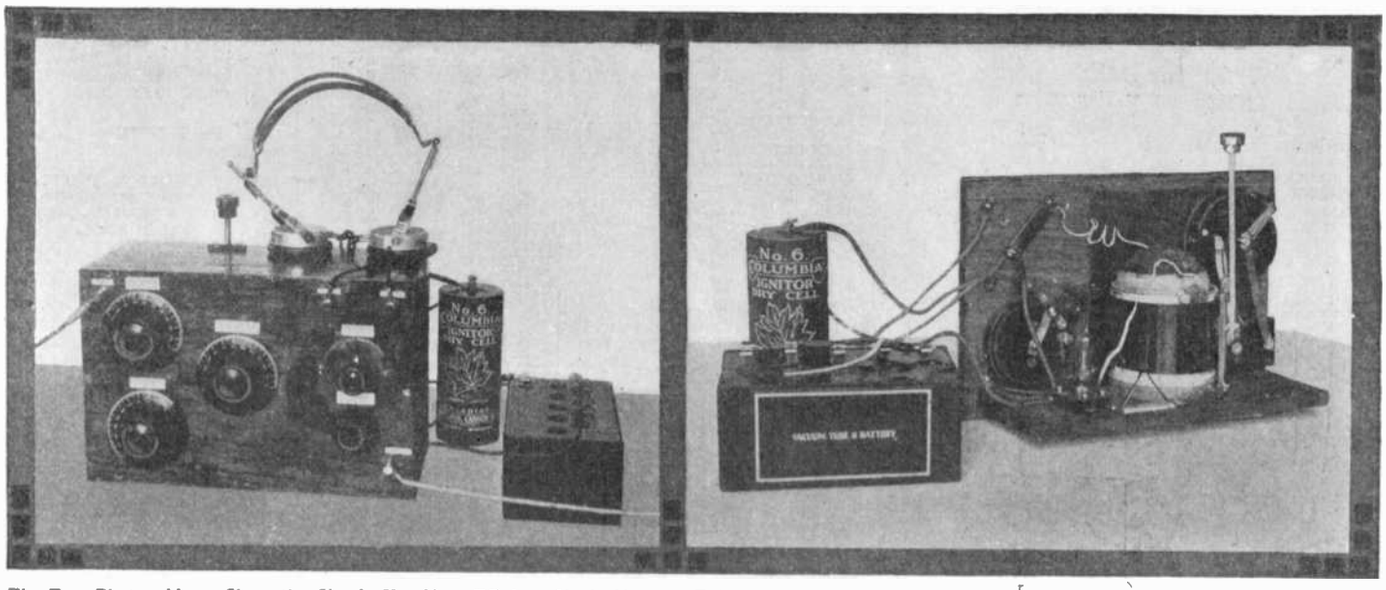
After hunting over the whole set, and having no other detector tube, one of the amplifier tubes was placed in the detector socket. The phones were switched into the detector circuit, and with the amplifier tube of the U. V. 201 type, perfect reception was had at once, thus proving that it was the detector tube which had started to leak air, or for some other reason had proclaimed itself ready for the scrap pile or repair shop, several companies now repairing and re-exhausting vacuum tubes. The next day a new U. V. 200 detector tube was purchased and the set worked fine.

GRID LEAKS AND GRID CONDENSERS

Cheap grid condensers and grid leaks are a frequent source of trouble. A set may work for months in good shape; grid condenser and grid leak may not be suspected, but my advice to any radio enthusiast today is to use nothing but mica insulated grid condensers. One of the best grid leaks is of the type which is sealed in a glass tube with a bakelite or other suitable insulating base and spring clips to hold it. These parts cost but a very small sum, and it pays to purchase two or three of them of different sizes and try them on your set, and in some cases increased efficiency will be found by changing them when the detector bulb becomes aged, or when a new detector bulb is placed in the set, as the characteristics change and vary for different bulbs.

The grid condenser is, of course, of very small capacity, and if a pair of headphones and a battery are connected across the condenser to test it, a slight click only will be heard as the contact is completed; if the condenser is short-circuited, a loud click will be heard in the phones the same as if no condenser were in circuit at all. In testing a grid leak, the phones and battery connected

(*Continued on page* 189)



The Two Photos Above Show the Simple Yet Very Efficient Single Vacuum Tube Receiver Here Described By Major Nelles, of Ottawa, Ontario, Canada, Who Has Accomplished Some Very Fine Results With This Set, Using a W. E. Peanut Tube For the Detector. Other Tubes Can Be Used, of Course, In Its Place.

A "DX" Single Peanut Tube Receiver

By MAJOR DOUGLAS H. NELLES

IN the majority of articles and answers to questions published in radio magazines, the distance that a single valve set with a regenerative circuit will receive radiophone broadcasts, is generally placed at from 75 to 200 miles. To show that this is a very conservative figure and to describe how to build a set that will do better work is the object of this article. The average distance of 43 stations received with such a set is 555 miles, the longest distance was 1,401 miles.

One of the first Peanut Tubes (No. 215-A) to be placed on sale in Ottawa was used in this set, and has brought in over 45 phone stations loudly and clearly. Of this number 2 were local, 3 at 111 miles, 3 at about 215 miles and the rest between 300 and 1,400 miles distant. Local stations 2 miles distant can be heard 20 feet away from the phones and a whole concert has been listened to by putting a phone over the phonograph tone arm and thereby turning it into a loud speaker.

The hookup is of the single circuit regenerative type as illustrated; but the points that make it efficient are the arrangement of instruments so as to get the shortest possible wiring connecting them; the use of a special main condenser, vernier condenser, special vario-coupler, vernier rheostat and special grid leak. These features will be described in turn.

The wiring should be made with copper strips, ⅓ of an inch wide, where the connections are rigid. Where connections are movable, such as leads to batteries, heavy rubber insulated, flexible lamp cord should be used. All connections should be soldered. In making connections to the valve socket, solder leads to the projecting piece of brass to which the valve makes direct contact and not to the bolt that holds it in place, as all loose connections add resistance to the circuit, and should be avoided wherever possible.

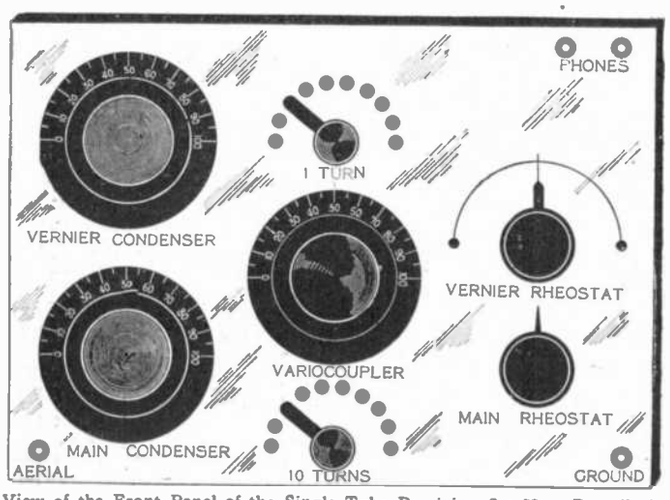
To make connections to the axes of instruments which rotate, bend a strip of thin copper like a watch spring and solder in such a fashion that the spring takes up the twist. Many noises that are generally attributed to "static," "tube noises" or "battery noises," are caused by sliding contact connections and so avoided in this way. Never brighten contact connections, such as valve tips with emery cloth or paper; use a file as a small bit of emery on a valve socket connection will produce a cataract of noises.

In order to avoid any possible high resistance leaks all of my wooden panel connections were insulated from the panel by making the holes larger than the screws and bushing the holes with mica.

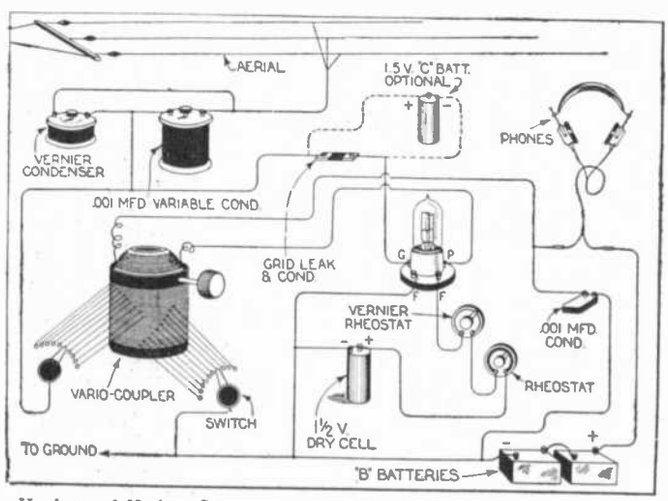
A .001 mfd. condenser is placed in the aerial. In the set illustrated the writer designed and had made a condenser with only two plates, having a calculated capacity of .0019 mfd. This gave splendid results over a wave-length range of from 360 to 440 meters with the primary coil set at 41 turns. By experiment a .001 mfd. condenser gave equally good results.

When using a large condenser in the aerial, a slight rotation will throw the receiver out of tune. It is therefore necessary for fine tuning, especially when tuning in distant or weak stations to have a "vernier" or three plate condenser shunted across the main condenser.

(*Continued on Page* 183)



View of the Front Panel of the Single Tube Receiving Set Here Described By Major Nelles.



Hook-up of Various Instruments Used In the Single Tube Receiving Set. The Use of the Vernier Condenser Is Optional.

Radio For The Beginner

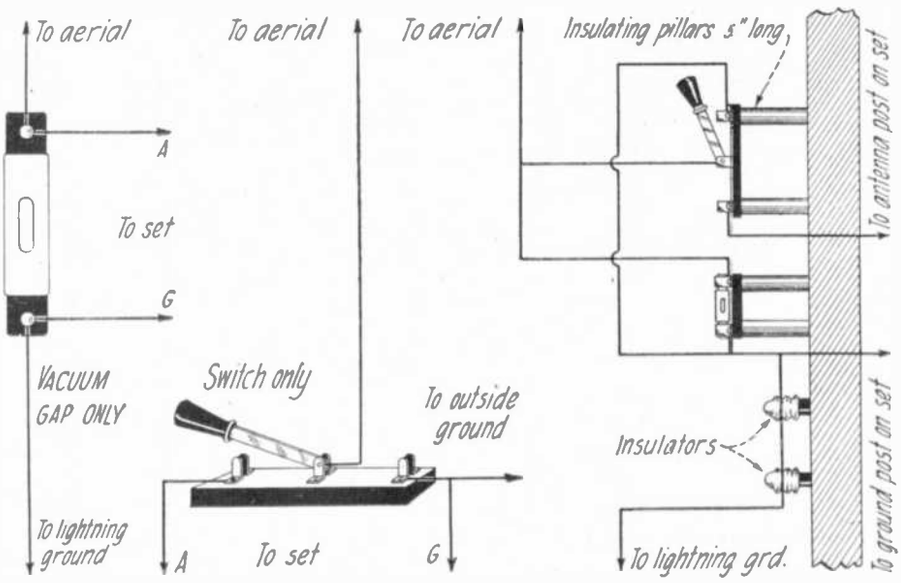
By ARMSTRONG PERRY

No. 16--Protection Against Lightning

AS Summer approaches, radio beginners who hastily installed their antennas in the quickest and easiest way, and got away with it, begin to worry about the fire inspector, the electrical inspector and the fire insurance man. The underwriters' rules that they skipped in reading the directions for installing their sets begin to haunt them and the first thunder shower keeps them shivering for fear that retribution for their sins of omission is about to overtake them.

Peace of mind can be secured at small expense of time and money, and it is worth whatever it costs.

A direct hit by lightning on an antenna is a rare occurrence. But it does happen and it is so serious when it occurs that the mere possibility justifies the expenditure of a ten dollar bill for protection. Besides the danger of a direct hit there is the greater danger that a heavy charge of electricity, placed by a lightning bolt on other wires, will produce by induction a heavy surge in your antenna and its connections that will be almost as disastrous as the bolt itself.



With the Coming of Summer Months It Is Necessary To Provide Your Radio Receiving Station With the Proper Protection Against Electrical Surges Due To Thunder Storms. The Methods Shown At the Left Will Pass Inspection. The Diagrams Illustrate the Correct Installation of Lightning Switch, Lightning Arresters and a Combination of Both.

An antenna is like an upward-opening funnel, ready to catch any electrical current that comes near it and pour it down into the apparatus below and on into the ground. Like water, electricity tries to get to the ground. When it comes in large quantities, as it does when the lightning flashes, we want it to get there as soon as possible and by some other route than the one through the house. Protection against lightning, therefore, is merely the providing of a path so much easier for the lightning than the one through our radio apparatus, that it will choose the safe instead of the hazardous route.

In installing a receiving antenna the main idea is to erect it so that it will hold every bit of energy picked up and send it into the receiver. In installing protection against lightning the idea is exactly the opposite, to get rid of the electricity as quickly as possible.

The safest method, except for the human element involved, is the lightning switch. An efficient one must be able to carry a current of high voltage and of a strength of 100 amperes. Such switches cost from $3.00 to $5.00, for they contain much copper, several terminals, and a heavy insulating base to keep the current from jumping from blade or terminals to the woodwork or other material to which the switch is attached.

When the radio apparatus is in use, this switch connects it with the antenna. To the novice it seems as though the weak radio currents would get lost in the bulky lightning switch, but the fact is that they flow through it much more easily than through the fine wires of the receiver and phones. The larger the wire or switch blade, the less its resistance to the current. A pair of ordinary phones presents three thousand times as much resistance to the passing current as the enormous switches and ground wires of a high-power transmitting station. Resistance, however, does not keep a powerful current out. A flash of lightning will burn up a receiver in an instant if it finds a pathway to it. When not operating his apparatus, the radio user is supposed to have his lightning switch changed over to its other position, the blade connecting the antenna with a heavy wire leading to the ground instead of connecting antenna and apparatus.

Right here is the weak point of the switch It is not automatic. It does not change itself. If the operator is in the house when the electrical storm breaks he usually thinks of the switch and throws it. But while skjes are fair, friends arrive in a car, hurried preparations are made for taking a ride with them, and the switch is forgotten until a sudden blackening of the horizon reminds the far-away operator that his home is in danger.

To supplement the switch, therefore, a lightning arrester is recommended. There are many types, but the principle is always the same, namely, to provide an out-of-doors path to the ground for the antenna current to follow when that current becomes so strong as to menace the apparatus and the house. In some lightning arresters there is an air space between two rows of copper teeth. If a heavy current comes in on the antenna, part of it jumps this gap and goes down the ground wire to the earth, just as water bursts from a pipe when the volume and pressure are excessive.

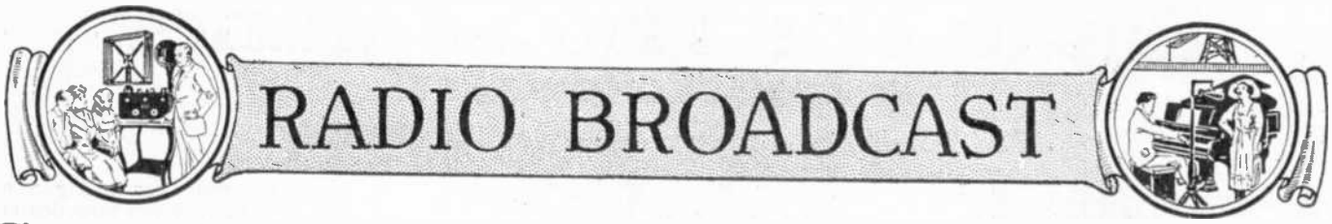
In purchasing a lightning arrester it is advisable to select one that is approved by the National Board of Fire Underwriters. Any kind gives protection if it works, but if the house burns as a result of being struck by lightning, and it is discovered that an unapproved safety device was used, the insurance company may refuse to pay the loss and the law will sustain the company.

There is little use in installing a proper switch and lightning arrester if, as sometimes happens, a small wire is used to connect them with the ground. The regulations require a wire as large as No. 14, B. & S. guage, copper. Any dealer who sells wire knows how large that is. The ground wire should be well insulated, otherwise heavy currents will leap from it to the house as lightly as monkeys. Also it should be held away from the house by brackets with insulators.

Any ground wire is inefficient unless it makes good contact with the ground. It should connect with a metal pipe or stake driven down far enough to reach moist earth in all seasons, or to sheets or pieces of metal buried in moist earth. It is better to avoid connecting it to a pipe that enters the house.

After the lightning ground has been installed, the ground-lead from the set may be connected to it between the switch and the ground.

With loop aerials, inside the building no lightning switch is required, and reception can be carried on through thunder-storms if desired.



Complete List of Broadcast Stations in United States

REVISED AND CORRECTED TO MARCH 1, 1923

All stations transmit entertainment, (concerts, lectures and music). Those with † transmit market reports; those with ‡ transmit weather reports.

Call	Name	City and State
††KDKA	Westinghouse Electric & Manufacturing Co.	East Pittsburgh, Pa.
††KDN	Leo J. Meyberg Co.	San Francisco, Cal.
KDPM	Westinghouse Electric & Manufacturing Co.	Cleveland, Ohio
KDPT	Southern Electric Co.	San Diego, Cal.
‡KDYL	Telegram Publishing Co.	Salt Lake City, Utah
KDYM	Savoy Theatre	San Diego, Cal.
‡KDYQ	Oregon Institute of Technology	Portland, Ore.
‡KDYS	The Tribune	Great Falls, Mont.
KDYW	Smith Hughes & Co.	Phoenix, Ariz.
‡KDYX	Star Bulletin	Honolulu, Hawaii
KDZA	Arizona Daily Star	Tucson, Ariz.
KDZB	Frank E. Siefert	Bakersfield, Cal.
KDZE	The Rhodes Co.	Seattle, Wash.
KDZF	Auto Club of Southern California	Los Angeles, Cal.
KDZG	Cyrus Peirce & Co.	San Francisco, Cal.
‡KDZH	Fresno Evening Herald	Fresno, Cal.
KDZI	Electric Supply Co.	Wenatchee, Wash.
KDZK	Nevada Machinery & Electric Co.	Reno, Nev.
KDZQ	William D. Pyle (Hal G. Nichols)	Denver, Colo.
KDZR	Bellingham Publishing Co.	Bellingham, Wash.
KDZT	Seattle Radio Association	Seattle, Wash.
KDZX	Glad Tidings Tabernacle	San Francisco, Cal.
KDZZ	Kinney Bros. & Sipprell	Everett, Wash.
KFAD	McArthur Bros. Mercantile Co.	Phoenix, Ariz.
KFAE	State College of Washington	Pullman, Wash.
KFAF	Western Radio Corp.	Denver, Colo.
KFAJ	University of Colorado	Boulder, Colo.
KFAN	The Electric Shop	Moscow, Idaho
KFAP	Standard Publishing Co.	Butte, Mont.
KFAQ	City of San Jose	San Jose, Cal.
KFAR	Studio Lighting Service Co.	Hollywood, Cal.
KFAT	S. T. Donohue	Eugene, Ore.
‡KFAU	Independent School District of Boise City, Boise High School	Boise, Idaho
KFAV	Abbot Kinney Co.	Venice, Cal.
KFAW	The Radio Den (W. B. Ashford and T. White)	Santa Ana, Cal.
‡KFAY	Virgin's Radio Service	Medford, Ore.
KFAZ	C. H. Weatherill	Reedley, Cal.
††KFBB	F. A. Buttrey & Co.	Havre, Mont.
KFBC	W. K. Azbill	San Diego, Cal.
KFBD	Clarence V. Welch	Hanford, Cal.
KFBE	Reuben H. Horn	San Luis Obispo, Cal.
KFBG	First Presbyterian Church	Tacoma, Wash.
KFBH	Thomas Musical Co.	Marshfield, Ore.
‡KFBK	Kimball-Upson Co.	Sacramento, Cal.
KFBL	Leese Bros.	Everett, Wash.
KFBS	Trinidad Gas & Electric Supply Co. and Chronicle News	Trinidad, Colo.
KFBU	The Cathedral	Laramie, Wyo.
KFCB	Nielsen Radio Supply Co.	Phoenix, Ariz.
KFCD	Salem Electric Co.	Salem, Ore.
KFCF	Frank A. Moore	Walla Walla, Wash.
KFCH	Electric Service Station (Inc.)	Billings, Mont.
KFCK	Colorado Springs Radio Co.	Colorado Springs, Colo.
†KFCL	Los Angeles Union Stock Yards	San Antonio, Cal.
KFCM	Richmond Radio Shop (F. T. Doeing)	Richmond, Cal.
KFCP	Ralph W. Flygare	Ogden, Utah
KFCQ	Motor Service Station (N. R. Hood)	Casper, Wyo.
KFCV	Fred Mahaffey, Jr.	Houston, Tex.
KFCY	Western Union College	Le Mars, Iowa
KFCZ	Omaha Central High School	Omaha, Neb.
KFDA	Adler's Music Store	Baker, Ore.
††KFDB	Mercantile Trust Co. of California	San Francisco, Cal.
KFDC	Radio Supply Co. (E. B. Craney)	Spokane, Wash.
KFDD	St. Michaels Cathedral	Boise, Idaho
‡KFDF	Wyoming Radio Corporation	Casper, Wyo.
KFDH	University of Arizona	Tucson, Ariz.
KFDJ	Oregon Agricultural College	Corvallis, Ore.
KFDL	Knight-Campbell Music Co.	Denver, Colo.
KFDO	H. Everett Cutting	Bozeman, Mont.
KFDP	Hawkeye Radio & Supply Co.	Des Moines, Iowa
KFDR	Bullock's Hardware & Sporting Goods	York, Neb.
KFDU	Nebraska Radio Electric Co.	Lincoln, Neb.
KFDV	Gilbrech & Stinson	Fayetteville, Ark.
KFEB	City of Taft	Taft, Cal.
††KFEC	Meier & Frank Co.	Portland, Ore.
KFEJ	Guy Greason	Tacoma, Wash.
KFEL	Winner Radio Corp.	Denver, Colo.
KFEP	Radio Equipment Co.	Denver, Colo.
KFEQ	J. L. Scroggin	Oak, Nebr.
KFER	Auto Electric Service Co.	Fort Dodge, Iowa
‡KFEV	Radio Electric Shop	Douglas, Wyo.
KFFA	Dr. R. O. Shelton	San Diego, Cal.
KFFB	Jenkins Furniture Co.	Boise, Idaho
KFFE	Eastern Oregon Radio Co.	Pendleton, Ore.
‡KFFQ	Marksheffel Motor Co.	Colorado Springs, Colo.
KFGB	Lowenthal Bros.	Pueblo, Colo.
KFGF	Buchanan Stevens & Co.	Mount Vernon, Wash.
KFGH	Leland Stanford University	Stanford University, Cal.
KFHJ	Fallon & Co.	Santa Barbara, Cal.
KFI	Earle C. Anthony (Inc.)	Los Angeles, Cal.
KFV	Foster-Bradbury Radio Store	Yakima, Wash.
KFZ	Doerr-Mitchell Electric Co.	Spokane, Wash.
KGB	William A. Mullins Electric Co.	Tacoma, Wash.
KGG	Hallock & Watson Radio Service	Portland, Ore.
KGN	Northwestern Radio Manufacturing Co.	Portland, Ore.
KGO	Altadena Radio Laboratory	Altadena, Cal.
KGU	Marion A. Mulrony.	Honolulu, Hawaii
‡KGW	Portland Morning Oregonian	Portland, Ore.
KGY	St. Martins College	Lacey, Wash.
‡KHJ	Times-Mirror Co.	Los Angeles, Cal.
KHQ	Louis Wasmer	Seattle, Wash.
KJJ	The Radio Shop	Sunnyvale, Cal.
KJQ	C. O. Gould	Stockton, Cal.
KJR	Northwest Radio Service Co.	Seattle, Wash.
KJS	Bible Institute of Los Angeles	Los Angeles, Cal.
KLB	J. J. Dunn & Co.	Pasadena, Cal.
KLN	Monterey Electric Shop	Monterey, Cal.
KLS	Warner Bros.	Oakland, Cal.
KLX	Tribune Pub. Co. (Oakland Tribune)	Oakland, Cal.
††KLZ	Reynolds Radio Co.	Denver, Colo
KMC	W. W. Lindsay, Jr.	Reedley, Cal.
‡KMJ	San Joaquin Light & Power Corp.	Fresno, Cal.
KMO	Love Electric Co.	Tacoma, Wash.
KNI	T. W. Smith	Eureka, Cal.
††KNJ	Roswell Public Service Co.	Roswell, N. Mex.
KNN	Bullock's	Los Angeles, Cal.
KNT	Grays Harbor Radio Co.	Aberdeen, Wash.
KNV	Radio Supply Co.	Los Angeles, Cal.
KNX	Electric Lighting Supply Co.	Los Angeles, Cal.
‡KOA	Young Men's Christian Association	Denver, Colo.
‡KOB	New Mexico College of Agriculture and Mechanic Arts	State College, N. Mex.
KOP	Detroit Police Department	Detroit, Mich.
KPO	Hale Bros.	San Francisco, Cal.
KQI	University of California	Berkeley, Cal.
KQV	Doubleday-Hill Electric Co.	Pittsburgh, Pa.
‡KQW	Charles D. Herrold	San Jose, Cal.
KQY	Stubbs Electric Co.	Portland, Ore.
KRE	Berkeley Daily Gazette	Berkeley, Cal.
‡KSD	Post Dispatch	St. Louis, Mo.
KSL	The Emporium	San Francisco, Cal.
KSS	Prest & Dean Radio Co. and Radio Research Society of Long Beach, Cal.	Long Beach, Cal.
KTW	First Presbyterian Church	Seattle, Wash.
††KUO	Examiner Printing Co. (San Francisco Examiner)	San Francisco, Cal.
KUS	City Dye Works & Laundry Co.	Los Angeles, Cal.
KUY	Coast Radio Co.	El Monte, Cal.
KWG	Portable Wireless Telephone Co.	Stockton, Cal.
‡KWH	Los Angeles Examiner	Los Angeles, Cal.
KXD	Modesto Herald Publishing Co.	Modesto, Cal.
KYI	Bakersfield Californian (A. Harrell)	Bakersfield, Cal.
‡KYJ	Leo J. Meyberg Co.	Los Angeles, Cal.
KYQ	Electric Shop	Honolulu, Hawaii
††KYW	Westinghouse Electric & Manufacturing Co.	Chicago, Ill.
KZC	Public Market, Department & Market Stores Co.	Seattle, Wash.
KZM	Preston D. Allen	Oakland, Cal.
‡KZN	The Deseret News	Salt Lake City, Utah
‡KZU	Wenatchee Battery & Motor Co.	Wenatchee, Wash.
WAAB	Valdemar Jensen	New Orleans, La.
WAAC	Tulane University	New Orleans, La.
WAAD	Ohio Mechanics Institute	Cincinnati, Ohio
††WAAF	Chicago Daily Drovers Journal	Chicago, Ill.
WAAH	Commonwealth Electric Co.	St. Paul, Minn.
WAAJ	Eastern Radio Institute	Boston, Mass.
††WAAK	Gimbel Bros.	Milwaukee, Wis.
WAAL	Beamish Electric Co.	Minneapolis, Minn.
WAAM	I. R. Nelson Co.	Newark, N. J.
‡WAAN	University of Missouri.	Columbia, Mo.
‡WAAP	United Electric Co.	Wichita, Kans.
WAAQ	New England Motor Sales Co.	Greenwich, Conn.
WAAS	Georgia Radio Co.	Decatur, Ga.
†WAAW	Omaha Grain Exchange.	Omaha, Neb.
WAAY	Yahrling-Rayner Piano Co.	Youngstown, Ohio
WAAZ	Hollister-Miller Motor Co.	Emporia, Kans.
WBAA	Purdue University	West Lafayette, Ind.
WBAD	Sterling Electric Co.	Minneapolis, Minn.
WBAF	Fred M. Middleton.	Moorestown, N. J.
††WBAG	Diamond State Fibre Co.	Bridgeport, Pa.
WBAH	The Dayton Co.	Minneapolis, Minn.
WBAN	Wireless Phone Corp.	Paterson, N. J.
WBAO	James Millikin University	Decatur, Ill.
††WBAP	Wortham-Carter Publishing Co. (Star Telegram)	Fort Worth, Tex.
WBAU	Republican Publishing Co.	Hamilton, Ohio
‡WBAV	Erner & Hopkins Co.	Columbus, Ohio
WBAW	Marietta College	Marietta, Ohio
WBAX	John H. Stenger, Jr.	Wilkes-Barre, Pa.
WBAY	American Telephone & Telegraph Co.	New York, N. Y.
WBL	T & H Radio Co.	Anthony, Kans.
WBS	D. W. May (Inc.)	Newark, N. J.
††WBT	Southern Radio Corporation	Charlotte, N. C.
WBU	City of Chicago	Chicago, Ill.
WBZ	Westinghouse Electric & Manufacturing Co.	Springfield, Mass.
WCAB	Newburgh News Printing & Publishing Co.	Newburgh, N. Y.
WCAC	John Fink Jewelry Co.	Fort Smith, Ark.

Call	Name	City and State
‡WCAD	St. Lawrence University,	Canton, N. Y.
WCAE	Kaufmann & Baer Co.,	Pittsburgh, Pa.
WCAG	Daily States Publishing Co.,	New Orleans, La.
WCAH	Entrekin Electric Co.,	Columbus, Ohio
WCAJ	Nebraska Wesleyan University,	University Place, Neb.
WCAK	Alfred P. Daniel	Houston, Tex.
WCAL	St. Olaf College	Northfield, Minn.
WCAM	Villanova College	Villanova, Pa.
WCAO	Sanders & Stayman Co.,	Baltimore, Md.
WCAR	Alamo Radio Electric Co.,	San Antonio, Tex.
WCAS	William Hood Dunwoody Industrial Institute	Minneapolis, Minn.
‡WCAT	South Dakota State School of Mines,	Rapid City, S. Dak.
†WCAU	Durham & Co.	Philadelphia, Pa.
WCAV	J. C. Dice Electric Co.,	Little Rock, Ark.
†WCAW	Quincy Electric Supply Co.,	Quincy, Ill.
WCAX	University of Vermont,	Burlington, Vt
‡WCAY	Kesselman O'Driscoll Co.,	Milwaukee, Wis.
WCAZ	Robert E. Compton & Carthage College	Carthage, Ill.
WCE	Findley Electric Co.,	Minneapolis, Minn.
WCK	Stix-Baer & Fuller Dry Goods Co.,	St. Louis, Mo.
†WCM	University of Texas	Austin, Tex.
††WCN	Clark University	Worcester, Mass.
††WCX	Detroit Free Press	Detroit, Mich.
‡WDAC	Illinois Watch Co.	Springfield, Ill.
WDAD	Central Kansas Radio Supply,	Lindsborg, Kans.
††WDAE	Tampa Daily Times	Tampa, Fla.
††WDAF	Kansas City Star	Kansas City, Mo.
WDAG	J. Laurance Martin	Amarillo, Tex.
WDAH	Trinity Methodist Church (South),	El Paso, Tex.
‡WDAI	Hughes Electrical Corporation,	Syracuse, N. Y.
‡WDAJ	Atlanta & West Point R. R. Co.,	College Park, Ga.
WDAK	The Courant	Hartford, Conn.
††WDAL	Florida Times-Union,	Jacksonville, Fla.
WDAO	Automotive Electric Co.	Dallas, Tex.
††WDAP	Mid West Radio Central (Inc.),	Chicago, Ill.
WDAR	Lit Bros.	Philadelphia, Pa.
WDAS	Samuel A. Waite	Worcester, Mass.
WDAU	Slocum & Kilburn.	New Bedford, Mass.
WDAX	First National Bank.	Centerville, Iowa
‡WDAY	Fargo Radio Service Co. (K. M. Hance)	Fargo, N. Dak.
WDM	Church of the Covenant,	Washington, D. C.
WDT	Ship Owners Radio Service,	Stapleton, N. Y.
WDZ	James L. Bush	Tuscola, Ill.
WEAA	Fallain & Lathrop	Flint, Mich.
††WEAB	Standard Radio Equipment Co.,	Fort Dodge, Iowa
WEAD	Northwest Kansas Radio Supply Co.,	Atwood, Kans.
WEAF	Western Electric Co.	New York, N. Y.
WEAG	Nichols-Hineline Bassett Laboratory,	Edgewood, R. I.
††WEAH	Wichita Board of Trade and Lander Radio Co.	Wichita, Kans.
WEAI	Cornell University	Ithaca, N. Y.
WEAJ	University of South Dakota,	Vermilion, S. Dak.
WEAK	Julius B. Abercrombie.	St. Joseph, Mo.
WEAM	Borough of North Plainfield,	North Plainfield, N. J.
‡WEAN	Shepard Co.	Providence, R. I.
††WEAO	Ohio State University,	Columbus, Ohio
††WEAP	Mobile Radio Co.	Mobile, Ala.
‡WEAR	Baltimore American & News Publishing Co.	Baltimore, Md.
WEAS	Hecht Co.	Washington, D. C.
WEAT	John J. Fogarty	Tampa, Fla.
‡WEAU	Davidson Bros. Co.	Sioux City, Iowa
WEAV	Sheridan Electric Service Co.,	Rushville, Neb.
WEAX	T. J. M. Daly	Little Rock, Ark.
WEAY	Iris Theatre (Will Horowitz, Jr.),	Houston, Tex.
WEB	Benwood Co.	St. Louis, Mo.
††WEH	Midland Refining Co.	Tulsa, Okla.
‡WEV	Hurlburt-Still Electrical Co.,	Houston, Tex.
††WEW	St. Louis University.	St. Louis, Mo.
‡WEY	Cosradio Co.	Wichita, Kans.
††WFAA	Dallas News and Dallas Journal,	Dallas, Tex.
WFAB	Carl F. Woese	Syracuse, N. Y.
WFAC	Superior Radio Co.	Superior, Wis.
WFAF	H. C. Spratley Radio Co.,	Poughkeepsie, N. Y.
WFAG	Radio Engineering Laboratory,	Waterford, N. Y.
WFAH	Electric Supply Co.,	Port Arthur, Tex.
WFAJ	Hi-Grade Wireless Instrument Co.,	Asheville, N. C.
‡WFAM	Times Publishing Co.,	St. Cloud, Minn.
††WFAN	Hutchinson Electric Service Co.,	Hutchinson, Minn.
WFAQ	Missouri Wesleyan College and Cameron Radio Co.	Cameron, Mo.
††WFAT	Daily Argus-Leader,	Sioux Falls, S. Dak.
WFAU	Edwin C. Lewis.	Boston, Mass.
‡WFAV	University of Nebraska.	Lincoln, Neb.
WFAW	Miami Daily Metropolis .	Miami, Fla.
WFAY	Daniels Radio Supply Co.,	Independence, Kans.
‡WFAZ	South Carolina Radio Shop,	Charleston, S. C.
†WFI	Strawbridge & Clothier,	Philadelphia, Pa.
WGAD	Spanish-American School of Radiotelegraphy	Ensenada, P. R.
WGAH	New Haven Electric Co.,	New Haven, Conn.
WGAJ	W. H. Gass.	Shenandoah, Iowa
WGAK	Macon Electric Co.	Macon, Ga.
WGAL	Lancaster Electric Supply & Construction Co.	Lancaster, Pa.
WGAM	Orangeburg Radio Equipment Co.,	Orangeburg, S. C.
WGAN	Cecil E. Lloyd	Pensacola, Fla.
WGAQ	Glenwood Radio Corporation (W. G. Patterson)	Shreveport, La.
WGAR	Southwest American.	Fort Smith, Ark.
WGAT	American Legion, Department of Nebraska	Lincoln, Neb.
WGAU	Marcus G. Limb.	Wooster, Ohio
WGAW	Ernest C. Albright.	Altoona, Pa.
WGAX	Radio Electric Co,	Washington Court House, Ohio
WGAY	Northwestern Radio Co.,	Madison, Wis.
WGAZ	South Bend Tribune.	South Bend, Ind.
‡WGF	The Register and Tribune,	Des Moines, Iowa
††WGI	American Radio & Research Corp.,	Medford Hillside, Mass.
WGL	Thomas F. J. Howlett,	Philadelphia, Pa.
WGM	Atlanta Constitution.	Atlanta, Ga.
††WGR	Federal Telephone & Telegraph Co.,	Buffalo, N. Y.
†WGV	Interstate Electric Co.	New Orleans, La.
‡WGY	General Electric Co.,	Schenectady, N. Y.
††WHA	University of Wisconsin,	Madison, Wis.
WHAA	State University of Iowa,	Iowa City, Iowa
‡WHAB	Clark W. Thompson.	Galveston, Tex.
WHAC	Cole Bros. Electric Co.,	Waterloo, Iowa
WHAD	Marquette University,	Milwaukee, Wis.
WHAE	Automotive Electric Service Co.,	Sioux City, Iowa
WHAG	University of Cincinnati,	Cincinnati, Ohio
WHAH	Hafer Supply Co.	Joplin, Mo.
WHAI	Radio Equipment & Manufacturing Co.	Davenport, Iowa
WHAK	Roberts Hardware Co.,	Clarksburg, W. Va.
WHAL	Lansing Capital News,	Lansing, Mich.
††WHAM	University of Rochester (Eastman School of Music).	Rochester, N. Y.
WHAO	Frederic A. Hill.	Savannah, Ga.
WHAP	Otta & Kuhns.	Decatur, Ill.
WHAQ	Semmes Motor Co.	Washington, D. C.
WHAR	Paramount Radio & Electric Co.,	Atlantic City, N. J.
‡WHAS	Courier-Journal and Louisville Times,	Louisville, Ky.
WHAV	Wilmington Electrical Specialty Co.,	Wilmington, Del.
WHAW	Pierce Electrical Co.	Tampa, Fla.
WHAY	Huntington Press.	Huntington, Ind.
WHAZ	Rensselaer Polytechnic Institute,	Troy, N. Y.
††WHB	Sweeney School Co.,	Kansas City, Mo.
WHD	West Virginia University,	Morgantown, W. Va.
WHK	Radiovox Co. (Warren R. Cox),	Cleveland, Ohio
‡WHN	Ridgewood Times Printing & Publishing Co.	Ridgewood, N. Y
WIAB	Joslyn Automobile Co.	Rockford, Ill
‡WIAC	Galveston Tribune.	Galveston, Tex.
WIAD	Ocean City Yacht Club,	Ocean City, N. J
WIAE	Mrs. Robert E. Zimmerman,	Vinton, Iowa
WIAF	Gustav A. DeCortin.	New Orleans, La.
WIAH	Continental Radio & Manufacturing Co.	Newton, Iowa
‡WIAI	Heer Stores Co.	Springfield, Mo.
WIAJ	Fox River Valley Radio Supply Co. (Quinn Bros.)	Neenah, Wis.
††WIAK	Journal-Stockman Co.	Omaha, Neb.
WIAO	School of Engineering of Milwaukee and Milwaukee News,	Milwaukee, Wis.
WIAQ	Chronicle Publishing Co.,	Marion, Ind.
WIAR	Paducah Evening Sun,	Paducah, Ky.
WIAS	Burlington Hawkeye-Home Electric Co.	Burlington, Iowa
WIAT	Leon T. Noel	Tarkio, Mo.
WIAU	American Trust & Savings Bank,	Le Mars, Iowa
WIAV	New York Radio Laboratories,	Binghamton, N. Y.
WIAW	Saginaw Radio & Electric Co.,	Saginaw, Mich.
†WIAY	Woodward & Lothrop,	Washington, D. C.
WIAZ	Electric Supply Sales Co.,	Miami, Fla.
WIK	K. & L. Electric Co.,	McKeesport, Pa.
WIL	Continental Electrical Supply Co.,	Washington, D. C.
‡WIP	Gimbel Bros.	Philadelphia, Pa.
†WIZ	Cino Radio Manufacturing Co.,	Cincinnati, Ohio
WJAB	American Electric Co.,	Lincoln, Neb.
WJAD	Jackson's Radio Engineering Laboratories	Waco, Tex.
‡WJAG	Norfolk Daily News.	Norfolk, Neb.
‡WJAJ	Young Mens Christian Association,	Dayton, Ohio
††WJAK	White Radio Laboratory,	Stockdale, Ohio
WJAM	D. M. Perham.	Cedar Rapids, Iowa
‡WJAN	Peoria Star.	Peoria, Ill.
WJAP	Kelley-Duluth Co.	Duluth, Minn.
WJAQ	Capper Publications.	Topeka, Kans.
WJAR	The Outlet Co.	Providence, R. I.
WJAS	Pittsburgh Radio Supply House,	Pittsburgh, Pa.
WJAT	Kelly-Yawter Jewelry Co.,	Marshall, Mo.
††WJAX	Union Trust Co.	Cleveland, Ohio
WJAZ	Chicago Radio Laboratory.	Chicago, Ill.
WJD	Richard H. Howe.	Granville, Ohio
WJH	White & Boyer Co.	Washington, D. C.
WJX	De Forest Radio Telephone & Telegraph Co.	New York, N. Y.
††WJZ	Westinghouse Electric & Manufacturing Co.	Newark, N. J.
‡WKAA	H. F. Paar.	Cedar Rapids, Iowa
WKAC	Star Publishing Co.	Lincoln, Neb.
WKAD	Charles Looff (Crescent Park),	East Providence, R. I.
WKAF	W. S. Radio Supply Co.,	Wichita Falls, Tex.
WKAH	Planet Radio Co.,	West Palm Beach, Fla.
WKAK	Okfuskee County News,	Okemah, Okla.
‡WKAL	Gray & Gray.	Orange, Tex.
WKAN	Alabama Radio Manufacturing Co.,	Montgomery, Ala.
WKAP	Dutee W. Flint.	Cranston, R. I.
WKAQ	Radio Corporation of Porto Rico,	San Juan, P. R.
WKAR	Michigan Agriculture College,	East Lansing, Mich.
WKAS	L. E. Lines Music Co.,	Springfield, Mo.
WKAV	Laconia Radio Club,	Laconia, N. H.
WKAW	Turner Cycle Co.	Beloit, Wis.
WKAX	William A. McFarlane,	Bridgeport, Conn.
WKAY	Brenau College.	Gainsville, Ga,
WKC	Joseph M. Zamoiski Co.,	Baltimore, Md.
WKN	Riechman-Crosby Co.,	Memphis, Tenn.
‡WKY	WKY Radio Shop.	Oklahoma, Okla.
††WLAC	North Carolina State College,	Raleigh, N. C.
††WLAG	Cutting & Washington Radio Corp.,	Minneapolis, Minn.
WLAH	Samuel Woodworth.	Syracuse, N. Y.
†WLAJ	Waco Electrical Supply Co.,	Waco, Tex.
WLAK	Vermont Farm Machine Corp.,	Bellows Falls, Vt.
WLAL	Tulsa Radio Co.	Tulsa, Okla.
WLAN	Putnam Hardware Co.	Houlton, Me.
WLAP	W. V. Jordon.	Louisville, Ky.
WLAQ	Arthur E. Schilling.	Kalamazoo, Mich.
WLAS	Central Radio Supply Co.,	Hutchinson, Kans.
WLAT	Radio & Specialty Co.,	Burlington, Iowa
WLAV	Electric Shop.	Pensacola, Fla.
WLAW	Police Dept., City of New York,	New York, N. Y.
WLAX	Putnam Electric Co. (Greencastle Community Broadcasting Station),	Greencastle, Ind.
WLAY	Northern Commercial Co.,	Fairbanks, Alaska
WLAZ	Hutton & Jones Electric Co.,	Warren, Ohio
††WLB	University of Minnesota,	Minneapolis, Minn.
‡WLK	Hamilton Manufacturing Co.,	Indianapolis, Ind.
††WLW	Crosley Manufacturing Co.,	Cincinnati, Ohio
WMAB	Radio Supply Co.	Oklahoma, Okla.
WMAC	J. E. Page (Olive B. Meredith),	Cazenovia, N. Y.
WMAD	Atchinson County Mail,	Rock Port, Mo.
WMAF	Round Hills Radio Corporation,	Dartmouth, Mass.
WMAG	Tucker Electric Co.	Liberal, Kans.
WMAH	General Supply Co.	Lincoln, Neb.
†WMAJ	Drovers Telegram Co.,	Kansas City, Mo.
‡WMAK	Norton Laboratories.	Lockport, N. Y.
WMAL	Trenton Hardware Co.	Trenton, N. J.

Call	Name	City and State
‡WMAM	Beaumont Radio Equipment Co.,	Beaumont, Tex.
WMAN	Broad Street Baptist Church,	Columbus, Ohio
WMAP	Utility Battery Service,	Easton, Pa.
WMAQ	Fair Corp. and Chicago Daily News,	Chicago, Ill.
WMAR	Waterloo Electrical Supply Co.,	Waterloo, Iowa
‡WMAT	Paramount Radio Corporation,	Duluth, Minn.
†WMAV	Alabama Polytechnic Institute,	Auburn, Ala.
WMAW	Wahpeton Electric Co.,	Wahpeton, N. Dak.
WMAX	K. & K. Radio Supply Co.,	Ann Arbor, Mich.
WMAY	Kingshighway Presbyterian Church,	St. Louis, Mo.
WMAZ	Mercer University.....Macon. Ga.	
††WMC	Commercial Appeal....Memphis, Tenn.	
††WMH	Precision Equipment Co.,	Cincinnati. Ohio
WMU	Doubleday-Hill Electric Co.,	Washington, D. C.
WNAB	Park City Daily News,	Bowling Green, Ky.
WNAC	Shepard Stores.....Boston, Mass.	
WNAD	Oklahoma Radio Engineering Co.,	Norman, Okla.
WNAK	Manhattan Radio Supply Co.,	Manhattan, Kans.
WNAL	R. J. Rockwell.....Omaha, Neb.	
WNAM	Ideal Apparatus Co...Evansville. Ind.	
WNAN	Syracuse Radio Telephone Co.,	Syracuse, N. Y.
WNAP	Wittenberg College. Springfield. Ohio	
WNAQ	Charleston Radio Electric Co.,	Charleston. S. C.
WNAR	C. C. Rhodes ..... Butler. Mo.	
WNAS	Texas Radio Corporation and Austin Statesman ..... Austin. Tex.	
WNAT	Lennig Bros. Co... Philadelphia, Pa.	
WNAV	Peoples Telephone and Telegraph Co.,	Knoxville, Tenn
WNAW	Peninsular Radio Club,	Fort Monroe. Va.
WNAX	Dakota Radio Apparatus Co.,	Yankton. S. Dak.
WNAY	Ship Owners Radio Service.	Baltimore. Md.
WNJ	Shotton Radio Manufacturing Co..	Albany. N. Y.
WOAA	Dr. Walter Hardy...Ardmore. Okla.	
WOAB	Valley Radio...Grand Forks, N. Dak.	
WOAC	Maus Radio Co.....Lima. Ohio	
WOAD	Friday Battery & Electric Corporation.	Sigourney. Iowa
WOAE	Midland College.....Fremont, Neb.	
WOAF	Tyler Commereial College,	Tyler. Tex.
WOAG	Apollo Theatre (Belvidere Amusement Co.) .....Belvidere, Ill.	
WOAH	Palmetto Radio Corporation,	Charleston, S. C.
‡WOAI	Southern Equipment Co.,	San Antonio, Tex.
WOAJ	Ervins Electrical Co.,	Parsons, Kans.
WOAK	Collins Hardware Co.,	Frankfort, Ky.
WOAL	William E. Woods,	Webster Groves, Mo.
WOAN	Vaughn Conservatory of Music,	Lawrenceburg, Tenn.
WOAO	Lyradion Manufacturing Co.,	Mishawaka, Ind.
WOAP	Kalamazoo College,	Kalamazoo, Mich.
WOAR	Henry P. Lundskow..Kenosha, Wis.	
WOAS	Bailey's Radio Shop,	Middletown, Conn.
WOAT	Boyd M. Hamp.....Wilmington, Del.	
WOAU	Sowder Bolling Piano Co..	Evansville, Ind.
WOAV	Pennsylvania National Guard, 112th Infantry, 2d Battalion,	Erie, Pa.
WOAW	Woodmen of the World,	Omaha, Neb.
WOAX	Franklyn J. Wolff (Monument Pottery Co.).....Trenton, N. J.	
WOAZ	Penick Hughes Co....Stamford, Tex.	
‡WOC	Palmer School of Chiropractic,	Davenport, Iowa
WOE	Buckeye Radio Service Co.,	Akron, Ohio
††WOI	Iowa State College.....Ames, Iowa	
WOK	Pine Bluff Co.....Pine Bluff, Ark.	
††WOO	John Wanamaker...Philadelphia, Pa.	
††WOQ	Western Radio Co..Kansas City, Mo.	
WOR	L. Bamberger & Co...Newark, N. J.	
††WOS	Missouri State Marketing Bureau,	Jefferson City, Mo.
†WOU	Metropolitan Utilities District,	Omaha, Neb.
††WOZ	Palladium Printing Co.,	Richmond, Ind.
††WPA	Fort Worth Record.	Fort Worth, Tex.
WPAA	Anderson & Webster Electric Co.,	Wahoo, Neb.
WPAB	Pennsylvania State College,	State College, Pa.
WPAC	Donaldson Radio Co.,	Okmulgee, Okla.
WPAD	W. A. Wieboldt & Co..	Chicago, Ill
WPAF	Peterson Radio Co.,	Council Bluffs. Iowa
†WPAH	Wisconsin Department of Markets.	Waupaca, Wis.
WPAJ	Doolittle Radio Corporation,	New Haven, Conn.
‡WPAK	North Dakota Agricultural College.	Agricultural College, N. Dak.
WPAL	Superior Radio & Telephone Equipment Co. .....Columbus, Ohio	
WPAM	Auerbach & Guettel... Topeka, Kans.	
WPAP	Theodore D. Phillips,	Winchester. Ky.
WPAQ	General Sales & Engineering Co.,	Frostburg. Md.
WPAR	Ward Battery & Radio Co..	Beloit, Kans.
WPAS	J. & M. Electric Co..	Amsterdam, N. Y.
WPAT	St. Patricks Cathedral.	El Paso. Tex.
‡WPAU	Concordia College..Moorehead, Minn.	
WPAV	Paul Tinetti & Son..Laurium, Minn.	
WPAW	Radio Installation Co..	Wilmington. Del.
WPAX	S-W Radio Co. (J. R. Shumate, Jr.),	Thomasville, Ga.
WPAY	Bangor Radio Laboratory.	Bangor, Me.
WPAZ	Dr. John R. Koch.	Charleston, W. Va.
WPE	Central Radio Co..Independence, Mo.	
††WPG	Nushawg Poultry Farm.	New Lebanon, Ohio
WPI	Electric Supply Co.....Clearfield, Pa.	
WPM	Thomas J. Williams.	Washington, D. C.
WPO	United Equipment Co.Memphis, Tenn.	
WQAA	Horace A. Beale, Jr.,	Parkesburg, Pa.
WQAB	Southwest Missouri State Teachers College .....Springfield, Mo.	
WQAC	E. B. Gish.....Amarillo, Tex.	
WQAD	Whitall Electric Co..Waterbury, Conn.	
WQAE	Moore Radio News Station,	Springfield, Vt.
WQAF	Sandusky Register....Sandusky, Ohio	
WQAH	Brock-Anderson Electrical Engineering Co.....Lexington, Ky.	
WQAJ	Ann Arbor Times News,	Ann Arbor, Mich.
WQAK	Appel-Higley Electric Co..	Dubuque, Iowa
WQAL	Coles County Telephone & Telegraph Co.....Mattoon, Ill.	
WQAM	Electrical Equipment Co.,	Miami, Fla.
‡WQAN	Scranton Times.....Scranton, Pa.	
WQAO	Calvary Baptist Church,	New York, N. Y.
WQAQ	West Texas Radio Co.,	Abilene, Tex
WQAR	Press Publishing Co....Muncie, Ind.	
WQAS	Prince-Walter Co.....Lowell, Mass.	
WQAT	Radio Equipment Corporation,	Westhampton, Va.
WQAV	Huntington & Guerry (Inc.),	Greenville, S. C.
WQAW	Catholic University,	Washington, D. C.
WQAY	Gaston Music & Furniture Co.,	Hastings, Neb.
WRAA	William M. Rice Institute,	Houston, Tex.
WRAB	Board of Public Education,	Savannah, Ga.
WRAC	State Normal School,	Mayville, N. Dak.
WRAD	Taylor Radio Shop....Marion, Kans.	
WRAM	Lombard College.....Galesburg, Ill.	
WRAN	Black Hawk Electrical Co.,	Waterloo, Iowa
WRAO	Radio Service Co....St. Louis, Mo.	
WRAR	Jacob C. Thomas,	David City, Neb.
WRAU	Amarillo Daily News.	Amarillo, Tex.
WRAV	Antioch College. Yellow Springs, Ohio	
‡WRAY	Radio Sales Corporation.	Scranton, Pa.
WRK	Doron Bros. Electric Co.,	Hamilton, Ohio
WRL	Union College....Schenectady, N. Y.	
WRM	University of Illinois....Urbana, Ill.	
WRP	Federal Institute of Radio Telegraphy.	Camden, N. J.
‡WRR	City of Dallas, Police and Fire Signal Department .....Dallas, Tex.	
WRW	Tarrytown Radio Research Laboratory.	Tarrytown, N. Y.
WSAA	B. S. Sprague Electrical Co.,	Marietta, Ohio
WSAB	Southeast Missouri State Teachers' College .....Cape Girardeau, Mo.	
WSAC	Clemson Agricultural College,	Clemson College, S. C.
WSAH	A. J. Leonard, Jr.....Chicago, Ill.	
WSAJ	Grove City College...Grove City, Pa.	
WSAL	Franklin Electric Co..Brookville, Ind.	
††WSAS	State of Nebraska, Department of Agriculture .....Lincoln, Neb.	
WSAT	Plainview Electric Co..	Plainview, Tex.
WSAV	Clifford W. Vick Radio Construction Co. .....Houston, Tex.	
††WSB	Atlanta Journal.....Atlanta, Ga.	
†WSL	J. & M. Electric Co.....Utica, N. Y.	
‡WSY	Alabama Power Co.,	Birmingham, Ala.
WTAC	Penn Traffic Co.....Johnstown, Pa.	
WTAS	George D. Carpenter. Elgin, Ill. (near)	
WTAU	Ruegg Battery & Electric Co.,	Tecumseh, Neb.
†WTAW	Agricultural and Mechanical College of Texas.....College Station, Tex.	
‡WTG	Kansas State Agricutural College.	Manhattan, Kans.
WTP	George M. McBride..Bay City, Mich.	
WWAC	Sanger Bros.....Waco, Tex.	
WWAD	Wright & Wright (Inc.),	Philadelphia, Pa.
WWAX	Wormser Bros.....Laredo, Tex.	
WWAY	Marigold Gardens.....Chicago, Ill.	
WWB	Daily News Printing Co.,	Canton, Ohio
WWI	Ford Motor Co.....Dearborn, Mich.	
††WWJ	Detroit News.....Detroit, Mich.	
WWL	Loyola University..New Orleans, La.	
WWZ	John Wanamaker..New York, N. Y.	

New Wave-Lengths For Broadcasting

To clear up the congestion in radio broadcasting, the Department of Commerce has ent out a new schedule of wave-lengths. which goes into effect on May 15th. Definite wave-lengths have been allotted to each of five zones into which the country has been divided, and broadcasting stations will have to adhere to these or else suffer the penalty of loss or suspension of license.

For the Class B stations, there will be en wave-lengths in each zone, and all of these vill be adjusted so as not to conflict with .ny other.

Of the ten wave-lengths assigned to Zone 1, which extends from New England through the District of Columbia, three of them, 405, 455 and 482 meters, have been assigned to New York City and Newark.

Other assignments of wave-lengths thus far in this zone are:

Springfield, Mass., and Wellesley Hills, Mass., 337 meters.

Schenectady and Troy, 380 meters; Philadelphia 509 and 395 meters, and Washington, 435 meters. Wave-lengths of 303, 319, 469 meters also are reserved for this zone.

Assignments in the other zones up to this time are:

Zone 2—Pittsburgh, 326; Chicago, 448; Davenport and Des Moines, 484; Detroit and Dearborn, 517; Cleveland and Toledo, 390; Cincinnati, 309; Madison and Minneapolis, 417.

Zone 3—Atlanta. 429; Louisville, 400; Memphis, 500; St. Louis, 546.

Zone 4—Lincoln, Neb., 341; Kansas City, 411; Jefferson City, 441; Dallas and Fort Worth, 476; San Antonio, 385; Denver, 323; Omaha, 527.

Zone 5—Seattle, 492; Portland, 455; Salt Lake City, 312; San Francisco, 509 and 423; Los Angeles, 395 and 469; San Diego, 536.

None of the wave-lengths go above 600 meters.

Besides the Class B stations, which broadcast to long distances, there are 540 Class A stations which use the 360 meter wave-length. These will be allowed to retain that wavelength or can come into a special band between 222 and 300 meters. If a new station is erected and it cannot meet the qualifications of Class B station, it will not be allowed to use 360 meters, but must go into the 222-300 band.

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.

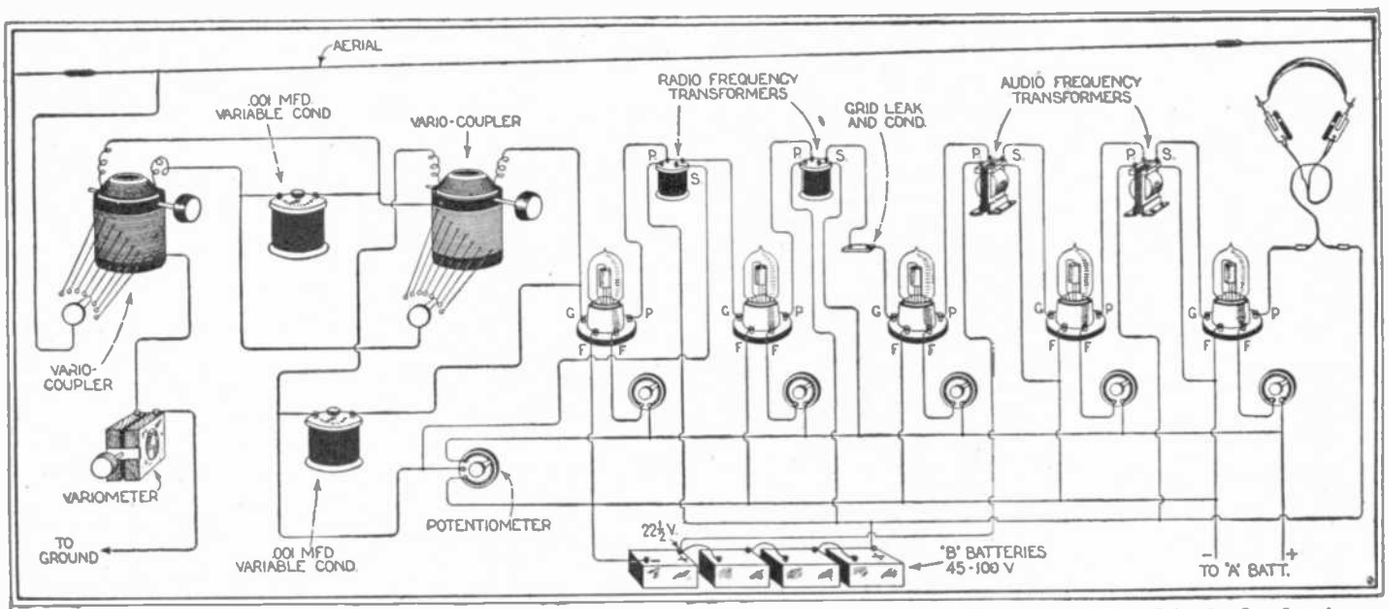
A SELECTIVE DX SET

(140) Frank Holut, La Grange, Ill., refers to the diagram of the set used by the first prize winner in our Radio Interference Preventer Contest and asks:

Q. 1. Can you give me a diagram of two stages of radio frequency amplification, a detector and two stages of audio frequency amplification used in connection with this tuner?

A. 1. We are giving in these columns a circuit diagram as requested. The tuning apparatus is the same as illustrated in our Interference Preventer Contest and is not regenerative.

Standard radio and audio frequency transformers may be used in this circuit and the potentiometer illustrated is absolutely necessary for efficient results.



A Five Tube Circuit Diagram As Requested By Mr. Holut Is Shown Above. The Tuner Is the Same As That Awarded First Prize In Our Interference Preventer Contest and Will Give Exceptional Results. Standard Transformers May Be Used Throughout This Circuit.

TWELVE-INCH SPARK COIL

(141) Edward C. Hanson, Quebec, Canada, asks:

Q. 1. What is the correct data for the construction of a spark coil capable of giving a 12-inch spark, and what is the required voltage for operating same?

A. 1. We give here the required data on a 12-inch spark coil. The core is 21 inches long and is composed of a cylindrical bundle of iron wires built up to a diameter of 1⅞ inches. The primary is wound with 3 layers of No. 10 D. C. C. wire, and over this is slipped an insulating tube with a wall ⅛ of an inch thick. The secondary is wound with No. 30 enameled or S. S. C. wire in 80 pies. Thirty pounds of wire will be required for this work. The primary voltage should be about 20 volts.

ADDITIONAL RECEIVING RANGE

(142) Edward Hesher, Decatur, Ind., requests:

Q. 1. Will one stage of audio frequency amplification increase the receiving range of a radio set?

A. 1. In some cases, signals are rectified by a detector tube, but are so faint as to be practically inaudible. In such a case the addition of one stage of audio frequency amplification will virtually add to the receiving range as it will bring into the range of audibility signals from distant stations which otherwise could not be heard.

LAYOUT OF PANEL

(143) C. R. Hill, Newark, N. J., asks:

Q. 1. Can you give me the lay-out for the panel of a radio set consisting of a standard short wave regenerative tuner employing a vario-coupler, two variometers and a detector tube?

A. 1. We cannot supply patterns for laying out panels for radio sets, inasmuch as almost every amateur desires to use different makes of apparatus. We could advise you to decide upon what kind of a set you wish to have and then to purchase all the apparatus necessary. Lay this out on your panel and re-arrange it to suit your own taste. Then you can go ahead and drill the panel and you will have a set of your own design. If you desire, you can place the binding posts upon hard rubber or bakelite strips mounted perpendicular to the base on its back edge. With this you can have all the connections made back of the panel.

Q. 2. Why is an aluminum sheet used in the rear of some radio panels, and how thick should the same be?

A. 2. The idea of the aluminum shield against the back of the panel is to shield the instruments from body capacity. The aluminum need not have any particular thickness, but may be of any thickness you may happen to have on hand or can readily purchase. Copper or tinfoil is widely used.

SETTING UP A LARGE RECEIVING SET

(144) J. F. Hathaway, Akron, Ohio, says that he has constructed a set similar to one appearing in our June issue, but his results have not been very good. He says he has checked the circuit carefully and can find no mistakes. He asks:

Q. 1. Can you give me any help towards obtaining good results with this set?

A. 1. Before setting up a receiving outfit of the size you mention, it is always advisable to test each piece of apparatus separately for short or open circuits. Such may be the trouble with your set, but it is practically impossible for us to say whether or not it is, because we do not have complete information on your results. It may be that your vario-coupler or variometers are not designed correctly, or that your antenna inductance is not of the correct value. If your condensers have fibre ends, you no doubt are losing considerable energy there by leakage.

If you used acid soldering flux in connecting up your set, you may find that the flux has caused high resistance shorts in your radio frequency amplifier, which results in their being unable to operate efficiently. We would advise you to look into the above items.

REMAGNETIZING HEAD PHONES

(145) George Koci, East St. Louis, Ill., asks:

Q. 1. How can I remagnetize the magnets of my radio receivers which have lost their strength?

A. 1. We would advise you to send your radio receivers which have lost their magnetism back to the manufacturers, who are fully equipped to restore the strength of the same.

Q. 2. Can shellac be employed on radio sets? Can iron parts, such as brads and screws, be used in making the sets?

A. 2. Shellac may be used in making radio sets, but there are several disadvantages in the use of iron parts. They influence the magnetic fields of the various instruments, sometimes to the detriment of the receiving qualities. Also, where these iron parts carry radio frequency current there is a loss due to the high skin resistance.

Q. 3. Can a six volt automobile generator be used for lighting the tubes in a radio set?

A. 3. If you attempt to use your six volt generator to supply the potential for lighting the filament of an audion bulb, you will encounter serious trouble from the hum produced by the generator.

RECEIVING RANGE

(146) John C. Kane, Mt. Pleasant, Mich., asks several questions regarding the receiving radius of radio sets, such as detector alone, detector and one step amplifier and detector and two step amplifiers.

A. 1. The editor of this department respectfully requests that readers do not ask questions of this nature. As has been stated many times in past issues of this magazine the receiving range is such a variable quantity that it can only be guessed at. Numerous factors enter into the estimation of the receiving range for each individual case, which are impossible for us to know. Therefore, we will have to refuse in the future to give any guesses at such ranges. With one detector tube alone an amateur situated in a certain position might be able to receive stations only within the radius of thirty-five miles, while another operator in a different locality might, with the same set, receive over a thousand miles.

The only way to get any kind of an answer to this question is to put up a set and try it out.

FADING

(147) Carl Kirkwood, Summerland, Calif., wants to know:

Q. 1. Can you tell me what is wrong with my radiophone receiving set; when I tune in a station the music will come in loud, only to fade out until it cannot be heard and then will come in loud again? This keeps up all through the program.

A. 1. The trouble you mention is due undoubtedly to what is known as *fading*, and for which practically no remedy has yet been found.

However, various types of receiving sets are affected in different ways by fading, and you may find that by changing your particular type, you may eliminate the trouble. The addition of one or two stages of radio frequency amplification will in most cases also assist.

AERIALS

(148) Henry Jarvis, Jr., Glasgo, Conn., asks:

Q. 1. Will an indoor aerial located in my attic be a lightning hazard?

A. 1. An antenna located in such a position will incur no danger from lightning.

Q. 2. In a multi-wire aerial should all the strands be connected together at both ends or only at one end?

A. 2. If you use an aerial with several strands of wire, only one end of the wires need be connected together, and a lead-in taken from the connection to the radio set.

A. C. ON TUBES

(149) F. A. Jewell, Henderson, N. C., requests:

Q. 1. Can you tell me where I can get complete data on the construction of the transformer necessary for use in connection with the five tube set developed by the Bureau of Standards which operates on A. C.?

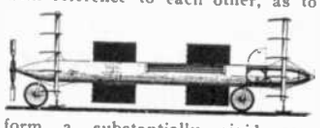
A. 1. Complete data on the transformer you mention appeared in the September, 1922 issue of SCIENCE AND INVENTION on page 469.

LATEST PATENTS

Aircraft

(No. 1,427,314, issued to George Francis Myers)

A combined aircraft body and radiator so constructed and arranged with reference to each other, as to

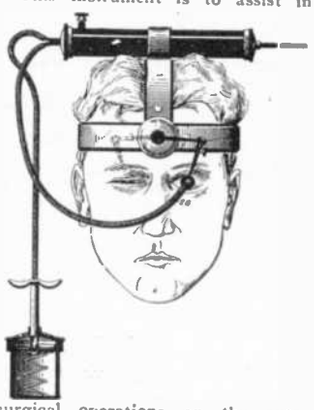


form a substantially rigid construction, and to minimize their combined resistance through the air without impairing the efficiency of the radiator as a cooling agent, is embodied in this patent. This radiator, for use in cooling the water of a gasoline engine, comprises two manifolds of crescent form, arranged one in front of the other in the upper part of the body within the covering, the upper part of one of said manifolds being connected with the outlet pipe of the engine cooling system, and the lower part of the other with the inlet. Automatic doors for the aviator which are normally closed but may be opened for determining location, etc., and a manually controlled stabilizer are also claimed.

Surgical Device for Optical Operations

(No. 1,441,754, issued to Ernest E. Sanders)

This instrument is to assist in

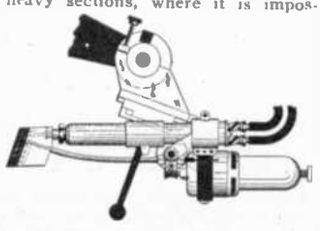


surgical operations on the eyes, whereby the eye-ball is held against movement, or may even be retracted by means of a suction socket instead of the usual pressure method of holding the same. The suction will tend to keep the vitreous humor within the eye instead of tending to expel it. It will be seen in the diagram that a head gear is strapped to the patient to be operated upon. Suspended from this is a suitable holder which grasps the vacuum cup. This holder may be drawn away from the patient, or may assume any desired position, the adjustment being made by a micrometer screw. Because of this micrometer adjustment, undue strain will not be brought to bear upon the muscles of the eye.

Autogenous Welder

(No. 1,438,285, issued to James L. Anderson)

In hand welding of comparatively heavy sections, where it is impossible to secure sufficient thickness of metal in the weld, it has been customary to add metal to the seam while in fusion from the end of a wire or rod melted by the flame of the single jet tip. In this device a tip having chambers and jet passages for oxy-acetylene, is also provided with a channel through which wire passes to the region immediately adjacent to the ends of a seam to be welded, preceded and followed by the welding jets.



Sex Calculator

(No. 1,428,065, issued to Hubert Royds Tidswell)

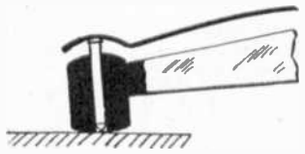
This sex calculator comprises a

series of scales which are to be set by the user, in an effort to determine the sex of the offspring. The inventor presupposes that a certain sequence of ovulation is followed, and bases his patent on this surmise, claiming that the theory is proven. As a matter of fact, in 1887 no less than two hundred and sixty theories on such predeterminations advanced prior to that time were compiled, proven and then disproven again. It is our opinion that the theory upon which this patent is based, is no more infallible than any of those two hundred and sixty to which we refer. The device consists of two or more parts on which are marked the months of the year with suitable subdivisions. The time of ovulation and the nature of the sex is likewise indicated. Means are provided for moving the parts relative to one another.

Recorder

(No. 1,438,829, issued to Fred B. Howell)

For recording pressures the improvement embodied in this patent, is of interest. In adapting such an instrument to a test railroad tie for recording the forces acting upon a rail as the locomotive passes over it, the instruments heretofore caused irregular markings due to the sudden pressure brought to bear and

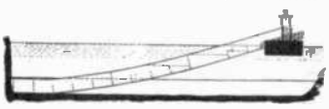


which they had to register. In this invention, the recording arm is pressed against the record with a comparatively large force. The recording arm does not rigidly support the stylus but contacts with the record sheet on a smooth hard surface, such as steel. Such an arrangement enables the recording arm to slide over the record sheet with comparatively little friction. The recording stylus is carried in the recording arm in the form of a slender needle, preferably of brass coacting with a record sheet made of paper having a metallic coating, and although the pressure on the recording arm may become great, the pressure of the needle may be so adjusted as to be extremely delicate and sensitive.

Tunnel Construction

(No. 1,441,698, issued to James C. Meem)

In order that subaqueous tunnels may more easily be built, this meth-

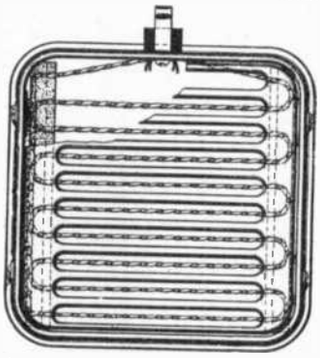


od is proposed. The tunnel is built on a floating barge in the form of a shell, which may be of wood or steel, and there is added thereto interior trussing means, such as precaste concrete ribs spaced sufficiently apart from each other to allow for flexibility. One end is sunk in place, and the remainder of the tunnel is continued, section after section being added to the one already sunken, by attaching it thereto and paying it out as the barge moves ahead. The tunnel rises in a gradual curve to its place on the permanent construction barge; it becomes very easy to continue building the same. The rocking cradle which does not permit bending to less than two thousand feet radius, is used to slide the continuously constructed tunnel to the bottom of the waters.

Heating Element

(No. 1,438,424, issued to Charles C. Armstrong)

An improved arrangement of resistance element over the usual

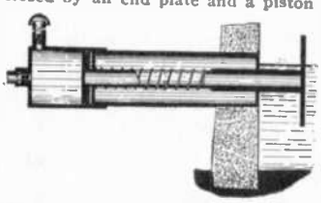


device, is embodied in this patent. In this system parallel slots are cut into the faces of the insulating members, thus forming upstanding projections. The resistance element coming from the current fixture, socket or plug runs back and forth between the end members passing around the projections. Thus each plane of heating element is independent of the other. Such a construction is beneficial as either element may be removed without disturbing the other. The arrangement of the element around projections instead of passing around end members, effects a material saving in the length of the resistance element, without reducing the effectual heating area.

Wave Motor

(No. 1,439,984, issued to Charles S. Talbert)

A cylinder is so mounted that it projects rearwardly and horizontally from the sea wall. Its front end is closed by an end plate and a piston

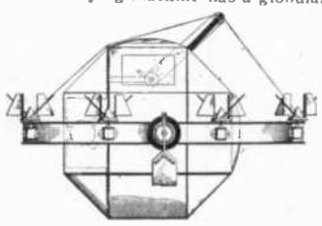


rod passes through this end plate terminating in a large surface against which waves are to act. Valves are arranged within the piston, so as to provide for the compression of air or other fluid. A spring is mounted on the piston rod, so as to bring back the piston and the external abutting surface on which the waves act to the original positions. It will be seen, therefore, that the impact of the waves will cause the piston to move again, compressing the air contained in the cylinder, which air can be used for driving motors.

Flying Machine

(No. 1,435,235, issued to William S. Hull)

This flying machine has a globular

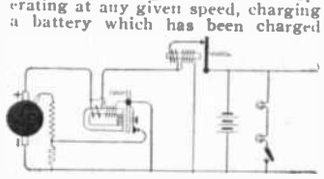


body, a flat bottom and side walls. On the walls are mounted a number of adjustably mounted propellers carried on a ring, so that the relative positions of the propellers with respect to the body, can be changed for causing the machine to travel in a vertical direction, in a horizontal direction or at an angle. The screws are claimed to be so disposed, that when in operation they cut out the air in front of the car and discharge it backward, so as to allow the force of the atmospheric pressures to be exerted against the under sides and rear end of the body, forcing the machine forward. The inventor says that he has found that if he is able to create a partial vacuum in front of the car, which he claims he does by means of these screws, the car would rise much more easily. Any type of driving mechanism may be employed.

Electric System for Vehicles

(No. 1,440,879, issued to Thomas L. Lee and Raymond H. Sullivan)

In an effort to overcome present charging methods for storage batteries in automobiles, the inventors have provided a three brush generator, in which a shunt field winding is connected between one or more of the main brushes and one or more auxiliary brushes are interposed between the main brushes. Assume such a generator to be operating at any given speed, charging a battery which has been charged



to any given degree, and has attained a corresponding electromotive force. If the resistance of the charging circuit be increased by increased heat in the battery, the voltage across the generator terminals increases. In such a system, while the condition of the battery as to charge, cannot be gauged by the voltage alone, it can be gauged by reference to the related variation of both voltage and current. The charge controller is a relay having a voltage winding of high resistance, connected across the generator terminals, and a current winding of low resistance connected in series with the generator and the battery and in opposition to the voltage winding.

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.

INVISIBILITY

(1477) Charles Portanier, Valletta, Malta, asks:

Q. 1. Can you give me data on any methods whatsoever of making a person become invisible?

A. 1. If you have an audience before you and can hypnotize this audience, it is a relatively simple matter to suggest to them that you are becoming invisible, and finally that you are invisible. Under the hypnotic spell, they will be unable to contradict, and when they come out of it, they will believe that you have actually become invisible.

Magicians today use a method of becoming seemingly invisible, which make use of the fact that the color of their costumes, skin, etc., blend with the surrounding colors. If, for instance, they are covered completely with orange materials standing against an orange background and an orange light be projected upon them, they automatically become invisible. If they stand behind a bank of flood lights, the flood lights being thrown toward the audience, they also fade from view. Draping the body in black against a black curtain, renders it invisible to the audience. If a performer is now completely clothed in black with his head and arms uncovered, and the entire theatre is thrown into darkness, a purplish light thrown upon the performer's face gives him a very weird appearance. Concealing the body behind mirrors is often used for becoming seemingly invisible.

FILTERING LIGHT AND HEAT WAVES

(1478) Wilson Post, New York City, refers to the filter experiment described on page 246 of the July, 1922, issue of SCIENCE AND INVENTION, and asks the following questions:

Q. 1. How long will the iodine and carbon disulphide solution last, and will light have any detrimental effect upon the same?

A. 1. The iodine and carbon disulphide solution will last indefinitely if kept in a bottle and tightly corked. The light will have practically no detrimental effect upon the same.

Q. 2. Do you know of any chemical that will have the reverse result, that is, that will absorb the heat rays and permit the light rays to pass through?

A. 2. A bottle filled with solution of alum in water will absorb quite a good percentage of the heat rays and the water itself becomes heated.

You might try a series of interesting experiments along this line, using the above facts as a basis. At any time you may be sure of our assistance in any matters of this kind which may puzzle you.

AUTOMATIC GAS LIGHTER

(1479) O. Riddel, Chicago, asks:

Q. 1. What is the substance used on gas jets so that the latter is lighted automatically when the gas is turned on.

A. 1. If a piece of platinum sponge is placed over a gas jet, so that when the same is turned on, the gas will come in contact with the sponge, the sponge will become red hot, and cause the gas to ignite. The sponge is apt not to last very long if left in this position, consequently it should be removed as soon as the gas is lit.

Q. 2. How are selenium cells connected to detect a fire?

A. 2. We believe that the idea you have in mind for connecting selenium cells so as to detect fire is that the light of the fire will lower the resistance of the selenium cell, which in turn will close the circuit through a relay and sound an alarm. This, however, would not make a very good fire alarm because of the fact that so many selenium cells would be necessary to cover all the spots at which a fire might start and it would take a very bright fire to cause them to function. However, you could connect a selenium cell in series with a battery and a relay. The contacts of the relay are then connected in series with another battery and a gong or other form of alarm.

Q. 3. Kindly give me the equations involved in Ohm's laws applied to power calculations.

A. 3. The following are the equations which you request:

V times A equals W
W divided by A equals V
W divided by V equals A

In which V equals voltage, A amperage and W wattage.

WOLLASTON WIRE

(1480) Fred P. Roman, Halifax, Canada, asks:

Q. 1. How is Wollaston wire made?

A. 1. This wire is made by plating a platinum wire with a heavy coat of silver, and drawing the same out to a very small diameter. In this way the platinum wire inside is drawn out to almost infinitesimal size, subsequently the silver is dissolved by nitric acid.

SOMETHING FOR NOTHING

(1481) Minter Wherritt, Pleasant Hill, Mo., wants to know:

Q. 1. Is there any possible way in which an object can be moved without the person moving it doing any work whatsoever, in the true sense of the word?

A. 1. No matter how you attempt to move an object, you will always have to perform a certain amount of work, even though the object be perfectly balanced upon bearings and otherwise arranged so that friction is reduced to a minimum and may be treated as zero value. This work, of course, may be very light, but nevertheless it is still work, and can be measured.

RECTIFIER TROUBLE

(1482) C. B Noe, Jackson, Mich., states that he has constructed a rectifier such as described upon page 155 of the June, 1922, issue of SCIENCE AND INVENTION. He wishes to use it to charge a 6-volt, 60-ampere hour storage battery, but states that he does not obtain enough current to do this work. He asks:

Q. 1. Can you tell me what is wrong?

A. 1. The reason you do not get enough current through your rectifier is because you have too high a resistance in the 110-volt circuit. You should use eight carbon filament or other type of lamps which consume one ampere each and connect them in parallel. The entire set is then connected in series with one side of the A. C. line. This will allow the rectifier to deliver about 8 amperes.

ALUMINUM SOLDER

(1483) Max Van Arsdol, Fort Wayne, Ind., asks:

Q. 1. Can you give me a formula for a solder which can be used to join together pieces of alumirum?

A. 1. A solder for aluminum which does not require the use of flux, may be made as follows:

Silver 2%
Aluminum phosphide 9%
Tin 39%
Zinc 50%

The surfaces to be soldered are first scraped clean, then tinned with the solder itself. The surfaces may be cleaned by dipping them in a solution of nitric acid in three times its bulk of hot water, containing about 5% of commercial hydrofluoric acid.

WEHNELT ELECTRODES

(1484) W. B. King, Denver, Colo., wants to know.

Q. 1. Can you tell me what Wehnelt electrodes consist of and where they can be purchased?

A. 1. These electrodes consist of platinum wires encased in porcelain tubes, the ends of the wire being bared. We do not know of any book dealing with the construction of these electrodes only, but can supply upon receipt of a stamped self addressed envelope the names of companies from whom they may be purchased.

CUTTING BRASS WITH AN OXY-ACETYLENE TORCH

(1485) E. J. Kenner, Somerville, N. J., asks:

Q. 1. Can an oxy-acetylene torch be used for cutting thick sheet brass in the same way that it is used for cutting steel?

A. 1. We have obtained the following information on the cutting of various metals with the oxy-acetylene torch, from one of the leading companies of New York using this process. All kinds of steel can be actually cut with the oxy-acetylene torch. Other metals that are drawn can be cut in the same manner. This includes brass, copper, iron and other metals. These latter, however, if cast, cannot actually be cut by the flame, but the point at which the flame is applied will melt, and by a continued process of melting along the desired line, a result will be obtained somewhat similar to the cutting, but the work will have ragged edges

COLD CREAM AND SOAP FORMULAS

(1486) W. C. King, Vancouver, B. C., Canada, asks:

Q. 1. Can you give me a formula for making a greaseless cold cream?

A. 1. We are giving you herewith the formula for making a greaseless cold cream.

Stearic acid (stearin)....2	oz.	av.
Sodium carbonate, pure..1¼	oz.	av
Borax powder 1¼	oz.	av.
Glycerine 4	fl.	oz.
Water 32	fl.	oz
Oil of rose.....20	drops	
Heliotropin 20	gr.	
Alcohol 4	fl.	oz.

Mix all the ingredients except the perfumes and alcohol together, and heat on a water bath until effervescence ceases. Remove and stir at intervals until the mixture begins to stiffen. Then incorporate the aromatic substances dissolved in the alcohol. Beat thoroughly with a paddle or egg beater. It may be made more creamy by re-heating and beating it again. There is very little difference between the greaseless cold cream and the so-called vanishing cream, and the above preparation will do for either.

Q. 2. Can you give me a formula for making white pumice soap?

A. 2. You may make a white pumice soap as follows:

Cocoanut oil 20	parts
Tallow 4	parts
Soda lye (38-40° Baumé)...12	parts
Phenol 1	part

Prepare the body soap by stirring the liquified fat into the lye at 113° F., and when the two have combined, incorporate the phenol and any desired amount of ground pumice. Stir quickly and pour into the molds. The amount of pumice will depend upon your own personal taste as to whether you require a large or small quantity.

Magic for Everybody

By PROF. JOSEPH DUNNINGER

(*Continued from page* 141)

After the genuine and inspected rope is passed through the opening of the post it is caught in the bayonet catch and carried down over the pulleys and into the post proper. The duplicate is drawn from out the post and carried through the unprepared post so that the trick-joint is brought to a point directly in front of the performer. When the cloth is held up before him so as to obstruct his action from view he has but to open the trick joint with his hands, pass before it and again close it behind him. He has to all appearances passed through the rope. As the rope is drawn out of the posts, the mechanical action is reversed and the duplicate or trick rope is once more drawn into the post and the original one brought to view.

Bank-Note Trick: The mind-reader and the assistant enter. The lecturer or the assistant requests a bill or bank-note from anyone of his many spectators. He explains that codes or forms of mechanical communication are out of the question as the mind-reader will call all the numbers upon the bill without one word of conversation prior to the calling. This, the lecturer asserts, eliminates all suspicion as to verbal communication. The lecturer holds the bill between his fingers, and at once the mind-reader mysteriously calls the exact serial numbers thereupon. The mind-reader, of course, stands at a distance of some twenty or thirty feet away from his assistant.

Now for the explanation; the diagram makes all clear. A signal finger system is employed. The entire code is disclosed in the drawing. The reader will understand that the lecturer during the action of deep concentration is quite naturally handling the bill and is secretly signaling the information to the mind-reader unawares.

Scientific Problems and Puzzles

By ERNEST K. CHAPIN

(*Continued from page* 142)

is approximately one calorie per gram per degree Centigrade, that of air 0.24, etc. On calculating the amount of heat that would be liberated by various substances on cooling from their respective temperatures to the temperature of melting mercury (—39 C.), it develops that the four cubic feet of air in the baking oven would liberate about 8,500 calories, the red-hot pound of iron over ten times as much, the room at 90 C. nearly 80 times as much, and the cubic foot of boiling water about 600 times as much. The amount of heat which would be liberated by the ice on a frozen lake on cooling from, say zero Centigrade to —39 C., would depend upon the quantity of ice present, but certainly the amount of heat would be thousands, yes, hundreds of thousands of times greater than that of a cubic foot of boiling water, for it would take but eleven cubic feet of ice to yield the heat equivalent of the boiling water.

A QUESTION OF WEIGHT

Since cream floats on milk, its density is obviously less than that of milk. Hence a pint of cream weighs less than a pint of milk.

THE FLYING BIRD AND THE FLOATING STICK

No change in weight will be noticed in either of the cases mentioned. The weight of the flying bird is transmitted to the floor of the case by the downward beating of its wings which is necessary to support it in the air. The weight of the floating stick is transmitted to scales through the medium of the water.

THE SLIDING ROPE

The acting force on the rope at any instant is evidently equal to the weight of the rope hanging over the edge of the surface. Then, since the mass of the rope is constant, the acceleration produced in it is directly proportional to this acting force. If the force on the rope were constant the acceleration would be constant as it is for a freely falling body, but, as the force is increasing all the time, as more and more of the rope passes over the pulley, we can see that the acceleration must increase. However, there is evidently a limit to this, for by the time the last of the rope has passed over the pulley its acceleration will be constant and equal to that due to gravity. Thus it is apparent that while the force of acceleration of the rope must start at zero and increase until all of the rope is free of the surface, the rate of change of acceleration will be maximum at the start, get less and less, and finally equal zero the instant the last of the rope is clear.

THE BALLOONIST

As soon as the body of the pilot reached the surface of the water the buoyant force of the water relieved the balloon of some of his weight and thus checked its descent until the pilot had been rescued. Of course, the balloon was still leaking and the pilot was slowly sinking, but it required a very considerable leakage to make him sink very far, the buoyant force of the water being so much greater than that of the air.

Light Beams Measure Ocean Depths

By EDWARD H. LONDON

(*Continued from page* 129)

light through the air, but in water we encounter much greater difficulties.

An experiment in projecting a beam of light through the water was tried by the Sperry Gyroscope Company. Here a three-foot Sperry projector capable of developing three hundred million candle-power, was placed in a large tank, having a two-inch plate glass window in it and also housing an observer to determine the amount of penetration. Mr. P. R. Bassett of the Sperry staff recounted his experiences in this connection. The searchlight beam projected out to sea for many miles. As the structure was lowered it seemed as though part of the beam was chopped off and that below the water level was much shortened, as shown in the illustration at 3. Looking at the tank from the top, one could see that the rays of light were being dispersed in the water about forty feet in front of the tank, whereas the top half of the ray not below the water level, projected outward an indefinite distance, see 4. When the tank in which the searchlight was housed was completely submerged, the light rays stopped in some cases but fifteen feet from the tank, and in others not more than thirty-five feet from their point of origin. It was strange to note that the beams of light were so completely dispersed that they enshrouded the tank in a complete ovoid of light, so that there was as much illumination on the back of the tank opposite the egress of the light beam as there was at any other point, see 5. When the tank was lowered to a depth of thirty feet, the water became greenish in color, but one could not see the path of the light beam. Visibility from the tank itself in some places was not greater than twenty feet.

The reason that this experiment was tried, was that a certain inventor proposed placing searchlights in the front of submarines so that they could see when they were running into a submerged bomb or net. It is evident, therefore, that the invention of Captain John Hurns, whose photo we show in the act of looking through a bubble sextant, which has nothing to do with the apparatus mentioned, may be good for plotting depths of water which do not extend beyond the limit of visibility with the type of lights he employs.

Practical Chemical Experiments

(*Continued from page* 138)

tated. Violent shaking will cause this to collect, leaving the liquid almost perfectly clear. This is filtered off and washed well with water. It can afterward be mixed with dry sodium carbonate and the mixture of the two heated on a charcoal block with a blowpipe flame, resulting in the formation of pure metallic silver.

How to Build a Wind Power Motor

(*Continued from page* 144)

[*It may be interesting to note that in a twenty-five mile wind, an eight foot windmill will develop* 1⅓ *horse-power. With a lower wind pressure, such as that of a gentle pleasant breeze of five miles per hour, the eight foot windmill develops* .011 *horse-power. With a wind at ten miles per hour this same mill will give* .088 *horse-power. A very brisk wind at twenty miles per hour, will with the same mill develop* .7 *of a horsepower; and with a high wind of thirty miles an hour, we can obtain more than two horse-power from such a windmill. A* 12 *ft. mill will develop* 1.6 *H. P. with a* 20 *mile wind; and a* 16 *ft. mill will give* 1.2 *H. P. with but a* 15 *mile breeze.*—ED.]

Doctor Hackensaw's Secrets

By CLEMENT FEZANDIÉ

(*Continued from page* 123)

ing, when you consider the losses of heat that occur at the incredibly high temperature I am obliged to use to decompose the lead. I have to use all kinds of devices to prevent loss of heat, and I make the cooling gases impart their heat to the new gases whose temperature is to be raised."

"What material do you use to resist these high temperatures?" asked Silas.

"Ah, that was indeed a difficult problem to solve," replied the doctor. "Given a heat sufficiently high to decompose *any* substance, I had to find some substance that would not be decomposed by the heat."

"Why, that's an utter impossibility!" cried Silas.

"It would seem so," said Doctor Hackensaw, chuckling. "Nevertheless I solved the problem, and it isn't the first impossible problem that has been solved, by any manner of means."

"But what in the world did you do?"

"My solution was really a very simple one. I made use of a portion of the very gas I was decomposing, to serve as a container for the portion that was being decomposed. For example, in decomposing lead, I first vaporize the lead, and then gradually heat this lead vapor. At the final stage of the process this vapor passes in a slow stream between the two electrodes that carry the electrical current. The resistance to the current, offered by the gas, raises the central portion of the stream of vapor to a temperature high enough to decompose it, but the outer portion of the stream is not decomposed. The decomposed portion, owing to its lightness, rises very rapidly and can thus be separated from the other portion, which is led back and fed through the electrode with the new lead vapors."

"But don't the electrodes themselves melt?"

"No, the heat there is not so intense. Besides I use special means to refrigerate them, utilizing the heat itself for the purpose of cooling them."

"By the ammonia process?"

"No. The evaporation of ammonia to produce cold is too clumsy a method for use in my furnace. I produce cold electrically. You probably know that, by heating two dissimilar metals, you can produce electricity. It is also possible to produce cold by passing an electrical current through two such metals. But to return to what I was saying. In these experiments of mine I struck a new and altogether unlooked-for obstacle. I had not reckoned on the isomeric and allotropic forms of my products."

"What do you mean by "isomeric" and "allotropic"?

"It often happens, especially in organic compounds like the sugars and alcohols, that two entirely dissimilar substances have nevertheless exactly the same chemical composition,—they are made up of the same elements in the same percentages or relative amounts. The arrangement of the elements in the molecule appears to be what causes the difference in the compounds. Such compounds are called 'isomeric.' 'Allotropy' is precisely the same thing, but applies to our so-called 'elements.' Thus the diamond, graphite (what you call the lead in your lead-pencil), and charcoal are all nothing but different forms of carbon. As what we call 'elements' are really compounds, the inference is that here, too, the arrangement of the entities that compose the element differs in some way."

"Well?"

"Well, to return to what I was saying, After I had decomposed some substance, say carbon, by subjecting it to a heat so intense that after changing it first into carbon dioxide and then forcing the atoms of carbon and of oxygen to separate and finally be decomposed, I found that my carbon when it recombined, sometimes cooled in the form of graphite, sometimes as diamonds, sometimes as charcoal—almost always the latter. And I discovered in this way many new, hitherto altogether unsuspected allotropic forms of the elements. It was only after much experimenting that I learned how to produce the form I sought."

"How do you accomplish it?"

"It would take too long to explain in detail. But I depend principally on 'catalysis'."

"Catalysis? What's that?"

"In chemical experiments we often find two substances which, when placed together, have no effect on each other. If, however, we introduce a third substance into the mixture, chemical combination takes place, and yet the third substance is unchanged at the end of the operation. This is called 'catalysis.' Sometimes the third substance acts mechanically. In all true catalysis, however, the third substance is really decomposed and re-composed a number of times. It takes something from one of the two substances and gives it up to the other. By the introduction of such catalyzers into my cooling carbon I found I could force the entities, that composed the atoms, to cool in the form of diamonds, of graphite, or of carbon, whichever I wished. I have some specimens of diamonds that I shall show you, obtained in this manner, that are larger than ostrich eggs, and yet perfect in every respect."

"Is it possible!" cried Silas, with dilated eyes.

"To me," continued Doctor Hackensaw simply, "these diamonds are interesting merely from a chemical point of view. My interest is chiefly centered on my radium. I find I can manufacture my radiobile engines at very low cost. The one-sixth horse-power size, (i. e. a tube containing one gram of radium), is useful for ordinary household work, running a sewing-machine or phonograph, etc. If a higher horse-power is wanted, for a vacuum cleaner or for cooking and lighting purposes, the heater attached to the tube must be used. I have a patent device by means of which the radium may be made to heat itself."

"Heat itself?"

"To be sure. In my earlier experiments I used an acetylene burner to heat my radium whenever I wished to increase the horse-power. Then it occurred to me that it was foolish not to use the energy of the radium itself for the purpose. The stream of radium emanations could be easily reflected back upon the tube and produce the degree of heat required. This leaves my radium engine so compact that it can be carried in my vest pocket. There is one that I always carry around with me, and which fits any of my automobile or airplanes, my motor boat, my drills and other machines, my electric lighting and heating arrangements. In fact, these six grams of radium are really a hundred horses that I carry around in my pocket, ready for use at any moment."

Silas Rockett took the small metal tube handed for his inspection and surveyed it gingerly.

"Isn't it rather dangerous to use?" he asked at length.

"No, it is fool-proof. The tube is made of a metal absolutely impervious to the emanations. It can only be opened by a special key which fits into this keyhole. I

never manufacture a loose key, but always have the key cast *in* the automobile or other apparatus which the engine is to run, as an integral part of it. Consequently the tube can only be opened by placing it in the proper socket in the automobile and then giving it a turn. This turn locks the tube into the automobile at the same time that it releases the emanations. But these find themselves shut in by a valve in the auto which the driver opens or closes at will to let on or shut off the power. The driver has also control of the heating attachment and can with a six gram engine obtain any range of power from nothing to one hundred horsepower at will, and can use this power not only to run the car, but to heat and light it, or even work an electric fan to keep the flies off the baby. No gasoline, no spark plugs, no cranking, no batteries, no noise, no fuses. The machine is so quiet that I fear I shall have to attach sleigh-bells to it to warn people of its coming. In war-time, however, a quiet airplane will be a great advantage.

"By the way, speaking of war reminds me that I am taking along with me some new gas-bombs to test out. Gas-bombs will certainly be used in future warfare and it seemed to me that a humane gas could be found which would incapacitate the enemy for the time being, yet cause none of the atrocious sufferings or injurious after-effects of the chlorine and other war gases. My *snap-on gas masks*, too, are a great improvement on the ordinary masks. They can be snapped on in one second."

* * * * * * *

"It's a great pity, doctor," said the landlord of the inn. "Tonight the *White Caps* are going to tar and feather that young couple that's just come here. They're believed to be the ones who set fire to Smith's house, but, to tell you the truth I think they're innocent."

"Why doesn't the sheriff prevent them?"

"Him? Why the white-livered skunk, knowing there would be trouble, has gone to the next township so as to wash his hands of any responsibility. You can see the fire in the woods from here. They're melting the tar and getting thing ready."

"Come along, Silas," cried the doctor. "Jump into the radiobile. We two have got to take a hand in this business!"

The radiobile was a somewhat clumsy looking machine. The body resembled that of an airplane. The wheels were light like bicycle wheels and could fold up under the car when the legs were used. The legs were long and joined at the knee. They resembled the trestle-work of a bridge, and were built of triangular units, the triangle being the strongest unit possible for such work. A square unit can be pulled or pushed into the shape of a rhombus, but a triangle will give in no direction.

In order to avoid danger from the radium emanations, they were changed into helium gas before being allowed to escape from the machine, and hence could not harm anyone. In fact, the helium gas, owing to its lightness, rose high in the air as soon as released.

There was no trouble in finding the spot where the mob were assembled. In the dusk the fire was visible several miles away. The spot chosen was an open field near some large woods. A crowd had already collected, and automobiles, carriages, motorcycles and bicycles were visible in large numbers.

"You've undertaken a pretty big contract, doctor!" said Silas, setting his teeth together. "If, as I imagine, your intention is to save the young couple, you'll have no easy job. Besides we could never escape from those autos and motorcycles!"

The doctor made no reply. He pressed down the lever that let down the four legs of the machine and that simultaneously folded the wheels flat under the car. The

radiobile now walked at a rapid rate, its legs being lifted alternately by revolving eccentrics.

The machine left the road and approached the fence that bounded the woods. A quick shift of a lever transferred a weight to the rear of the car lifted the front legs of the machine over the fence. Another shift and down they came on the other side. A reverse operation brought the hind legs over. The machine had stepped over the fence with the greatest ease, and was now climbing a very steep hill, for the four hollow rubber balls which had previously served as feet, were pushed aside to make room for sharp points which dug into the turf and would have pulled the machine up an incline of more than forty-five degrees.

"Now, Silas," said Doctor Hackensaw, "We'll leave the machine here on the edge of the woods. Take two gas masks with you and two bombs. Get as close to the girl as you can. I will attend to the man. When I give the signal, throw your two gas bombs into the crowd, and I will do the same. Then get the gas-masks on yourself and the girl as quickly as you can, and meet me at the car."

As the pair approached the mob, it was evident that the young couple had just been given a mock trial while the tar was being heated. A young ruffian had been chosen for the judge, and he now pronounced sentence:

"Guilty, both of them! I sentence the man to three dozen lashes on his bare back, and then we'll hang him to the nearest tree. As for the girl, we'll only give her ten lashes, and then we'll tar and feather her and ride her out of the township on a rail!"

At the words, a great shout went up from the mob, and a dozen willing hands tore off the man's coat and shirt. The girl, too, was stripped to the waist in a twinkling.

Doctor Hackensaw's blood boiled. He saw there was no time to lose, and pushing forward, he shouted to Silas: "Now!"

The four gas-bombs exploded with a single deafening report. The crowd fell back in alarm except one tattoed brute who was holding the struggling girl. But Silas sent the fellow sprawling with a well-directed blow of his fist.

By the time the crowd, sneezing and sputtering, realized what was happening, Silas and the doctor, with the rescued pair had reached the radiobile and were hastening along the lumber-road in the woods to the main road a mile distant. They had not gone far, however, before a chugging of autos warned them that pursuit was at hand. Luckily they reached the cross-road before their pursuers, so the chase was behind them.

Escape seemed possible for a time, and then it became evident that some of the pursuers were catching up. At the same time a dozen autos appeared in front of them and blocked the road.

"It's no use, doctor; we're done for!" cried Silas. "We're hemmed in, in front and behind!"

"I'm afraid that's the end, sir," observed the man. It was kind of you to try and save us, and I swear to you we are both innocent. Mitzi and I will get out of the machine, and you two gentlemen may then be able to escape."

"Sit right where you are!" cried the doctor. "We're not lost yet." With the words he pulled a lever, and some concealed wings opened out like a fan, and a propeller appeared as if by magic at the back of the car. The machine was really a combined auto and airplane.'

They rose rapidly from the earth, and a few shots that went wide of the mark showed how narrow had been their escape.

But even now the danger was not at an end. Three or four of the lynching party owned airplanes, and a few minutes later, three of the machines could be seen in pursuit. And what was worse, the pursuers were gaining upon the doctor's party.

Doctor Hackensaw's face clouded. Then suddenly he gave a cry of joy. "Look, Silas!" he exclaimed, "There's Lake Michigan! We're saved!" And sailing out over the lake, the doctor pressed two levers in rapid succession. Instantly the car closed hermetically and dived down into the water, for the doctor's radiobile was not only a walking automobile and an airplane—it was also a *submarine* fitted with automatic gills for obtaining air under water.

The machine was now beyond the reach of its pursuers. When, after an underwater voyage of a hundred miles, it came to the surface, not a pursuer was in sight.

The wings were again called into requisition and the whole party soon reached a hotel in a large city, safe from the lawless mobs, whose only useful function seems to be to remind us how little man has really evolved above the level of the savage.

The Great Food Panic

By BURNIE L. BEVILL

(*Continued from page* 122)

discovered at the World Food Corporation's plant this morning. Apparently the entire force of the factory has been wiped out at a blow, and the greatest mystery is that none of the equipment of the plant is injured in the least. All of the concentrated food bricks that are stored at the plant are covered with a dense coat of a yellowish powder, and it seems that the people have been poisoned. For the last four or five days a huge air machine has been seen hovering over the factory, and it has been noticed that during this time the food has been covered with a thin coating of the powder. It is believed that the gaseous material that has been seen to issue from the airship is the cause of the disaster, but all this is conjecture. As well as could be estimated, there are about two thousand women and one thousand men killed."

Since the days of Jonathan Horton, the World Food Corporation had supplied the world with its entire quantity of food. Horton was a great scientist, and by extensive experimentation he had discovered the scientifically perfect food—a food that contained everything that is necessary for the maintenance of life,—and he had invented a process for its economical manufacture. Hence, the founding of the World Food Corporation. The monstrous factory that supplied the world with food was capable of producing 2,000,000,000 food bricks of food per day, and as these bricks were highly concentrated, each of them contained sufficient nourishment for one person for a day. The company employed only about three thousand persons as it was supplied with every conceivable labor-saving device known to man. Now this entire force was destroyed at one blow. The fact was appalling beyond measure.

"That's the work of those scientist-devils of Wake Island," exclaimed Carl. "Since their failure in the attempt to destroy civilization by setting fire to everything with their fiendish tenth ray, they have been striving with every ounce of their diabolical cunning to hatch up some other method of attack."

This scientific alliance that had been formed on Wake Island by that notorious

rascal, who claimed that he was imbued with the spirit of the devil and had the devil's own cunning, in short, none other than the late Dr. Szolcoze, of the University of Russia, had upon several occasions almost caused the downfall of civilization by its scientific plots. None other than the evil brains of the alliance could hatch up such far-reaching schemes as that of destroying the world. They had chosen Wake Island for the purpose of promoting their plans because of its remoteness from civilization; and upon its tiny coral reef there had been erected a gigantic steel and aluminum laboratory, the like of which has never been witnessed by an outsider. Only distant glances of the building have been obtained through the most high-powered Einsteinscopes, those tiny instruments that were invented by Einstein and which employ curved light rays. Numerous attempts have been made to overrun their stronghold, but without success, as it has always been the case that, when approaching the island, such gases have been encountered as to positively preclude the possibility of one's getting within ten miles of the place. Radio warnings have been coming every night at midnight for the world to beware the hand of the alliance, every scientist of the country had directed his skill upon the case, and the world had become accustomed to the menace, and now, as we supposed, the hand of the alliance had struck. Alas! We were soon to learn that we surmised the truth.

Suddenly a piercing light smote upon us through the open window and, looking out, we beheld the most grotesque air machine we had ever witnessed. It appeared to be a huge box-like structure with one circular opening which I judged to be about six feet in diameter. This opening was centrally located in the bottom of the machine, and from it a dense, yellowish gas was issuing in great clouds. Directly beneath the machine were the immense stock-yards of the city——that fascinating maze of steel and aluminum fencing that enclosed the live product of the world—millions of well-fed cattle that were to be used soon to furnish the meat element of the scientific food that was manufactured in Frankfort. It was feeding time, and enormous autotrucks were dumping out great bundles of a special grade of food, that was suitable for cattle. As we watched, a wave of yellow gas rolled over the food and immediately gave to it a golden hue. The cattle continued to eat, however, and presently there could be seen thousands of the beautiful animals staggering and falling to earth, dead—the poisonous gas had done its work. In five minutes the entire number of them was lifeless. This was the second blow of the alliance. The machine shot upward.

The telephone rang. Carl answered it, conversed with someone a moment, then turned to me. "Chief wants us in Washington," he said, as he hung up the receiver. "He refused to give details, but asked that we rush there immediately."

Making hasty preparations, we left the office and hurried to the roof of the building, where we obtained the fastest flier of the Zolberg station. It was of the Olson type and guaranteed to make at least four hundred miles per hour. In less than two hours we were in the chief's office in Washington.

"Gentlemen," he commenced, "conditions of the gravest import to the world confront us today. There has been committed the most fiendish crime in the history of mankind—the destruction of the three thousand workers of the food plant and the annihilation of the world's cattle supply. Something must be done, and that at once. You two gentlemen, being of superior intelligence and of exceeding fearlessness, have been chosen by the Secret Service Department to make investigations upon Wake Island. The Government's most powerful

flier is to be furnished you and a crew of the most fearless men are to accompany you."

Accordingly, the following morning we mounted the steps of the U. S. Government flier, the Chaser, for the purpose of frustrating the aims of the alliance on Wake Island, which meant that we were to endeavor to rescue the world from starvation.

The Chaser was the largest of the Government's fliers. It was manned by a hundred husky men of proven courage. In addition to these, there were four of the most famous scientists of the age, including the world renowned Dr. Barton Gregory, of the School of Hawaii. The machine was equipped with the very latest of scientific apparatus and materials. The craft was supplied with a powerful watermotor of the latest type, which was capable of developing a thousand horsepower and was able to drive the machine at the enormous speed of four hundred miles per hour. Two immense evacuation tanks surmounted either side of the cabin, and these were capable of sustaining a hundred tons. Thus equipped, we departed for Wake Island.

As the island is about ten thousand miles from Washington, we were some hours in making the journey. As we neared our objective a perceptible odor was noticed in the atmosphere. This the scientists pronounced to be chlorine. Undaunted, we donned our gas masks and sped onward. We were at this time traveling at an altitude of about ten miles, but, as we approached close to the magnificent metallic structure occupied by the alliance, we began to descend.

Suddenly it seemed that the entire ocean leaped up to meet us and a terrific explosion rent the air. A tremendous spray of water rose two miles into the air and enveloped our craft as if it had been a moth flying through the mists of Niagara Falls. With a sickening plunge we were drawn down into the depths of the Pacific and my last view as the waters closed over us was of a huge, box-like machine hovering over the place where we struck. As Carl and I had been the firmest of friends in life, so we decided to be the same in death and we clung to each other until we lost consciousness in the salty foam.

When I again recovered consciousness, I found that immense aluminum walls rose perpendicularly upon all four sides of the inclosure in which I lay. Turning on my side, I beheld Carl lying beside me, but as yet unconscious. Dazedly, I arose to my feet, and then I saw that the floor on which I stood was of plate glass and that below this rolled the blue waters of an ocean. Without loss of time, I set to work to revive my companion, and after laboring with him for a half hour or so I succeeded in arousing him from the coma into which he had fallen. We were unhurt as far as we could ascertain, and we started at once to make an investigation of our prison. The mighty aluminum walls extended some five hundred feet high and were surmounted by a huge skylight, through which we could see the blue sky. There was no opening in the walls, and we were at a loss to know what to do. However, we had not long to wait before something developed.

An invisible panel slid upward in one of the walls, and we were confronted by a grinning Celestial of about the age of twenty. In his hand he carried a golden goblet which was filled with some liquid.

"Drink this," he said, as he passed the goblet to us.

We were somewhat hesitant to touch the liquid, fearing that it was some potent drug, but upon being informed by the Chinaman that it was only a cooling beverage, we tasted it gingerly and found that it was good. By this time we had developed quite an appetite and a thirst, and we found that the drink satisfied both ways. We were refreshed to the utmost, and felt much better.

"Come," said the Chinaman, as he took the goblet and motioned us through a doorway; "me show you to big Mogul." So saying he led us through the opening and down a long hallway, admitting us at last into a well-lighted room, that was filled with every conceivable scientific instrument that could be imagined. At the farther end of the room, upon a gilded dais, was seated an old, much wrinkled Chinaman, dressed in all the splendor of an Oriental monarch. Upon his head, there reposed what appeared to be some sort of crown, but upon closer inspection we decided it to be a new kind of radio receiving instrument, the like of which we had never seen. There seemed to be a dense maze of very minute aluminum wires stretched across the top of the device and there depended from the sides of it, upon either side, a contrivance that fitted over the ears, which we judged to be the receivers of the instrument.

Upon entering the room, the Chinaman slave saluted the monarch after the manner of his kind, by bowing the left knee and raising his right hand straight above his head.

"Your Scientific Majesty," he addressed the Royal one, "these are the two remaining survivors of the impudent Amelican ship of the air that dared to approach your Royal Kingdom of Science."

We observed that the servant could speak almost perfect English when he wished to do so.

"The others of the crew are dead," he continued, after which he bowed and withdrew.

"You infernal Chinese dogs," Carl raged. "You shall pay dearly for this. You have destroyed three thousand people already and annihilated the entire cattle supply of the world. Why, the world is now afire by your devilish outrages."

The Chinese received this outburst of Carl's without the least sign of emotion. "I am Hong Farlo, the Imperial Master of Science," he replied. "It is my purpose to conquer the world for science, and in order to do this, I must first destroy the greater portion of it. My illustrious predecessor, the Honorable Dr. Szolcoze, made several attempts to depopulate the earth, but failed. I have originated a plan that cannot fail. I purpose to starve the people of the world. As you have seen, I have destroyed the entire force of the World Food Plant and poisoned the entire cattle supply. Within the immense storage vat that is hidden beneath the food company's plant is enough food and materials to supply the world for three days in case of emergency. I intend to plant one of my gas bombs that contain in each bomb enough of the special compound sulphate of mirconium to poison the entire lot. Gentlemen, that is my next step. I shall start at once and you shall have the pleasure of accompanying me. In order to give you a few extra thrills, I shall kill the mob that is thronging around the food plant at the present time. Ah! I hear them now through the earphones. There are, I should judge, about ten thousand people clamoring for food. The pangs of hunger are beginning to gnaw at their soul. Soon there will be a riot and I shall be there on the scene to witness it and, methinks, I can add to the fun by giving them a dose of my Prussic pentoxide. Think of the pleasure of seeing the thousands of the human beings stagger and fall to rise no more! Then I shall be nearer my goal. Soon the people will all starve to death and the alliance, with myself as master, will be the only group of human beings left. The world will be ours and we will be the absolute masters of it. Come let us go."

By this time Carl was almost ready to swoon and I was seized with an ague. This fanatic was about to destroy another ten

thousand persons and eventually the entire world, merely to satisfy his insane passion for dominion. It was uncanny—ghastly. But I was powerless to do anything to prevent the carrying out of this evil design—I could only stand speechless and gasp.

He led us forth through a tiny door that opened outward upon an equally tiny platform that was built over the blue water of the Pacific. Resting upon the mighty ocean, adjacent to the platform, was the immense box-like aircraft that it had been our lot to behold several times and always to our dismay. At the sharp command, "Kek," a tiny doorway began to recede into the machine. It had moved about three feet into the craft when it glided noiselessly to the right. Through this aperture, we entered, to be ushered into a magnificently appointed salon. The room was well lighted, but there was not a light to be seen. Two Hawaiians, dressed in the manner of slaves, attended to our wants. We were fed with the best of food—a food that was unlike the scientific product to which we were accustomed, but which we found to be of a superior quality. Having supplied us with food and drink, our host, the Master of Science, and his servants, vanished through a panel in the doorway. We were alone.

Having made sure that we were not watched, we began to examine the room. We discovered that the light which illumined it was supplied by stored sunlight that was emanating from the ceiling. Seeing a row of tiny buttons along one of the walls, I pushed one of them. To my amazement, a small drawer slid outward upon noiseless bearings and, to our satisfaction, we found that it contained several brands of cigarettes and a cigarette lighter. Having no cigarettes with me when we embarked on this ill-fated cruise, I was almost famished for a smoke, and we were not long in regaling ourselves with one. Suddenly my head swam, and the next instant I fell to the floor and lost consciousness.

When I regained my senses, Carl was standing over me. "Look beneath you!" he cried. Rolling over, I perceived that I was lying upon a clear glass through which I could see the ground far below. I perceived that we were directly over a large city, and seeing the immense sign board that had been placed for the direction of the aircraft, I realized that the city was none other than Frankfort, Kentucky. A large crowd was gathered before the mighty pile of steel and stone that was the food plant. A loud cry arose from the mob. With a crash, the mob made an attempt to rush past the guards that had been placed there by the Government.

As we watched, a serene and calm little man with a smile upon his face, forced his way through the howling mass of starving humanity and made his way to a large platform that was in front of the building. It was President Woods of the United States.

"Ladies and Gentlemen," he began, his voice sounding clear and loud through a horn in the corner of our room, "today we are confronted with the greatest peril that has ever befallen the human race. It seems that starvation is before us, but we must do our best to defeat the evil. There is stored beneath this building enough food to last the entire world three days, and we will bring it forth for you to eat. It will be distributed evenly among you, so that none shall suffer."

A mighty shout went up from the crowd. "Long live the president!" was the cry. Immediately, a great army of workers began to carry forth the food bricks in large hods, and stacked it in rows in front of the assembled masses. When it was all ready for the distribution to those present, a dense cloud of yellow gas began to descend from the machine in which were imprisoned. Great God! It was terrible. To see this mass of

humanity denied the food that was to keep them from death was a ghastly sight.

A hoarse wail arose and thousands of men, women, and children snatched at the food as though nothing should keep them from it. A powerful barrage of machine-gun fire was directed upon us, but to no avail. Slowly but surely the door of our prison opened and a tiny, shrivelled old man entered, silently as death. He appeared to be of a great age, and he was almost as emaciated as a mummy. Standing before us in the pale gray of morning, with the pendemonium that was raging beneath, he reminded me of Death himself, that grim reaper, come to claim us for his own. I shuddered.

"Be not afraid; I bring you news," he said, in a thin, cracked voice. "My good men, he, whom you see before you, was once the associate of the late Dr. Szolcoze, the mighty King of Science. The great Doctor and I could not agree and I killed him with this dagger, which I carry at my side. I have repented since that time, and now Hong Farlo, that infamous Chinese devil, seeks to hold the position that Szolcoze once held. He shall not so long as I live, and this day I see a chance to revenge myself upon him for the crime he committed against me by depriving me of the rightful place that should be mine. Come, follow me, men." So saying, he made his way through the door.

We followed him through and up a small ladder that led to a hole in the ceiling of the aircraft. Through this we crept also. "Here," said the old man, "is the mechanism that operates the ship. Here is a tiny radium crystal that gives up enough of its energy to overcome gravitation." That it was—a tiny crystal that gleamed in the sunlight as a scintillating diamond. A leaden cover was arranged for it that was capable of being moved in any direction so as to guide the craft.

With a huge hammer that he picked up from the floor, the old man smashed the crystal at a blow and bade us leap to an iron rod that was above us. With a hissing sound the huge aircraft shot downward upon the ground a mile from the city. We found that the rod was sustained by a parachute device and we sailed gracefully to earth.

Needless to say, the little old man was pardoned by the president, for it developed that he was the Government's Secret Service Scientific investigator, who had been liying with the alliance for the last ten years awaiting an opportunity to bring the master mind of the alliance to justice. The old Chinese, Hong Farlo, was killed in the fall to earth, together with all of his followers, there being only a handful of his servants left at Wake Island.

A speedy airship was despatched to the island at once and the place was soon captured. Today it is used for the Government experimental station for the production of various kinds of food.

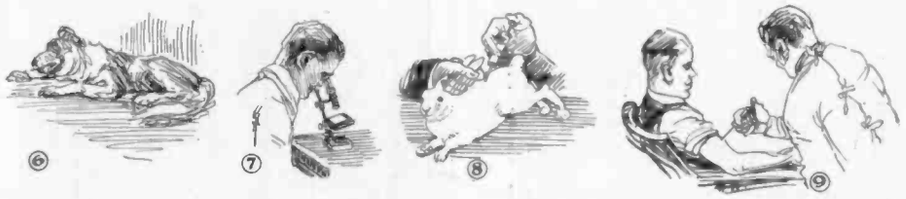
The food plant resumed its operations at once, and what came near to being the greatest calamity that has even befallen the world was averted—not by the brains of two young upstart detectives, but by the greatest scientist of the present day, Dr. Middleton, who made possible the scientific achievements of the present, the like of which have never been known before upon the earth.

Is Hydrophobia A Myth?

By ROBERT H. MOULTON

(*Continued from page* 118)

and occasionally with a little cheese. The guinea pigs are kept fat on carrots and other guinea-pig dainties, and the rabbits rejoice in green lettuce and cabbage. The animals are kept in perfect health and as far as possible in good spirits in order that the diseases given to them may be directly diagnosed and studied.



How the Hydrophobia Serum Is Prepared. When a Dog Dies of Rabies, Which Is Invariably Within Thirty Days, the Fluid From the Spinal Cord of the Dead Dog Is Injected Into a Rabbit, and Then the Rabbit Dies With Rabies. The Serum Used For Injecting For Hydrophobia Cases Is Made From the Spinal Cord of the Rabbit. The Brain of the Dead Dog, In the First Place, Is Examined Under a Microscope For Rabies Germs.

Probably the most interesting test is that for rabies, in connection with the effort now being made to stamp out hydrophobia in Chicago. In the examination for rabies the suspected dog's brain is examined and a portion of it injected into a guinea pig. If rabies existed, the effect will be apparent in the guinea pig in a couple of days. Measures are then taken to safeguard any person who may have been bitten by the dog or otherwise brought into contact with the germs.

Of course every dog that bites a person is not mad; the important thing is to find out whether it is or not. If a dog bites a person, it is taken by the police and never killed if it can be avoided. The suspected dog is sent to the city dog pound and put in a cage in a room set aside for such suspects. The animal is then carefully watched for thirty days. If it is mad, it will die before thirty days. In this case its head is cut off and sent to the city laboratories and its brain is examined for rabies germs. If these are found, it is certain the dog had rabies and persons bitten by the dog are then communicated with and urged to go to the hospital for treatment. These germs, called "Negri" because of their discovery by Professor Negri of the Italian University of Pavia, are in the form of little spots and are located in the nerve cells of the brains of rabid animals. If they are found in the brain of a suspected dog, it is certain that the animal had rabies.

To secure the serum used in treating the patient, the spinal cord of a mad dog is taken out, a culture made and this is injected into a rabbit. Then when the rabbit dies its spinal cord is taken out and hung up to

(*Continued on page* 177)

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.

H180 Signal Corps type, small size, 15 cells, 22½ volts. Each....95c

H134 Variable Large Navy size, 6½x1x3 inches 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each.....$1.80

H188 Combination Tapped 45 volts 30 cell, 13x6x3 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 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.

H201 For 6 volt battery.....$13.95
H203 For 12 volt battery.....13.95

STORAGE "A" BATTERY

A very high grade 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 new 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.

H194 6 volt, 40 ampere size. Each....$10.00
H196 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.

H105 Detector, UV200 C300 Ea.$4.30
H112 Amplifier, UV201A C301A 5.95
H118 5 Watt Transmitter.....7.70
H107 WD11 1½ v. Fil. Each.....$5.95
H101 WD12. Each.....5.95
H102 UV199. Each.....5.95
H103 UV199 Socket.....59c
H104 UV199 Adapter.....49c
H108 WD11 Socket. Each.....49c
H109 WD11 Adapter. Each.....48c

FILAMENT CONTROL RHEOSTATS

Best grade. High heat resisting base. Diam. 2⅛ in. cap 1¼ amp. Resist. 6 ohms. 1¼ in. knob with pointer. 75c value.

H132 Each.....45c

H131—25 Ohm Rheostat for 301A 201A tubes.....69c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.

H133 Each.....89c

VERNIER RHEOSTAT

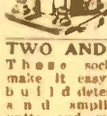
Gives exceedingly fine control of "A" battery current. A necessity for best receiving results.

H135 Each.....89c

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of brown bakelite. Four binding post connections. Right angled contact springs.

H140 Each.....39c



High Grade combination type for panel or table mounting. Metal tube. High insulation base. One of the best sockets made

H146 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.

H147 Two-gang socket.....$1.05
H149 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.

H732 Each.....59c

DETECTOR CRYSTALS CAREFULLY TESTED

H736 Galena, Arlington tested, per piece. 19c
H738 Silicon, Arlington tested, per piece. 19c
H735 Tested, Galena, per piece.....9c
H737 Tested, Silicon, per piece.....9c

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.	Net Mntd.	Art No.	Price Mntd.
25	120- 250	H301	$0.39	H320	$0.89
35	175- 450	H302	.42	H322	.96
50	210- 720	H303	.49	H323	1.04
75	390- 910	H304	.54	H324	1.08
100	500- 1450	H305	.58	H325	1.13
150	600- 2000	H306	.63	H326	1.17
200	900- 2500	H307	.72	H327	1.26
250	1200- 3500	H308	.78	H328	1.35
300	1500- 4500	H309	.82	H329	1.36
400	2000- 5000	H310	.97	H330	1.57
500	2800- 6100	H311	1.12	H331	1.63
600	4000-10000	H312	1.27	H332	1.78
750	5000-12000	H313	1.43	H333	1.93
1000	7900-15000	H314	1.70	H334	2.28
1250	9750-19500	H315	1.92	H335	2.49
1500	14500-26500	H316	2.18	H336	2.65

COIL MOUNTINGS

H340 Three-coil mounting.....$3.95
H341 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
- H390 Open circuit. Each.....43c
- H391 Closed circuit. Each.....48c
- H392 Two circuit. Each.....60c
- H393 Single circuit filament cont. 69c
- H394 Two circuit filament cont...85c

H395 Plug. Large space with set screws for attaching cord. Each.....49c

BINDING POSTS

Brass, polished nickel finish. Washer and 6-32 in. screw extending ⅜ in.

H370 Large size—barrel and knob ⅜ in. long, dozen..85c
H372 Smaller size—barrel and knob 9-16 in. long, dozen.....70c
H374 Large size with composition knob, dozen.....50c
H376 Large size with hole for phone tip or wire, dozen.....80c
H378 Small size with hole for phone tip or wire, dozen.....35c

SWITCH CONTACT POINTS

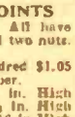
Brass polished nickel finish. All have ⅜ in. long size 6-32 screws and two nuts. All prices the same.

Dozen 18c Hundred $1.05

Order by Article Number.

H360 Head, ¼ in.; Diam. ½ in. High
H362 Head, 3-16 in.; Diam. ⅜ in. High
H363 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.

H382 1¼ in. Radius
H381 1½ in. Radius } 19c Ea.
H380 1 in. Radius

SWITCH LEVER STOP

Brass, polished nickel finish.

H386—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.

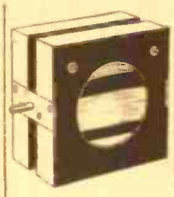
H900 2 in. Diam. for 3-16 in. shaft. Ea. 19c
H901 2 in. Diam. for ¼ in. shaft. Ea...19c
H904 3 in. Diam. for 3-16 in. shaft. Ea...25c
H905 3 in. Diam. for ¼ in. shaft. Ea...25c
H906 3½ in. Diam for 3-16 in. shaft. Ea 35c
H907 3½ in. Diam. for ¼ in. shaft. Ea 35c

OUTDOOR LIGHTNING ARRESTER

H980 Price.....$1.58

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

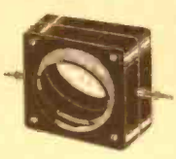


H410—Completely assembled, price $2.69

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.

H411—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. 4¼ in. square, 1⅜ in. thick.

H412 Price including mounting brackets $3.48

IMPROVED 180° VARIO-COUPLER

H418 Price.....$2.89

Our price shows 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 H990		Number H992		Number H991	
Gauge	Price	Gauge	Price	Gauge	Price
18	50c	22	45c	20	$0.78
20	60c	22	55c	22	.90
22	75c	24	61c	24	1.05
24	85c	26	65c	26	1.18
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.

H248—100 ft coil 72c H248—500 ft. coil $3.20

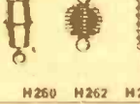
SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
H248—100 ft. coil 49c H242—500 ft. coil $2.35

Solid Bare Copper Wire, size 12
H244—100 ft. coil 67c H245—500 ft. coil $3.05

ANTENNA INSULATORS



H260 Size 1x3¼
Two for.....17c
H267 Size 2½x3¼.
Two for.....55c
H264 Size 1½x1.
Two for.....69c
H266 Size 1½x10½.
Two for.....$1.28

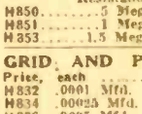
H260 H262 H264-6

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

H170 Phone Condenser .001 Mfd.
H172 Phone Bridging Condenser .0005 Mfd.
H174 Grid Condenser .00025 Mfd.
H175 Condenser .006. Each.....25c
H176 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.....39c

Resistance		Resistance	
H850	.5 Meg.	H855	2. Meg.
H851	1 Meg.	H857	3. Meg.
H853	1.5 Meg.	H859	5. Meg.

GRID AND PLATE CONDENSERS

Price, each.....55c

H832 .0001 Mfd. For special circuits
H834 .00025 Mfd. For U.V.201 and Cun. 301
H836 .0005 Mfd. For U.V.200 and Cun. 300

MOUNTINGS

Bakelite base. Spring clip contact.

H840 Single mounting. Each.....32c
H842 Double mounting. Each.....57c
H844 Triple mounting. Each.....76c

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling due to proper impedence 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 in apparatus.

H234 10 to 1 Mounted. Each.....$3.48
H235 10 to 1 Unmounted. Each.....2.95
H236 5 to 1 Mounted. Each.....3.40
H237 5 to 1 Unmounted. Each.....2.85

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

H812 43 plate .001 Mfd. $1.73
H813 21 plate .0005 Mfd. 1.43
H814 11 plate .00025 Mfd. 1.32
H815 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 rotable 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

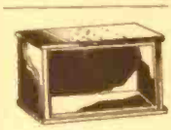
H824 23 plate .0005 Mfd. with dial and knobs. Price....$2.89
H826 43 plate .001 Mfd. with dial and knobs. Price....$3.45

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

H754 Baldwin Type C with universal jack ping.....$17.75
H755 Baldwin Type C unit with cord $5.50
H756 Red-Head. 5000 ohm.....5.78
H768 Brandes, 2000 ohm.....6.90
H770—2000 ohm Barawik.....3.75
H751 Murdock 56, 2000 ohm.....4.20
H752 Murdock 56, 3000 ohm.....4.95
H764 Frost, 2000 ohm.....4.20
H756 Frost, 3000 ohm.....4.85
H758 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 High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	H420	$2.48
6x10½"	5½"	10 "	7"	H422	2.75
6x14"	5½"	13½"	7"	H424	3.30
7x14"	6½"	13½"	7"	H423	3.60
7x18"	6½"	17½"	7"	H426	3.90
7x21"	6½"	20½"	7"	H425	4.20
9x14"	8½"	13½"	10"	H428	3.70
12x14"	11½"	13½"	10"	H430	4.40
12x21"	11½"	20½"	10"	H432	5.20

RADIO "BAKELITE" PANELS

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	¼" thick Art No.	Price	3-16" thick Art No.	Price	¼" thick Art No.	Price
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9x14	H454	1.60	H464	2.30	H474	3.10
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GRID CONDENSER

H162 Mounting holes spaced to fit lugs of above leak. Cap. .00025 MF.....14c
H163 Same as 162 but higher grade. Enclosed in metal case.....39c

HOW I SAVED MY HAIR!

The Tragedy of Baldness

BY ALBERT WOODRUFF

WHEN the barber told me my hair was getting thin I merely smiled and let it go at that. When my wife said, "Bert, I do believe you are becoming bald," I gave a little laugh and passed it off with a jesting remark. I took the gibes of my friends in the same spirit—and I laughed when the comedian at the theatre made his "cracks" about candidates for the "bald-headed row."

But it wasn't until my business associates commenced to notice that I was rapidly becoming bald and gray that I worried. For while I was just as full of pep and vim as I had ever been—while my business judgment was just as keen as ever, yet I worried for fear my associates might think of me as heading toward the "has been" class. I decided to try to save my hair—if it could be saved.

Then I became a slave to hair tonics. If a tonic was new I bought it on sight. I tried every kind of shampoo that I heard of. I was a victim of the barber's wiles. The money I spent—and all to no purpose. My hair continued to come out just as fast as it ever did before I had tried to stop it. Every time I combed my hair it told the story.

How I Prevented Baldness

One day I read a very interesting advertisement by the celebrated Physical Culturist, Bernarr Macfadden. Now, it so happened that I had seen Mr. Macfadden several times and I knew that he himself had wonderful thick hair. Naturally I was interested—although it was news to me that Mr. Macfadden had made a study of the hair and had written a book on the subject, entitled, "Hair Culture."

In the advertisement Mr. Macfadden said he was amazed to learn how little really authoritative information had been written about the proper care of the hair and scalp. He said that one need not let the hair grow thin and gray. He said that if the hair is falling out or getting gray a reasonable amount of proper care will restore it, unless one is completely bald. And this same care will keep the hair strong and healthy throughout life. He spoke of simple, natural and effective methods for treating the hair and scalp by following a few laws of nature. Then he casually mentioned that he was startled at the tremendous demand that existed for his comprehensive work. In fact, the first edition of his treatise was very quickly sold and a new edition had to be printed to take care of the orders that were flooding in on each mail.

I made up my mind right then that since Mr. Macfadden had written the book it was sure to be very practical—and the fact that so many had been sold clearly proved to me that the treatise must be filling a popular demand.

So I just jotted my name and address down on the coupon and returned it. When I received the book on five days' free examination I immediately read it very carefully and that very same night I started to follow the few simple rules. I must confess that within a very short time I noticed a decided improvement in the growth of my hair—it became thicker and more glossy. Then dandruff disappeared. Today, after following the rules laid down in this new method, I have just as fine a head of thick hair as you would see on any man—even a young man of eighteen or twenty has no thicker or glossier hair than mine. In fact, many haven't anywhere near such fine hair. The grayness has all disappeared and my hair has the glowing color of youth. My wife and children also adopted the rules which we discovered in Mr. Macfadden's treatise entitled "Hair Culture" and their hair is the admiration of all their friends. If you will examine the book I am quite sure that you will agree with me that it is one of the most valuable—if not the most valuable—and instructive books ever written on Hair Culture. *Albert Woodruff.*

"Only a short while ago my hair was falling out by combfuls, yet today I have fine, thick hair, with not the slightest trace of baldness or dandruff."

Bernarr Macfadden's Secrets of Hair Culture

These chapter titles will give you an idea of the scope and value of this remarkable book:

Bernarr Macfadden. Note his thick, luxuriant, healthy hair.

- Hair as an attribute to beauty.
- Facts everyone should know about hair.
- Care of healthy hair.
- How to care for baby's scalp.
- Facts about soap and shampoos.
- The cause of hair troubles.
- Dandruff.
- Dry Hair, Oily Hair, Split Hair.
- Falling Hair.
- Baldness.
- Gray Hair.
- Hair Dressing.
- Eyebrows and Eyelashes.
- Superfluous Hair.
- Hair tonics.

Women! Keep Your Hair Youthful

If your hair is graying prematurely you have every reason to hope that it can be stopped and that much can be done toward restoring it to its original youthful and becoming color.

If it is losing its luxuriant quality and glossy sheen the few simple rules taught by Bernarr Macfadden in his new book **HAIR CULTURE** will enable you to bring about an almost unbelievable improvement. Why spend time and money at the hair dresser's when you can give your hair a better home treatment in only a few minutes a day by this new method? You can easily have hair that is wonderfully silky in texture and your scalp can be cleansed of every trace of dandruff or scurf.

Send No Money

If you would like to take Mr. Woodruff's advice we will gladly let you examine "Hair Culture" for yourself, without obligation, and see how easily you can follow the methods that should bring new life, new lustre and luxuriance to your hair. Dont send one cent in advance—just fill in and return the coupon and the book will come to you by return mail. When the postman hands it to you, deposit only $2.00 with him. Then after you have kept "Hair Culture" for 5 days—after you have tested the methods—if you are not absolutely satisfied return the book to us and your money will be promptly refunded. If, however, you decide to keep this remarkable book, as you surely will, there are no further payments of any kind to be made—the book becomes your property for the one sum of $2.00 which you deposited with the postman.

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1926 Broadway, New York City

Without obligation on my part, please send me a copy of Bernarr Macfadden's Book giving me all of Nature's simple methods for preserving and beautifying the hair. I will pay the postman $2.00 on arrival, but I also have the privilege of returning the book if I desire and you will refund my deposit.

Name .....

Address .....

.....

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has it—All merchandise offered is standard and guaranteed against defective workmanship. If any goods are found defective they will be exchanged or money will be promptly refunded. Orders must include money orders or cash. No checks accepted and postage must be included.

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$20.00 WESSCO BATTERY CHARGER

DE LUXE, fully guaranteed—complete and ready to use including Ammeter, Socket, Plug and Battery Clips. Easy to operate on any 110 volt socket (alternating Current). Our introductory price

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"B" BATTERIES

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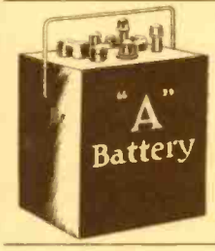
$1.75—22½ v. variable highest quality, small size.. .75



"A" BATTERIES

$24.00—100 amp., 6 v. $16.75
$19.00—80 amp., 6 v. 11.75
14.50—60 amp., 6 v. 8.75

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RHEOSTATS $0.45

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Special Electric Radio Soldering Iron, two heat $4.95

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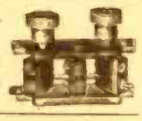

3 coil mounting $2.75
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20% off standard list on all coils mounted or unmounted.

Switch points, per dozen .....$ .08
Binding Posts, nickel plated, 3c ea. Black 5c. ea.
75c Dials, 3 in. ..... .25

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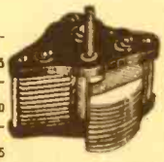

$5.00—23 pl. variable condenser $1.85
$5.50—43 pl. variable condenser $2.10
3 pl. Vernier variable condenser $0.75
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Grid Condenser ..... .10
Bronze Bus Bar, tinned, ft. ..... .02

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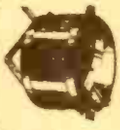

180° Variocoupler $2.40
$4.25 variocoupler, guaranteed, highest quality ..$2.25

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5x5	.45	9x10	1.60
7x12	1.50	6x12	1.25
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CABINETS: Mahogany finish.

Panel size — 7x12 in., 7x18 ", 7x24 ", 6x12 " — All these cabinets regardless of the size at $2.50 per piece.

SPAGHETTI, per length.....07½

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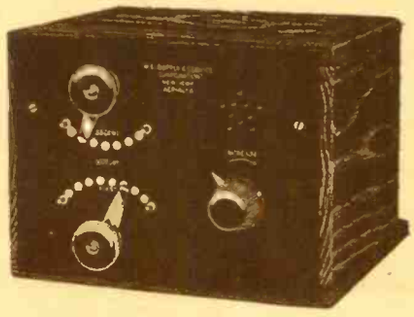

THE AERIAL-A is the most outstanding value ever given in a highly efficient and perfected Vacuum Tube Radio Receiving Set. It's efficiency is equal to or greater than sets worth many times it's cost. This is a WESSCO product backed by the principles of Highest Quality, volume production and small profit which combine to give you greater value and complete satisfaction. Beautifully designed, Silver Gray Oak Cabinet, Composition Rubber Knobs, Nickel Plated Metal Parts. Bakelite Panel. Wave Length—150 to 750 meters (Tested with General Radio Wave Meter). Receiving Radius—Guaranteed for 250 miles in summer and 500 miles in winter. Many owners are receiving broadcasting from stations 1000 miles distant. Audibility and Selectivty are unusually good. Awarded certficate of Excellence by New York Evening Mail. Guaranteed by New York Tribune Institute. High Grade material and workmanship in every detail. Price Complete $35.00, including Receiving Set, Phones, Aerial, Tube, "A" Battery, "B" Battery, Insulators, etc. All ready to use. Terms: Money order, including postage, must be sent with your order. Shipping weight is 10¾ pounds.

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DEALERS:

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Is Hydrophobia a Myth?

(*Continued from page 172*)

dry at room temperature. After eight days, and not later than twelve days, it is cut up and a quantity sufficient to treat one person is culled. The serum is injected into the patient by means of a needle syringe.

The behavior of suspected dogs which eventually turn out to be mad varies with the individual. Some of them remain passive throughout their period of confinement, others are sullen and growl at persons approaching their cages, while a few keep up a continual barking, snapping and snarling as long as anyone is in sight. There is a common idea that a mad dog shows an intense fear of water, and in case such an animal is seen to ford a creek or lake, this is taken as proof that he did not have rabies. Authorities declare, however, that this is a fallacy. This fear of water is a symptom usually marked in human cases, but is never present in the dog at any stage of the disease. Animals in the early stages when running about the country will cross bodies of water without the slightest fear. Even after the throat becomes paralyzed the animal will often constantly attempt to drink water from a pail or bucket if placed within its reach, but owing to the paralysis of the throat muscles, which may not occur until late in the course of the disease, swallowing is impossible.

After a person is bitten by a dog it frequently occurs that some friend will immediately look into the mouth of the animal. In case the mucous membrane is black, he will at once conclude that the bite is dangerous, even though the dog appears perfectly normal; but if the mouth happens to be red, he thinks there is no danger from the bite. This is entirely erroneous. The black color is due to a normal deposit of pigment in the mucous membrane of the mouth. It is present in a certain percentage of all dogs and has no connection with rabies.

Equally general is the erroneous idea that a mad dog is necessarily violent. The fact is that there are two forms of the disease; the quiet or dumb form, and the active or violent form.

It should be remembered that secretions from the mouth of a rabid dog are poisonous whether he shows any tendency to bite or not, and if they come in contact with a sore or open wound on the person of a healthy animal or human being they transmit the disease. The only safe rule to follow in handling a sick dog is to wear heavy gloves and to avoid secretions from the mouth. It is commonly supposed that the danger from hydrophobia comes from the roving, ownerless, stray dogs of the city. This is not the real truth. Most of the victims of hydrophobia are bitten by house dogs or cats that are household pets. For this reason, until it is absolutely certain that one's sick dog has not got hydrophobia, the only safe thing is to assume that he has and act accordingly. The dog should be kept under observation and out of the way of human beings and other animals for at least three weeks. If he has the disease, he will succumb to it in that time.

The curative value of the so-called "madstone" is still devoutly believed in by many. After a person has been bitten the madstone is applied to the wound, and it is believed that the longer it adheres the more sure it is of preventing the disease. Whether it will stick or not depends entirely on the amount of hemorrhage or discharge from the wound. Its specific value against rabies is no greater than that of a piece of blotting paper applied in the same manner.

Our Wonderful Brain—How It Works

By LEON AUGUSTUS HAUSMAN, Ph.D.

(*Continued from page* 120)

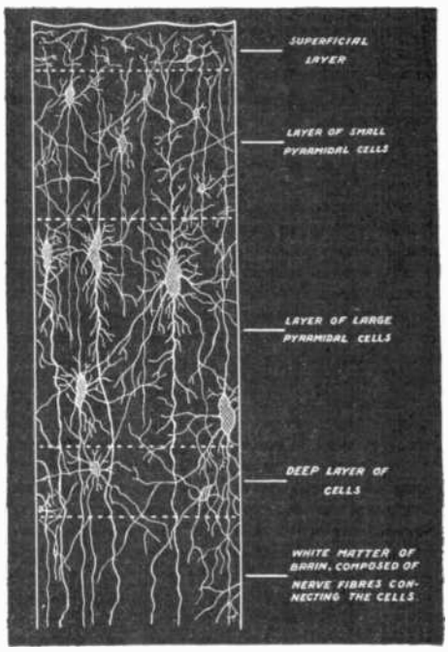
1). Covering the entire brain is a thin layer of "gray matter," which is distributed with great regularity over the cerebral hemispheres, where it is known as the cerebral cortex. And it is this portion of the brain, this rather thin layer of nerve cells which harbors the higher mental faculties. Think of it: our memories, our loves, our hates, ambitions, reverences, adorations, chagrins, logic, in short our personalities, all locked up in a smear of gray cells just underneath the roots of our hair!

Let us look into the minute structure of so remarkable a mechanism. It is the frontal region of the cerebrum, Figs. 2 and 3, which has to do chiefly with those faculties which distinguish man from his lower kindred, the anthropoid apes. The structure which the microscope reveals in the cortex of the cerebrum (cerebral cortex) is a complex mass of nerve cells, called neurones, arranged in four rather well-defined layers, from the surface downward (right). Each separate nerve cell consists of a cell-body, with long root-like tendrils reaching out and branching and ramifying in every direction. A closer examination of the cells in the four layers of the cortex shows that they are not all alike. The outer layer, or superficial layer, contains few minute cells, and the fourth, or deep layer, contains few, while in layers 2 and 3 are located the largest and most important cells of the cortex. They are known, from their general form, as pyramidal cells, and are chiefly concerned with our intellectual, and other advanced mental capabilities. These cells send out a large number of rootlets or tendrils (called dendrites), in such a way as to connect with one another and with other cells in the various portions of the brain.

As the result of numerous studies by scientists it has been shown that a direct relationship exists between the intelligence of an individual, and the number and development of his pyramidal neurones, and interestingly enough, his *pyramidal neurones of the third layer*. So it seems that these cells, these large pyramids, of nervous tissue, are the main workers in our brains, with respect, at least, to our mentalities. In persons of superior mental attainments, these neurones become larger, are more numerous, and what is perhaps most important of all become more perfectly connected together by reason of their branching rootlets, or dendrites. In short, we are now in a position to say that the mental capability of an individual depends upon: (1) the number of pyramidal cells or neurones present in the cerebral cortex, and especially in the frontal region of the cortex, (2) the size, or healthy development of these neurones, and (3) the length and richness of branching of the nerve rootlets, or dendrites. Furthermore we can say that this also conditions the mental powers of those animals with brains similar to our own.

A most curious fact about these precious pyramidal neurones is that until the tiny embryo within the womb of the mother attains the third or fourth month of foetal life the neurones continue to increase in numbers, and then stop. When the embryo, or foetus, is four months old, the number of its pyramidal neurones is fixed. No additional ones can ever be developed. Thus each individual starts off in life with a fixed number of these all-important brain cells, which he never can increase. He can, however, by education and mental training increase the size and vigor of the cells, and also increase the length and number of branches and interconnections of the dendrites.

For each of us, then, growth in mental ability means growth of the neurones and their root-like dendrites. Now, as we might expect, the brains of idiots and feeble-minded persons exhibit pyramidal neurones either few in number, small, or possessing few and short dendrites. In other words such persons "fail to make the connection" as we say, and in this phrase we express a deep physiological truth. Their pyramidal cells are not interconnected, and they can, in truth not make the connections between words, ideas, and what they have experienced. The brain of such a person is a machine with its parts not coordinated.



A Diagrammatic View Representing a Vertical Section Through a Portion of the Rind or Cortex of the Cerebral Hemispheres, Showing the Cells Upon the Size of Which the Higher Faculties Depend.

In extreme cases of idiocy, no rootlets, or dendrites, are present at all. This means that correlation of ideas, of memories, of acts are not possible. Such individuals do not live long.

Mentally incapable parents, such as the feeble-minded, cannot, therefore, transmit to their offspring anything better than their own mental machinery, and they often may contribute a worse one! This is a tragic fact. But if we may not add to the number of our "thought-producing units," we can at least take comfort from the reflection that we can, by education, increase the number of the interconnections of those pyramidal cells that we do already possess, and by sane and simple living and high thinking, become better and better, each day, mentally.

The fact is that most of us are feeble-minded when we compare what we now are mentally, to what we might be, if we would but give to the systematic training of our minds as much time and thought as we now give to, say, the selection of our clothes.

When we consider that there may be, in the average cerebral cortex millions upon millions of nerve cells, with the possibility of each one developing millions of dendrites, and that this would mean millions times millions of interconnections, with resulting mental powers, imagination itself is staggered when it attempts to conjecture what latent forces each of us possesses.

Radio for Every Tenant

(*Continued from page* 153)

The immense influence of radio on our daily life is very forcibly brought home to us in connection with this installation. How it will affect our lives in the future can only be imagined. Will it interfere with the welfare of the newspapers and eliminate the necessity of traveling from our homes to our places of business every day? This is not a very far cry from the radio set of today, especially when the above described "radio apartment house" is considered. Here the tenants get the very best of entertainment without the necessity of even leaving their comfortable abodes. The various weather reports and quotations on the stock market may also be heard, the latter being of great importance to the business man.

The opera brought to the dweller in the apartment house, as prophesied years ago, is now a reality in one case at least. That other builders will follow this precedent there is no doubt, as it offers a great inducement to prospective tenants, thereby increasing the value of the houses. The saving to the tenants is also appealing, for a set capable of bringing in the stations that the one described above will do, would be very expensive. Here the radio enthusiast can get all the joy of a high priced radio set without the attendant expense and trouble. All he has to do is plug in the phones or loud speaker and listen.—*Photos courtesy of Western Electric Company.*

Speed

By HAROLD F. RICHARDS, Ph.D.

(*Continued from page* 119)

Under the blow of the bullet, the block and the imbedded bullet are lifted a certain height against the force of gravity. Such a rise can only be produced by doing work upon the block, and the amount of work is equal to the vertical rise multiplied by the total weight lifted. This work is done at the expense of the energy of the moving bullet, and we have only to express it in terms of the speed and mass of the bullet in order to find the speed. We can not use the principle of conservation of energy, because a good deal of the energy of the bullet is dissipated inside the wooden block in heat and molecular deformations; but the principle of the conservation of momentum, however, helps us over the difficulty, stating that regardless of any dissipation of energy the whole momentum of the bullet is imparted without loss to the block.

By means of these laws we arrive at the simple formula given in the diagram. Thus if the experimenter will take the square root of the vertical rise, in feet, through which the center of the block is lifted, multiply that result by eight times the combined weights of the block and bullet, expressed in pounds, and then divide the result by the weight of the bullet, also in pounds, he will have as an answer the speed of the bullet, in feet per second, just before it struck the block. For example, if the vertical rise was 0.52 feet, the weight of the block 5 pounds, and the weight of the bullet 0.016 pound, the speed of the bullet would be calculated to be 1,800 feet per second, or 20.4 miles per minute.

The accuracy of the result will depend chiefly on the precision with which the vertical rise of the block and the weight of the bullet are determined. A druggist's scales may be used to weigh a sample bullet which has been discharged into wet sand and then cleaned. The farthest distance to which the pendulum swings should be determined by means of a self-recording device. A slender iron nail may be fastened into the lower face of the block, so that it will mark out the track of the swing in wet sand which has been carefully smoothed and curved just below the pendulum. The height can of course be calculated from the angle of swing, with the aid of a trigonometric table; but the method which I have indicated will give satisfactory results in all cases where great precision is not required.

It is necessary that the bullet be fired horizontally and from a sufficient distance to avoid adding the effect of the expelled gases to the impulse of the bullet, and the block should be struck at the center of the face. Strictly speaking, the point of impact should be 0.01 inch below the center, for a pendulum of the dimensions given. The suspension should be sufficiently long, and the block heavy enough, to prevent the pendulum from swinging through more than a quarter of the distance to the horizontal. Thus a shorter suspension, and a lighter block, would be used to measure the speed of the shot of an air rifle; while a long suspension, together with a large box filled with some dough-like material, should be used if the experimenter wishes to estimate the speed with which he can throw a baseball. In the latter case the side of the box towards the baseball should be open, so that the ball sinks into the softer material contained inside; since the reasoning which has been given cannot be applied if the projectile does not remain imbedded in the block of the pendulum.

(*Part II will appear in next issue.*)

Popular Astronomy

By ISABEL M. LEWIS, M. A.

(*Continued from page* 137)

Mars, and the mystery surrounding this twin-world of ours is, if anything, deepening.

Here is a planet known beyond doubt to possess a dense atmosphere, a planet that has always been assumed to be enveloped in dense clouds of water vapor, that has recently been found to exhibit not a sign of the existence of water vapor, oxygen or any other substance in its atmosphere! Moreover, recently, decided doubts have been raised once more as to the length of its day, which it seemed for a time had been definitely settled to be equal to the planet's period of revolution around the sun, or 225 days.

This planet, which we have every reason to believe is an inhabited world, challenges the astronomer to solve its mysteries, which are fully as puzzling as those that are presented to us by the planet Mars.

Statement of the Ownership, Management, Circulation, etc., Required by the Act of Congress of August 24, 1912, of

SCIENCE AND INVENTION,

published monthly at New York, N. Y., for April 1, 1923,

State of New York, } ss.
County of New York, }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of the SCIENCE AND INVENTION, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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H. GERNSBACK,
Editor.

Sworn to and subscribed before me this 27th day of March, 1923.

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(My commission expires March 30, 1923)

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How to Build a Motor Swing Whirler

By LAWRENCE B. ROBBINS

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piece of pipe over the bolt to act as bearing. It must allow all parts to turn easily without danger of binding.

The body of the whirler consists of a piece of straight grained 2″x4″ stuff, 14 ft. long set on the narrow edge. Square the ends and then bore a hole through the exact center into which should be driven a 4-in. length of pipe which will turn freely about the pivot bolt. Set this timber down over the bolt letting it rest upon the assembled bearing; put on washer and nut.

The running gear consists of a bicycle wheel at one end and the motive power at the other. The bicycle wheel forms the trailer and serves to keep the equilibrium of the timber. A suggested strap-in bracket is shown in detail. It is not intended to state a definite method of attaching this wheel but it should serve the purpose admirably. Part A is bolted to the top and bottom edges of the timber and projects out about 2 in. from the end. Part B is a bracket shaped piece, projecting out at each side, surrounding the wheel, and passing along in front of it. Holes should be drilled in each piece in exact line with each other to receive the axle of the wheel which must run at right angles to the timber. Then a third iron must be bolted to the piece B, near the hole, and bent up over the top of the wheel and bolted to the top edge of the timber about a foot back from the end. Parts A and B are shown in the top view detail sketch and part C in the assembly drawing.

The track, as illustrated, is of ½ in. round iron rod. From corner to corner it is 8 ft. long and bent to conform to an arc with a 14½ ft. radius.

The seat is made from a 1-in. hard wood board 24 in. long and 10 in. wide. Bore a ⅜-in. hole 2 in. from each end for the bridle which consists of a U-shaped frame of ⅜-in. round iron with an eye in the center of the U and each end threaded. Make this frame 40 in. long and 20 in. wide. Force the threaded ends through the holes in the seat, placing washers and nuts below, drilling the rod for cotter pins above. Clamp an electric snap switch to the left hand upright. Attach a strong turn-buckle to the eye and then, setting the seat on the track, attach the guides to the under side of the seat at the ends. These are made of strap iron as shown in detail.

Now connect the top eye of the turnbuckle to the bottom eye of the spring suspended from the limb with a piece of ¼-in. wire rope, so that the bottom of the seat is just lifted clear of the track when the timber is level. Further adjusting will be necessary later which will be explained.

The power is obtained from a popular type of Motor Wheel. Several kinds are on the market—any one of which may be adapted to this purpose but the kind illus-

trated in the sketch will probably do as well as any of them. I have not endeavored to explain any exact way of attaching this to the end of the timber but merely suggested a method. That is—have a heavy flat iron bracket made and bolted to the end of the timber with two holes to take a pivot bolt running parallel with the timber. To this the motor wheel is attached and a spiral spring and thrust shim made of a short nipple or a short length of pipe takes up side thrust and gives some flexibility. Then a second piece of lighter strap iron should be bolted to the opposite end of the motor wheel frame, curved around the wheel and brought around on the outside and pivoted to the same pivot bolt. This second strap iron should also be braced with a short piece to the mud guard. An eye should also be fastened to the end of the mud guard at the free end of the wheel. Conditions will probably suggest other and perhaps better methods of attaching this and other types of motor wheels but this can be used as a guide. They all should, however, operate at right angles to the timber and turn it counter-clockwise.

With the motor wheel in place, let's adjust the swing wire and try the whirler out. The timber should be exactly level and the seat resting over the pivot bolt. Put your passenger in position and then take up on the turnbuckle until the bottom of the guides touch the track. Run a length of small window wire from the eye in the motor wheel mud guard, through the pulley attached to the swivel and down through two or three small metal rings fastened to the swinging wire. A handle made from a bundle carrier should hang from it near the left hand. Also connect the motor wheel ignition with a loose braided wire to the switch of the bridle as indicated. A throttle control can be also extended to the bridle if desired but is not really necessary. With the passenger aboard, turn on the gas and ignition and let the wheel rest on the ground. Push this end of the whirler ahead until the motor starts, then let it pick up its own momentum. The whirler will gain headway and as it does so the swing will gradually travel outward along the track until it reaches the end at a wide angle. The spring overhead will allow any necessary flexibility and adjustments can later be made by means of the turnbuckle.

The whirler can be stopped any time by either cutting off the ignition at the bridle switch or by lifting the motor clear of the ground by pulling down on the handle. In the latter case,—when the passenger wishes to start another ride all he has to do is to lower the wheel gently until it gains traction—then let go the pull handle entirely.

After a few experimental turns the speed of the wheel can be set as desired and the arc of the swing thus regulated.

A "DX" Single Peanut Tube Receiver

By MAJOR D. H. NELLES

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Rheostats with the resistance wire wound upon a core are more solid and do not get out of order as easily as those where the resistance wire is a coil with no supporting core. In the latter instrument the resistance wire spacing is liable to become uneven.

On a 1½ volt tube the adjustment of the filament is very critical, especially when the carrier wave is weak, and a vernier rheostat proves very efficient. This is made by getting a switch knob, flattening out the brass strip, giving it a right angle twist and filing the lower edge to a knife edge. A short piece of resistance wire is bent in a semi-

note again. Keep the condenser on the low note and adjust the instruments until voice or music is heard; then with the vernier condenser tune it in as clear as possible. When the hand is taken away from the vernier condenser it will be found that the music is out of tune to a greater or less extent. The capacity of the hand adds to the capacity of the condenser and when the hand is taken away it has to be compensated for by adding to the capacity of the condenser by turning more of it into circuit. Note the two readings and the difference is equal to the body capacity and is to be allowed for in tuning other stations. Now adjust the filament with the vernier rheostat so as to obtain maximum clarity.

Each of the big broadcasting stations should be experimented with to find out the number of turns of the primary coil that will bring in the station the loudest and at the same time give the lowest filament current consumption. When the operator has this information the reading of the dials should be taken and noted. Then when he wishes to listen to any station on his list, all he has to do is to set the instruments at the readings for the station and slowly turn on the filament current and the music or voice will come in directly.

Photographing the Tracks of Atoms

By PROF. WILLIAM D. HARKINS

(*Continued from page* 130)

shoot straight through most of the atoms of the air, once in a while they hit the nucleus of an atom of one of the constituents of air, and the nucleus which is hit shoots forward at high speed, while the nucleus of the helium atom rebounds backward, as may be seen in Fig. 1. This is undoubtedly the best photograph of an atomic collision ever obtained. The nucleus of an atom contains nearly all of the mass (or weight) of an atom, yet it has a diameter about ten thousand times smaller than that of the atom itself. One marvelous feature of photographs like that shown here is that by measuring up all of the angles in the tracks, wherever they bend, it is possible to determine the diameter of the nucleus of an atom of any gas which is present in the cylinder. Air consists largely of two gases, nitrogen, 80 per cent, and oxygen, 20 per cent. It is probable that the nuclei of these two kinds of atoms have almost the same diameters, but pure nitrogen or pure oxygen can easily be used in the apparatus. In making a determination of the diameter of an atom nucleus it is necessary to obtain two photographs, instead of one, of each set of tracks. These two photographs are taken so as to give two views at right angles with each other, but upon the same strip of motion picture film This is done by using a set of mirrors and a prism set between the camera and the apparatus.

There has been much interest of late in what is termed the disintegration of atoms. When an electron is knocked out of an atom it is not said to be disintegrated, but only to be ionized, since the atom can easily pick up an electron from the surrounding materials, and thus becomes itself again. However, if the nucleus is broken apart, the atom is converted into another kind of atom, and is said to be disintegrated.

About twenty-four years ago Madam Curie discovered a radioactive substance, *polonium*, which disintegrates by itself, as all radioactive substances do. An atom of polonium shoots off a helium nucleus at a speed of about ten thousand miles a second, and thus changes into the nucleus of an atom of lead. The white speck on the back of the glass cylinder in our apparatus contains a minute speck, too small to be seen, of polonium. From this polonium shoot out the atom-nuclei, whose tracks are visible in the apparatus. Thus it is possible to photograph the effects of the disintegration of atoms of polonium and their transmutation into lead.

While the natural disintegration of atoms may be thus photographed, it has not been possible thus far to photograph their artificial disintegration. To secure this artificial disintegration it is necessary to bombard the atoms of nitrogen by helium nuclei, which are traveling faster than those which escape from polonium, and this can be done by using Radium C, Thorium C, or other radioactive substances in place of polonium, since helium nuclei from these substances travel about twice as fast as that radiated from polonium. These extremely fast particles, it has been shown by Sir Ernest Rutherford, sometimes disintegrate the nitrogen atom nuclei which they strike. The disintegration occurs so seldom, however, that it would be necessary to take an enormous number of photographs in order to secure a single one showing a disintegration.

The object of the present experiments is to see if there may not occasionally be cases in which the bombarded atom nucleus breaks up in such a way as to shoot off a helium nucleus. In any event, if such a disintegration were to be caught photographically, a single track would be seen to split into *three* instead of into *two* tracks, as in Fig. 1. One of these tracks would be due to the bombarding helium nucleus, one to the helium or hydrogen nucleus knocked out from the bombarded nucleus, and the third to the remnant of the bombarded nucleus left behind. In some cases one of these tracks might be so short as to escape detection. The difficulty of the problem lies in the rarity of the events we are endeavoring to photograph.

The development of the present apparatus is due to two fundamental discoveries. First, Aitken, a meteorologist, found that rain drops will not form in perfectly clean air, but easily form around dust particles in the air when the air is cooled in any way, as it is when it is expanded. About twenty-five years ago, C. T. R. Wilson, of Cambridge, England, found that water drops would deposit also on electrons or upon charged atoms; the latter are ions. About ten years ago he invented an elaborate apparatus by means of which he could photograph the tracks of helium nuclei in air. This apparatus worked so slowly that he obtained no photographs of atom collisions. About two years ago, Shimizu, a Japanese, working with Wilson, discovered that the cylinder of a pump could be used for cooling the air. The present photographs were obtained by R. W. Ryan and the writer, using a still further improved form of the apparatus by means of which we have taken more than ten thousand photographs. These are made by the machine at the rate of one in two seconds, if we wish to get a new set of tracks in each picture; or at a rate of 16 per second, if we wish to exhibit them in a moving picture. Moving pictures of the apparatus and of the flashing tracks have been exhibited in the Chicago theaters by the Pathé Co., but our own pictures are not yet ready for exhibition.

A "DX" Single Peanut Tube Receiver

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circle with the ends held in place by two small brass bolts. The positive lead from the "A" battery is connected with one bolt and connection taken from the axis of the switch arm to the main condenser.

It will be seen in the illustration that the variocoupler has a slider to put into the circuit the number of turns required on the primary coil. This coil is wound with 110 turns of No. 24 enameled wire.

The variocoupler is to be tightly coupled; that is the rotor ball is made so as to allow only a quarter inch space between it and the inner wall of the primary tube. The ball is wound with No. 28 enamel cotton covered copper wire, 60 turns, 30 on each side of the axis. When a brass axis is used, it should never be allowed to pass straight through the rotor, as this gives rise to cross-currents and trouble. In this set a wooden ball is used which was especially turned to fit the tube and an empty space was left in the center of the axis one and one-half inches long. In winding the ball, start each side from the part farthest away from the axis, leaving about a foot of loose wire, and taking care that both halves run in the same direction. The connection between the two halves should be soldered together.

Most variocouplers on the market have from two to four contact or sliding connections, each of which brings resistance into the circuit. In this variocoupler the ends of the winding of the rotor were left long enough so that they could be soldered directly to the plate contact strip (not to the bolt holding it in place) and to the phone condenser as illustrated.

The proper value for the grid condenser for the average tube is .00025 mfd. Used with the writer's design of grid leak, preference is given to one 2½ inches long by ½ inch wide, made with copper foil and having the ends covered with it, as solder can be used for making connections. The grid leak consists of two narrow strips of brass with a large hole bored in one end and a small hole in the other end of each piece, which are two inches long by ⅝ wide. The condenser and brass strips are screwed down to the base board and a piece of "9H" pencil put through the two small holes in the upper ends the strips being bent so as to grip the pencil lead firmly. The resistance can be varied by putting more or less lead into circuit and also by using different degrees of hardness in the lead. In this set the grid condenser is soldered directly on the grid contact strip of the valve socket.

Direct body capacity from the hands can be got rid of by putting two panels in the set 4 inches apart and extending the axis of the various instruments to the front panel with some insulating material. In this set the usual method was used; that is, a copper shield was placed on the back of the panel.

The following method of tuning is recommended to all owners of radiophones when first starting to operate a set. Provide a note book, rule one page up in columns, one column for each dial on the set, the station number, and its location, leaving the opposite page for remarks. Set the primary winding and the rotor at any arbitrary value, the vernier condenser half in and half out so as to be able to tune both up and down, the vernier rheostat in the center so as to be able to tune up or down; turn up the main rheostat until the filament of the valve is a dull red, turn the main condenser slowly around until a carrier wave whistle is heard. It will start with a high note, go down the scale to a low note and then up to a high

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.

COVER FOR STRAW HATS

(711) Benjamin Katz, Brooklyn, N. Y., submits an idea for a transparent rubber covering for straw hats and asks whether we would advise that he patent the same.

A. You are just a little too late with your rubber covering for straw hats. We would advise that you look at the August, 1922, issue of SCIENCE AND INVENTION, under the section entitled "Patent Digest." You will find that you have been antidated by just about eight months.

MULTIPLE CONTACT PUSH BUTTON

(712) Walter Kepler, St. Louis, Mo., asks what we think of a multiple contact push button, the drawing of which he has enclosed.

A. The only way in which your multiple contact push button could be used in radio is as a switching arrangement. Unfortunately, your illustration is not clear at all, and neither do you tell how the push button is supposed to operate. Therefore, we cannot advise more fully.

FOUNTAIN PEN BLOTTER

(713) George Kira, New York, N. Y., submits two models of a fountain pen blotter attachment, which attachment folds against the pen. He requests our advice.

A. With reference to your fountain pen blotting attachment, we are under the impression that although it may be possible to patent it, the idea is neither unique nor novel.

The writer believes that you would not care to have one of these attachments on your pen, and he is positive that he would not want one, even if they sold for only 10 cents. Consequently, assuming that the device would be made even smaller than that shown by you, its added bulkiness would be very undesirable, and it, therefore, would not be employed by ninety-nine and nine-tenths per cent of fountain pen users.

We have seen better suggestions than this, but inasmuch as such add to the bulkiness of the pen, and likewise make the pen unattractive, overbalancing the upper end of the same, we have not advised application for a patent in any case. This same advice would hold true for your suggestion.

CHECK PROTECTION

(714) Harry Schiff, Brooklyn, N. Y., requests our opinion on a check on which two signatures are placed under each other and upon one of these the amount of the check is stamped with rubber stamps.

A. Instead of suggesting a worthwhile idea, you merely substitute one evil for another. At least that is our opinion. A check writer is a comparatively neat small looking affair. Can you imagine what a hundred or a thousand rubber stamps would look like with amounts written thereon, "not over $5.00," "not over $10.00," etc., and don't you also know that a rubber stamp can easily be substituted by another, and that chemical ink erasers can be employed for eradicating a former mark; whereon, because of the two signatures on the same check (a waste of time and money), the forger may recopy the name with ease? We doubt very much if applying for a patent on your suggestion will give you any more than the patent itself, if it gives you that.

PATENTED STEAM BOILER

(715) Frank Slorka, Schuyler, Neb., asks our opinion of a steam boiler on which he holds a U. S. patent, the number of which is 1,199,623, granted to him in September, 1916.

A. We have no doubt whatever that the suggestion embodied in your invention is of value, but the difficulty lies here with the fact that an invention involving the expenditure of so much money in order to bring it to a successful termination, rarely if ever, is profitable. In order that experiments be conducted on the particular plant you have designed, a great expenditure of money is required to build the outfit. Then after the same has been developed, you obtain no more efficiency from the device than with oil sprayed into a boiler, by means of the ordinary types of nozzles. It is evident, therefore, that manufacturers would not care to undertake building a plant such as you have designed, as there is nothing gained in such a structure. Why should they then pay royalties to you for the use of your invention, and be compelled to experiment with it in order to obtain its most efficient results? We would suggest that if you can interest any manufacturer in the installation of the particular type of furnace you have designed, you permit him to do so without charge and even assist that manufacturer in making the plant a success. The publicity from this will probably be a means toward placing your device upon the market.

It would also be advisable to advertise your device in any publication interesting power plant engineers.

KEY SAFE

(716) J. B. Bellingham, San Francisco, Cal., requests our opinion of a Key Safe or holder made in the form of a pocketbook or wallet.

A. With regard to your Key Safe, we would advise that there is a possibility of sale, particularly if manufactured, advertised and exploited by yourself, you financing such exploitation. The wallet is not as clever, however, as those key holders now found on the market which sell for 25c. In your arrangement the keys will not hang in any fixed order; neither will the arrangement hold the wallet flat, but will tend to buckle it into the form of a roll. There are two changes which we would suggest. The first is to have the ring so arranged that it will present a flattened portion upon which the keys are hung; the second is to have a strip of leather to button around this flattened portion, so as to separate the keys, and at the same time to hold the wallet in a flat shape. If you will construct a model of this device, you will find that you must follow our suggestions or improve upon the same in order to make the device practical.

D. C. COMMUTATORLESS GENERATOR

(717) Chester Shurr, Berthold, N. D., submits three ideas; one of them is a radio dial with insulated bushing to fit the shaft; another is a potato picker, and a third is a direct current dynamo.

A. We doubt if you can obtain either a basic or any other kind of patent on your dial. There are many potato pickers on the market today, some of which may be attached to a plow directly, and which cost anywhere from $12.00 to $20.00. Unless we have further information on the same, we cannot suggest applying for a patent.

Your third idea regarding the direct current commutatorless dynamo, cannot in our opinion, be made practical, as regardless of how many frequencies or phases you have, and regardless of how even the ripples between waves of different phases may be made, you will always get the alternating current effect, due primarily to the fact, that even if the waves are but a fraction of a degree apart, each is a distinct and separate impulse, not always audible, but they may be measured and recorded and would ruin direct current instruments. This idea has been tried many times with practically no success. Many commutatorless D. C. dynamos now found are of the uni-polar type.

SPARK PLUG

(718) Sylvester Sage, Greenville, Mich., asks for our opinion of a spark plug with ball electrodes.

A. A spark plug with ball electrodes is very old. One of these was published way back in 1915 in the first issues of the "Electrical Experimenter Magazine," (this journal was then known under that name). We doubt very much if you can secure a patent on the plan, as suggested.

New French Colored Movie Process

(*Continued from page* 128)

corresponding to the green and blue, will stay dark, and will not impress an image upon the photographic plate, for it can only be lighted by rays which are respectively green or blue, and so it goes on. A point of complex color will impress itself simultaneously on two zones; the white and neutral rays will act upon the three zones.

The parts impressed will be transparent upon the developed positive.

To project these pictures, the operation is reversed from that of the exposure, but utilizing the same apparatus.

Placing the positive in the place of the ground glass, we light it from the rear by a beam of white light. The rays, of course, only pass through the transparent portions of the picture. The microscopic lenses follow the law of reversibility of the path followed by the luminous rays, distribute the white rays on the different zones of the color screen and the objective, which colors them, and this gives us in projection an image of the object photographed, reproduced on the screen in its exact colors.

As said in the beginning, the system is exceedingly simple, and in practice the great difficulty is to construct a practical screen of microscopic lenses.

The inventors now mould these lenses in the film itself. The surface of the film is embossed inappreciable by sight or touch, with a myriad of minute lenticular cells, whose respective intervals apart must be rigorously the same in all directions. Furthermore, the lines of junction must present a thickness comparable to the edge of a razor blade.

The first trials were carried out with films having 225 and then 520 cells to the square millimeter. They hope soon to carry the number up to 1000 or 1500 cells.

It is not necessary to work to this last stated degree of minuteness for obtaining good results. Thus, in ordinary films the precision may reach the twentieth of a millimeter, 1/800 inch, that is to say, each distinct point of the image is only one twentieth of a millimeter in diameter, which gives 400 points to the square millimeter, 640,000 points to the square inch.

Hunting Trouble in the Radio Set

By H. WINFIELD SECOR

(*Continued from page* 155)

in series across the leak will give a slight click each time the circuit is closed and opened, depending upon the resistance of the device. If no click at all is heard, or an extremely faint one, it is possible that one of the connections of the grid leak is not properly made, and it is better to try a new one in its place. A pencil line drawn on a piece of paper is a very changeable quantity as a grid leak, for paper is hygroscopic, and unless the grid leak has been thoroughly paraffined, it will change with the weather.

TRANSFORMERS

Transformers are now and then the cause of trouble in multiple stage V. T. receiving sets, whether they happen to be of the radio or audio frequency type. Either type of transformer may be tested in the same way as shown in the diagram, by means of a galvanometer, millivoltmeter, or milliammeter, and a battery of a few cells connected across first the primary and then the secondary terminals. If the winding in either case is continuous, a deflection will be noted on the instrument, or a click will be heard in the phones. The phone test is often very disconcerting, as in some transformers having very high resistance windings the click is very faint, but by making this test in a dark corner, a tiny spark may be seen as the wire is touched to the binding post, and this is a pretty sure sign that the click heard is bona fide and the circuit is continuous. With the usual radio head phones, which are very sensitive, a faint click can be heard in some cases with a winding open-circuited, owing to the capacity effect of the windings and a uni-laterial charge effect, which may give a false diagnosis of the trouble; i. e., the transformer may be open-circuited and yet be thought perfect. The meter test, therefore, is the best, and some radio-electricians prefer to use a 110-volt lamp connected in series with the electric light line, or with a 90-volt B battery, and then make a lamp test across the terminals of each transformer winding.

In testing transformers, it is always a good plan to see that the windings are not grounded to the iron core; do this by connecting one of the test wires to the core and touching the other wire to both primary and secondary terminals. The windings should not be grounded to the core, and if such a condition is found to be present, the transformer should be disassembled and the trouble remedied, as this may be the cause of endless trouble in the operation of the set, and it is better to buy a new transformer if the trouble cannot be cleared up. Usually it can be cured, even if the transformer has to be disassembled, in order to find whether the wire of the windings is touching the iron core. This would be the cause of serious trouble, particularly in the case where the iron cores are grounded to earth as practiced by some designers and builders of large radio sets, in order to reduce squealing and howling to a minimum.

DEFECTIVE OR WEAK "B" BATTERIES

Either by opening one of the main connections to the B battery or batteries, these units can be tested by means of a milliammeter placed in series with the circuit, which tests are made more convenient by means of a plug and flexible cord connected to the meter, and self-closing jacks connected in the main B battery feed wires. It is a very good investment to have a milliammeter on the panel of the receiving set, which will show the plate current passing at all times.

If a defective B battery should be at fault at any time and be the cause of trouble, this fact will be noted instantly by connecting up the milliammeter in the plate circuit of the vacuum tubes, as the usual current value will not be indicated. Again, the needle may rest at the zero point on the scale, as it did in one case with the writer a short time ago, one of the small units in a four B battery set having gone completely dead in one day; it was working well the night before and by the next noon-time when the set was started up, it had developed such a high resistance joint or defect in the connections somewhere, that it would not pass a fraction of a milliampere when 120 volts was applied to it from another set of B batteries. This is almost unbelievable, yet it actually happened. If a milliammeter or other testing appliance had been available and had been used at once, a lot of endless hunting for poor joints in the set or other suspected weak spots might have been saved. It is well to make a test about once a week to see what kind of condition B batteries are in; the writer finds a 110 volt, thirty to forty watt lamp one of the best means for testing such batteries. It lights dim red on a small 22½ volt unit, so long as the battery is fit to be kept in the circuit, and will no longer light the lamp even dim red when it is about time to discard it. The lamp lights up brighter and brighter, of course, as it is shunted across more cells of the B battery, and at 120 volts the lamp lights up to full brilliancy.

In one set the writer had this test lamp rigged up behind a peep hole in the front panel, with a push button on the panel, so that a test of the B battery with the lamp could be made at any time. A short circuiting switch or two placed across the loud-talker and head phone terminals will be found useful in testing out these devices, or in operating the loud-talker at full efficiency once the station has been tuned in by means of the head phones. Sometimes it may be desirable to cut out the loud-talker when the telephone rings, and with such short-circuiting switch this is very easy.

"A" OR STORAGE BATTERY

The storage battery, providing it is not too old a one, usually gives but little trouble in the operation of the multiple stage V. T. receiving set. Sometimes when batteries are rented while your own battery is being charged, it will be noticed that the operation of the set is not as smooth or as quiet as when your own battery is in use. In some cases this inferior result will be found due to the fact that the rental battery is in a poor stage of charge, and not in nearly as fine a condition as the garageman intimated. A quick test with hydrometer or voltmeter will determine the condition of the battery in any case. Explicit directions for reading the hydrometer, together with diagram, were given on page 1194 of the April issue of this journal, in the article entitled "Radio for the Beginner," by Mr. Armstrong Perry. A number of other useful wrinkles with respect to determining the polarity of batteries and other practical points of importance were also there given.

In trying out a new set, it is very important to see that the polarities of the various battery terminals are right and connections correctly made. Usually a voltmeter is available which indicates potential when a current passes through it in one direction, and deflects below the zero line when the current is reversed; knowing the positive terminal of the meter, it is the work of a moment to determine the positive and negative terminals of any battery. If two wires from the battery are dipped into a glass of salt water or acidulated water, the wire at which the most gas bubbles are generated is the negative wire. The positive terminal of the B battery is always connected to the

plate terminals (marked P on V. T. sockets), and where several B battery units are connected in series to attain a higher voltage, the positive terminal of one battery is connected with the negative of the next, etc. The negative terminal of a C battery in the grid circuit, when used to help stabilize or quiet down noisy tubes, such as a power tube with high plate voltage frequently connected in the second or third stage of audio-frequency, is connected so as to impress a negative charge on the grid, as shown in the diagram.

The grid leads of amplifier tubes should usually be connected to the negative A battery line, as the diagram indicates, and the detector grid wire to the positive A battery wire. It is always good practice to connect a volt or ammeter in the A battery circuit. To prevent flexible leads which go from the storage battery to the set getting loose and causing a short-circuit and a possible fire during the night, it is a good idea to have a short lead with a spring clip on it connected to the storage battery from a switch. This switch in the writer's apparatus is a double-pole, single-throw twenty-five ampere knife switch, connected as shown. As will be seen, this serves only as a single-pole switch, while the two top terminals are joined by a piece of ten ampere fuse wire, so that if a short-circuit should happen when the switch is closed, the storage battery will be protected by the blowing of the fuse.

AERIAL, GROUND AND TUNING APPARATUS

The principal troubles that arise in connection with the aerial, ground and tuning system are faulty connections, and with some types of variometers and vario-couplers, trouble can be looked for where flexible wire or *pig tail* connections are not used to connect the rotor or moving coil winding with the terminals of the instrument. A very good type of vario-coupler sold at a low price, has this decidedly bad feature, that the bearings are relied upon to carry the current into and out of the rotor winding; in one case these bearings served as first class connections for the rotor for about ten days and then trouble began to develop, manifesting itself by slight noises and crackles in the loud-speaker. This trouble was cleared up entirely by simply taking two short pieces of ordinary lamp cord and soldering them to the brass bearing uprights, and also to the two shafts of the rotor. Switches on vario-coupler primaries are often a source of trouble, as the springs frequently do not hold them tight enough in the bearings to give a perfect circuit. This is overcome by soldering a piece of lamp cord to the circuit wire and to the switch blade shaft.

All aerial and ground connections should be soldered for best results, if you care to have peace of mind and do not wish to hunt for trouble about every other night or so. If you have no soldering iron, borrow one from your local plumber or electrician, and solder every joint you can find, scraping it clean first and then applying some non-corrosive soldering flux, several of which are available on the market, powdered rosin being very good for the purpose. A note of warning may be sounded against spring binding posts in audion circuits, at least; the writer has found it the best practice, once the circuit has been tried out and found to be satisfactory in its operation, to solder the wires to the spring binding post, and not rely on the tension of the slotted spring member against the wire, as the slightest change or weakness of pressure at such a point will be amplified many times by the audions and cause disagreeable noises in the head phones or loud-speaker.

The writer has also found it best to solder short lengths of lamp cord or other wire to the flat brass terminals found on some makes of B batteries, and not to rely on spring

clips for such connections, as this is a fruitful source of crackling noises and variations in the strength of speech as heard in the loud-talker.

A peculiar trouble which came up with one set a short time ago, and was made manifest by a slight roughness mixed with slight but disagreeable and noticeable noises of the same crackling order, in the speech, was finally found to be due to dust which had settled between the condenser plates in a rotable variable condenser. Therefore, if your cabinet is not thoroughly dust-tight, it is a good idea to use a pair of bellows or else your lungs, and blow between the plates about once a week or so, so that they are free from all such dust particles. This trouble is particularly noticeable in houses where hot air furnaces are used. In one case the too familiar noises heard in the loud-talker were traced to particles of dirt and oil in the bearing plate on a variable condenser. After this was removed and the bearing wiped dry and clean, no further trouble was encountered.

LOUD-TALKERS

If everything else in the set has been checked up and gone over carefully and nothing else is suspected, except the loud-talker, it is a good idea to connect a pair of phones in the place of the loud-talker. If the arrangement shown in the accompanying diagram is in use, it enables you to make a test with the phones alone, and if speech is heard perfectly and clearly in the phones, then there is something wrong, no doubt, with the loud-talker. Where a separately excited field type of loud-talker, such as the Magnavox or Vitalitone, is used, the field frame will usually get slightly warm after the instrument has been used for an hour or so, and this is due to the heating effect of the current passing through the field coil and to the absence of ventilation, owing to the design of this instrument, and need occasion no alarm.

Practical Motor Hints

By H. WINFIELD SECOR

(*Continued from page* 140)

all. Contrary to what might be expected, the motor behaved very poorly and the car would hardly climb small grades with any show of pep. After the valve rocker arms and push rods had been adjusted to leave a few thousandths of an inch clearance between the valve stems and the ends of the rocker arms, the engine performed very nicely and gave an entirely different performance than previously.

It is not the writer's idea to recommend cast iron pistons as replacements for aluminum pistons, as if the car is especially designed and built in the first place for use with aluminum pistons, these are, of course, very light, and cast iron pistons, even the lightest ones, are heavier than aluminum pistons; but ordinarily, at least in the writer's case, which concerns a light six-cylinder sedan, and providing the car is not driven at high speed most of the time, the cast iron pistons will not be too heavy for the engine and they certainly do help to keep the oil consumption down, owing to the fact that they can be closely fitted to the cylinders. At any rate the writer's car has worked very finely indeed with respect to the engine, ever since last July, almost a year ago, with the cast iron pistons, and he has been able to use light oil ever since, which he could not do previously.

One or two practical hints which the writer has found to be efficacious in a car which he owned previous to the present one,

and which had a particularly strong penchant for throwing oil and fouling the spark plugs, is shown in Fig. 4. One of the leading American cars, at least in earlier models, had a habit of passing oil by the pistons, this being the type of car previously owned by the writer. This company finally overcame the oil trouble by using an extra long skirt cast iron piston, having four rings on it instead of three. It is frequently the case where such trouble is encountered that there is a sufficient space and stock on the piston, so that a fourth groove can be turned in the piston in order to use four rings instead of three. Another trick to help oil throwing engines is to drill a series of small holes about 3/32" in diameter, in the bottom of the lower groove, and in behind the piston ring so that any oil seeping around this ring will pass through these holes to the inside of the piston, and thence down into the oil pan.

As shown in Fig. 3, still another piston trick for oil throwing engines is to bevel off the square lower edge of the bottom piston ring groove and drill half a dozen small holes downwardly toward the inside in this beveled face, as the drawing shows. The theory of this trick is that the square edge of the piston ring will act as a scraper and force the oil into these holes, whence it will pass to the inside of the piston and drop back into the oil tank.

A handy trick in switching the electric lights on a closed car is that shown in Fig. 4. A pair of two point battery switches or, better still, two standard three-way switches are used to control the dome light, one of these switches being placed on the dash instrument panel, and the second switch on the rear of the front seat, or else on the side wall, convenient for those occupying the rear seat. In this arrangement the dome light or lights can be switched on or off from either switch.

"MOTOR HINTS" CORRECTION

A reader has called our attention to a seeming mistake in the "Motor Hints" department in the March issue. He refers to the article awarded first prize, which describes a device for preventing the overcharging of the battery used in a car. He states that if this arrangement were applied to the average car, the generator would burn out, providing such generator was of the three brush type used on some cars today.

The reader is right in the case of the three brush generator, but this machine is not used on all cars and even if a car owner were to try this stunt on such a dynamo, we hope that before trying it he would know enough about electricity to place fuses in the circuit to protect the machine. This is already done on the majority of the cars on the market today.

If, however, this appliance were tried on a car using an ordinary shunt wound dynamo, or one of the old style series wound machines, the generator would not be harmed in the least. Also the editors presumed that the car owner would investigate the fusing of his particular machine before applying this suggestion, whereupon no trouble could possibly ensue, regardless of the type of generator used.

The Phonofilm--Talking Movie

By DR. LEE de FOREST.

(*Continued from page* 154)

upon the cell is made to fluctuate hundreds or thousands of times per second, the electrical resistance of the cell is varied in strict accordance therewith.

"Connected to this photo-electric cell is a small battery for supplying current, which current is therefore controlled by the light falling upon the cell, and thereby made to exactly reproduce the original telephonic current which was derived from the transmitter when the sound picture was first recorded. This new telephonic current, however, is extremely weak, and must be amplified, again and again through a series of especially designed Audion Amplifiers, until it is increased in power hundreds of thousands of times. This powerful telephonic current then is passed through especially designed loud reproducers, which are located behind or alongside of the moving picture screen, upon which the picture itself is being thrown from the projection apparatus. In this way the reproduced sound appears to come from the voice of the speaker or the musical instrument, whose picture is being thrown upon the screen.

Synchronism: "By the Phono-film process the problem of synchronism is obviously completely solved. The photograph of the sound and of the object are always together on the same film and always in the same relative positions thereon. If the film breaks it is only necessary to insert a new piece equivalent in length to the part cut away, so that the synchronism is never impaired."

Dr. Lee de Forest has patented a light-controlling means which he uses in his talking moving pictures, and which he calls the *Photion*, although in his patent he calls it the Luxion. This device is similar to the vacuum tube patented by Dr. de Forest on February 18th, 1908, containing three electrodes, one of which is adapted to be heated, and each of the non-heated electrodes being located at relatively different distances from the heated electrode. These electrodes are located within an exhausted or partially exhausted envelop, in this particular instance, glass.

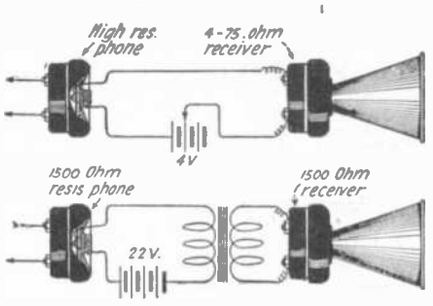
Referring to Fig. 1, U indicates the three electrode vacuum tube, which preferably contains within its glass walls a gas or vapor, such as mercury vapor at relatively low pressures. F is the filament lighted, as in the case of the audion, from a current source A, controlled by the variable resistance rheostat R. The grid electrode g, may be interposed between the filament F, and may be wound spirally around, but out of contact with the filament, as shown in the figure and the plate or wing electrode or anode W, preferably located at the end of the tubular extension E, and out of direct line with its axis, as indicated. This tubular extension E, is preferably located tangential to the vessel U, so that light from the filament F, may not travel through the tubular extension. A source of direct current B, of relatively high voltage, is arranged in series with the choke coil, K, and the plate electrode, W, at one terminal, and with the filament electrode, F, at the other terminal. C designates a battery located between the grid electrode, g, and one leg of the filament electrode, F. This current source is regulated by means of a standard type of potentiometer diagrammatically shown. T is an iron core transformer, whose secondary winding is connected in the grid-filament circuit, and the primary winding of which is in series wth the microphone, M, and a suitable source of current, A. V designates

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.

an auxiliary electrode, either surrounding the tubular extension or extending into the same, the purpose of which will presently be explained.

Dr. de Forest has found that when the filament is lighted, a luminous discharge will appear between the filament and the plate, unless too high a negative charge exists upon the grid. Sometimes in order to start this discharge, it is necessary to impress a positive charge from the grid source, C, on the grid electrode, g, or to close the switch, Y, thus putting the high positive charge from the current source, B, upon the auxiliary electrode, V. When the discharge is once established, its intensity is extremely sensitive to the voltage impressed on the grid electrode, the potential of which, either positive or negative, can be regulated by means of the potentiometer shunted across the current source. The light from the anode discharge, through the tubular extension, E, will of course be most intense when viewed at its end, so for that reason, when the light variations are employed for any of the various purposes, such as recording sounds on light-sensitive surfaces, photographic films, for instance, or for controlling photo-electric cells, a lens, L, is mounted in alignment with the axis of the tubular extension, so as to focus the light on the light sensitive device (such as a thalofide cell) diagramatically illustrated in Fig. 1 at D.

The Instantaneous Photography of Sound Waves

By ALLAN R. KENWORTHY

(*Continued from page* 145)

inches is not recommended. A printing frame from which the glass has been removed, mounted on a block of wood affords a very convenient means of holding the plates in position and readily permits their adjustment or interchange. If desired, a screen of white paper may be substituted for the photographic plate, permitting direct visual observation of the shadow of the wave by a number of observers; in fact, in the adjustment of the apparatus and the initial experiments the use of the screen is recommended, and not until the experimenter is assured of good results should the photography of the shadow be attempted.

In the adjustment of the apparatus, the object to be attained is a properly timed discharge at the spark gap from which the sound wave is illuminated. As the time elapsing between the discharge which creates the sound wave and the discharge producing the illumination is inappreciable, and is determined largely by the length of wiring between the two gaps, it will probably be a matter of some experimentation before the correct adjustment will be found.

When correctly adjusted, it is but necessary to charge the condenser until a discharge occurs across the two gaps, with the result that a sharp, clearly defined shadow of the spark gap at which the sound wave is generated will appear on the screen, surrounded by a dark ring; the shadow of the sound wave.

That the experimenter may gain some idea of the results he may expect from the apparatus, the illustrations in Fig. 2 are presented. Detail A, represents the shadow of the spark gap and the sound wave before it has progressed very far. In B, the wave is further away from the gap and just above the gap can be seen the shadows caused by the heated air as it rises from the gap. C represents a wave that has been reflected from a plane surface, and D, a wave reflected from a concave surface.

Numerous other experiments can be devised by the ambitious experimenter.

Scientific Tools of the Modern Detective

By FERI FELIX WEISS

(*Continued from page* 127)

in the enlarged photograph. Chemical erasing stains being in most cases yellow, and the ordinary plate of the camera being sensitive to yellow, the faintest stains, scarcely visible, are reproduced sometimes so strongly that words may be read where only a faint yellow smudge appears in the original.

In a recent case dozens of checks were put in evidence which the depositor claimed had been raised from ten dollars to larger amounts by using ink eradicator, bleaching out the first amount and raising the check to three, four, or five hundred dollars. Both original and raised amounts on the checks were in the same handwriting, and it was charged that the bookkeeper had made the changes after the depositor's signature had been affixed. This was, of course, a comparatively easy thing to do, but a fraud difficult of detection. Yet the camera plainly showed the alterations, and the conviction of the forger resulted.

Two instruments which are of the greatest help to the examiner of questionable documents and handwritings are the *color comparison microscope* and the *stereoscopic binocular microscope*.

The color comparison microscope shows the delicate differences in color of inks, papers, or articles of any kind; and by the use of the color glasses, the color of inks can be recorded with wonderful accuracy. Another advantage of this instrument is that it brings the two objects into one eyepiece so that they may be observed side by side. It is possible to detect with it the changing color of an ordinary nutgall ink every three hours during the first day it is put on paper. Later a change can be recorded every month or so.

The stereoscopic binocular microscope aids in the detection of *overwriting, patching erasures, folds,* and *crossed lines,* and shows them up with startling distinctness; it also shows if the calendering of the paper has been removed, and whether anything has been applied to the surface of the paper. Where chemical erasures have been made and some of the original ink remains in the fibres of the paper, this ink—if it contains iron—may be partially restored by chemical means. This restoration of the original writing, however, is only for an hour or so, after which it fades out, though the process can be repeated. While in its restored state the original writing may be photographed and preserved permanently. A glass desk is used in the examination of handwriting with the light shining from beneath and showing every detail.

Enlarged photographs of typewriting are useful for observing design and defects, slant, spacing, alignment and the sizes of type in the different makes of machines. The date of certain typewritten documents can be positively established by proving that the type used to write that document was not in the market until many years later. On the other hand, the type of another machine, then rather new, may not have shown certain defects which may be seen now, proving that the document was not written when the machine was new, but is of a much more recent date.

Ruled squares on glass, the *arcmeter,* which measures the degree of curvature of connecting lines, and the glass *protractor,* measuring exactly the slant and angles, are other aids to the scientific investigation of handwriting.

Evidence of this kind is admitted in every court in the land, since the use of micro-

scope and camera is only an extension of the principle of every-day eye-glasses, and objections on the part of a lawyer may be over-ruled by requesting him to take off his eye-glasses or to order the jurymen to remove theirs.

One of the most extensive uses of photography in criminology is, of course, in the field of identification. The collection of pictures in the Rogues' Gallery is for this purpose—*sight recognition*, it is called. Yet I remember many cases where a photograph and general description fitted two different individuals to a dot, and if it had not been for the Bertillon measurements and finger-prints, grave injustice would have been done by the police and court.

THE FINGER-PRINT

In fiction, the use of the finger-print as a means of identification has been dramatically illustrated in Mark Twain's "Pudd'nhead Wilson," in which the hero proves the innocence of the suspected man and the guilt of the criminal by means of finger-prints which he has taken previously of everyone in town as a fad. His dissertation on the subject is well worth reading.

The finger-print system originated in the East, where it was in practice among the natives from very early times and was adopted by Sir William Herschell in the latter part of the 18th century in the district of Hooghli in Bengal to identify the Hindus who came to the government offices to make or receive payments. It was well-nigh impossible for the British authorities to tell these people apart, so singularly alike are they in features, color of hair, eyes, stature and so on, until the wonderfully simple and efficient means of identification by thumb-prints was hit upon.

I myself noticed the great similarity in the Hindus for the first time when a ship-load of them arrived in Boston, destined for Luna Park at Coney Island, where they were to show some tricks. Not one of the party, excepting perhaps the leader from the Island of Ceylon, was able to read or write, so we made them sign the bond under which they were permitted to enter the country for exhibition purposes by putting down their thumb-prints.

The feasibility of the finger-print system once established and its infallibility proven beyond the slightest doubt, it is only a question of time when everybody in this country will be finger-printed. The value of this system to the police was forcibly illustrated to me not long ago. I happened to be talking with the chief of police in a small western town, when a long distance telephone call brought the request from Philadelphia for a certain finger-print record. The chief looked into his files and within two minutes had the record of a man who was wanted for the shooting of one of his own patrolmen. The man arrested in Philadelphia had given a false name, and although the label on his clothes betrayed the fact that he had bought his clothes in this small western town, without the finger-print record he would not have been known because of the Philadelphia alias.

It would lead too far for me to go into a technical description of this system. Suffice it to say that it is based upon the number and character of the arches, loops and whorls on the human finger-tips and their relation to lines from a given center, no two human beings having the same design or number of lines. The best book on the subject has been written by Sir E. R. Henry, the British expert, who spent a lifetime perfecting it. Recently there have been established special schools for teaching this aid to the detective, and an international conference has taken place where papers were read, cases discussed and recommendations made.

The apparatus of the professional detective for taking records consists of a tube

of special finger-print ink, a metal ink-plate, roller for distributing ink, magnifying glass, metal pointer for counting lines in finger-prints, a bottle of benzine used in removing ink from the finger-tips—all contained in a birch tray: the whole thing costing less than ten dollars.

Records are usually taken in the following manner: the specially prepared ink is spread evenly with the rubber-roller on the light steel plate. This dries very quickly. The subject rolls each finger separately upon the inked plate. If the fingers are covered with mud or clay, as is sometimes the case, rubbing them lightly with a benzine cloth will cleanse them thoroughly. They are then quickly withdrawn and rolled gently upon the identification or index card. The operation takes less time than telling about it. Police departments take a separate impression of each finger and thumb of each hand in a square of special size, and a regular code is followed in describing the lines, loops and whorls. A full impression is then taken of all four fingers together, so that no mistake is possible by substituting one finger for the other. Identification bureaus, jails and other institutions, besides police departments, place this record on file, often together with Bertillon measurements and Rogues' Gallery photographs. In a pinch the detective might use, with fair results, an ordinary inking pad, such as is used for rubber-stamps, clearness of lines only being necessary for identification purposes.

Crooks, knowing that the marks of an individual's finger-tips do not change in character from infancy to old age, are anxious to keep their hands in gloves at all times. The latest method of concealment used by burglars is to smear the finger-tips with collodion, which, forming a thin, skin-like covering, leaves no marks behind on any object touched, such as safe or window-sill.

Finger-prints left by the criminal on doors or elsewhere are made visible by the application of a *dark powder* on a light object and by a *white powder* on a dark object. They are usually photographed and enlargements made.

BERTILLON MEASUREMENTS

The *Bertillon* system was invented by Professor Bertillon of Paris and had quite a vogue before the finger-print gave a much simpler and quicker means of identification. It is founded on measurements (anthropometric) of certain parts of the human body. The word *anthropometry* comes from two Greek words: *anthropos*, man; and *metron*, measure.

Bertillon in his system takes for granted that certain parts of the human body change very little once maturity is reached. The measurements are: (1) Length and width of head; (2) length of left foot, middle and little finger of left hand; (3) length of lower part and upper part of body, as well as total height; (4) reach of arms; (5) height and breadth of left ear; and (6) length of left arm. He prefers the measurements of the *left side* because they are less *variable*. The height of a man is half an inch less at night than in the morning owing to the squeezing together of the vertebrae of the spinal column. These measurements are duly recorded on a card-index and the description becomes still more explicit when the color of the *iris* of the eye, which Bertillon grades in *seven shades*, is added.

Before leaving the subject of identification and going on to a new one, I should like to add that *Forgeot*, a prominent criminologist, has discovered that a two per cent silver solution will reveal clearly naked *foot-prints* on *hardwood floors*, and osmiosmic acid or hydrofluoric acid those of the *fingers* on *window-panes* or other glass as well as on *tapestry* and *wall paper*.

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Scientific Tools of the Modern Detective

(*Continued from page* 199)

PSEUDO-SCIENCES

Chemistry, like all modern sciences, has developed from a pseudo-science, which is only a more polite name for *fake-science*, called *alchemy*. During the dark ages, when humanity was groping in blackest ignorance and superstition, when women were burned at the stake as witches in order to clear up mysterious happenings; or to make them confess crimes of which they were innocent and ignorant, people were walked barefoot over burning coals or red-hot iron, strung up by their thumbs and subjected to all kinds of cruelty by instruments of torture; when poor lunatics, living in a frightful condition of filth and degradation, were chained and abused that "the devil or evil spirit" which possessed them might "be driven out"—it was then that alchemy flourished. Under its influence attempts were made to change baser metals, such as lead, into pure gold.

While alchemy has but few adherents nowadays, *astrology*, fake-sister to astronomy, has millions. Astrology pretends to read one's destiny as written in the skies at his birth. *Palmistry*, another pseudo-science, distantly related to the finger-print, is supposed to tell the past, present and future of an individual from the lines of his hand. *Mesmerism* and *clairvoyance*, too, are frauds which have cost many a dupe a lot of money and many a swindler a long term in jail.

LITTLE KNOWN SCIENCES

Of course, we cannot utterly ignore and positively deny certain phenomena in *telepathy, mind reading, thought transference*, which are beyond the sphere of the present development of modern scientific research, with its apparatus and instruments. Modern science admits that there are certain phenomena the origin of which it cannot explain. Professor Flammarion, director of the Paris Observatory, in his book "The Unknown" cites some three hundred cases of authenticated experiences of premonition, dreams that came true, thought-transference across oceans of water and other things of this nature, which he has gathered from all corners of the globe, and which before the age of the wireless might have impressed us as *supernatural*.

The various societies of *psychical research* also are reporting and investigating impartially cases which are brought to their attention.

Modern science also admits *magnetism, hypnotism, suggestion* and *auto-suggestion* as facts, and is trying to uncover the laws of nature which govern these phenomena. Professor Charcot of Nancy and Dr. Bernstein of Paris, Dr. Krafft-Ebbing of Vienna and many others have used this latent power to change formed habits, cure disease and even as an anesthetic agent in surgery.

In a few cases recently, hypnotism and psychology have figured in the courts—especially *psychology*. In almost every trial there are baffling points in the testimony: Was the witness telling the truth when he said he saw Mrs. Jane Jones wearing a black silk skirt and a green hat trimmed with red flowers, just before the fatal shot was fired around the corner in front of him? He asserts that he looked at the town clock at that moment and that it was just eight o'clock daylight-saving time.

The psychologist, called in by the defense, tells the jury that the witness has a very vivid imagination for no human eye can distinguish colors in the twilight. He also insists that the witness could not have been

positive where the shot was fired, as it is impossible to tell whether a shot is fired directly in front or directly behind unless the flash of fire is seen.

Courts and lawyers, however, regard psychology rather skeptically, with uplifted noses, as if to say, "Ah, these new-fangled theories—you cannot take much stock in them!" Yet the fool-proof detective who regards it as mere bunk is just as childish as was the detective who thought finger-prints were nothing but picture-puzzles for the baby. It takes time to convince a doubting world of all these things, but the scientific detective will be an established institution once this science of psychology can approximate one hundred per cent degree of accuracy in its statements and facts.

CHEMISTRY

There is scarcely an article in every day use but that somewhere in the process of creating or finishing the chemist enters. All industry today is eight per cent chemical. And as many sided as these industrial uses, is the detective's application of chemistry to his own ends. Take, for instance, a simple case like the following:

A coat was picked up not long ago in the investigation of an assault on a young girl, who could give no clue to her assailant, except that he had his coat on his arm, which he threw to one side and forgot to pick up when he ran away, scared off by approaching footsteps and the girl's screams. The detective who worked on this case knew enough to put the coat in a *moth-proof paper bag* and beat it with a whip. The dust collected in the bag in this manner was then *chemically analyzed*. It revealed pulverized particles of wood-fibre, gelatine and glue. "Woodworker!" I hear you exclain. Yes. But what kind? Carpenter, joiner, piano-maker, pattern-maker, saw-mill worker—which? The glue suggested more than a saw-mill worker or even a carpenter. And as there was a piano factory nearby, the employees were carefully checked up by the detectives and the ones absent the day of the assault were shadowed and "roped." The right man was thus discovered among these men, and brought to justice.

The chemist helps the detective as expert on narcotics, drugs, liquors and various chemical.

I have a case in mind where a friend of mine, a prominent American chemist and explosives expert, was called in to help the state police. A man was accused of having murdered his wife and of having then set fire to his home in order to collect the insurance money on her life and on the house. The man proved an alibi that was apparently indisputable: he was fifty miles from his home on the day of the fire. He said he knew nothing whatsoever about the fire till he was notified of the tragedy by the authorities upon his arrival in town. The case looked rather weak for the prosecution. What happened?

My friend, the chemist, called in by the authorities, looked the place of the fire over most carefully. The house had been burned down to its foundations, into the cellar. Everything that had not been inflammable had dropped into the cellar, much of it melted by the heat. The chemist noted how trees at some distance from the house were badly scorched. He ascertained by inquiries in the town and from U. S. Weather Bulletins the direction of the slight breeze blowing on the day of the fire, and knew that it would have taken a gale blowing at the rate of seventy to eighty miles an hour to have affected trees so far away.

Next he searched among the wreckage which had piled up in the cellar. He found the remains of a brass bedstead melted into big lumps of metal. As an expert chemist he knew that the heat of a fire resulting

Science Versus Spiritism

By JOSEPH H. KRAUS

(*Continued from page* 111)

were stumped by a rather difficult question), that they could scarcely stand up. Everyone present envied the powers (?) which the medium possessed.

OUR OWN "GHOSTS"

In the spirit photographs which we show on the present page, we see not only manifestations of ectoplasm—a term invented for a supposed fluid or substance which is supposed to emanate from the medium's body—but we also see fairies and complete manifestations of spirit faces and forms. Some of these were taken by Mr. Dunninger, the well-known telepathist and mind reader, and others by Father de Heredia, S.J. Mr. Dunninger produced these spirits right in our own office as follows. He arrived with a small satchel containing the usual five by seven view camera. Placing the camera-carry case down upon the desk he requested that we load our own plate holders with our own plates, in our own dark room. He did not at any time come into the dark room or otherwise interfere with what we were doing. He then requested that we scrutinize the camera, or if we desired, use our own. We preferred to do the latter. So our five by seven camera was placed on a tripod. It was focussed upon Mr. Dunninger and photographs were taken. In each case the spirit form will be clearly seen, and the position was always different. This plate holder never left our hands, and Mr. Dunninger did not handle any of the apparatus whatever.

Father de Heredia on the other hand came into the dark room with us, and told us to write our names across the bottom of each individual plate. His hands were held. We used five by seven cameras, eight by ten cameras, and in fact even used the Graflex. We could not see the spirit on the ground glass, but noticed that we not only got spirits, but also fairies.

In spirit photographs, such as those submitted by Mr. Dunninger, the pictures are printed for their educational value, as in opposition to those submitted by many writers of psychical books. Note the fairies as in opposition to Sir Arthur Conan Doyle's "The Coming of the Fairies." Professor Caesar, author of "The Unseen World," the world famed exponent of spiritualism, also posed with Mr. Dunninger in some of these pictures. Professor Caesar is opposed to the method employed by fake mediums, who are, as he claims, a menace to genuine spiritism. Recently at The City Hall, New York, before Mayor Hylan and a prominent audience of city officials, Mr. Dunninger exhibited scientific manifestations of supposed spiritualism. Although many of the newspapers have misquoted Mr. Dunninger as exposing spiritualism, such statements were incorrect inasmuch as the demonstrations consisted merely of duplicating spiritistic phenomenon by natural scientific means. The method of doing this is known to no one with perhaps the exception of Mr. Dunninger himself and a few of his followers.

A world-wide challenge has therefore been extended through the press and through this magazine to any medium who produces alleged spiritistic manifestations, or to any other medium now professionally practicing and claiming to demonstrate the possibility of communicating with the dead; to meet Mr. Dunninger at the offices of SCIENCE & INVENTION, who will duplicate under test conditions those same phenomena.

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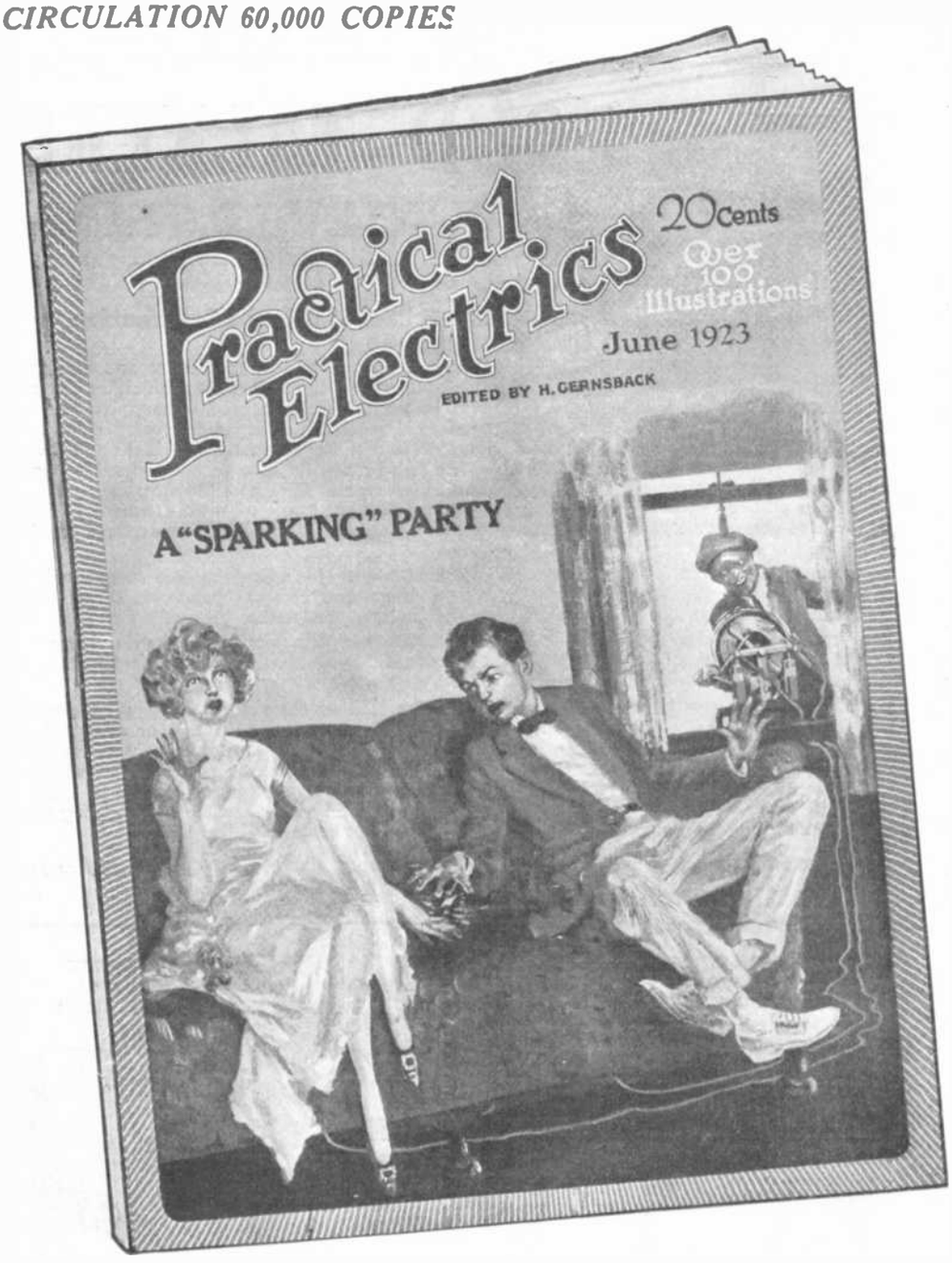

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