July

25 cents

Science and Invention

FORMERLY ELECTRICAL EXPERIMENTER

TELEVISION BY RADIO

See Page 234

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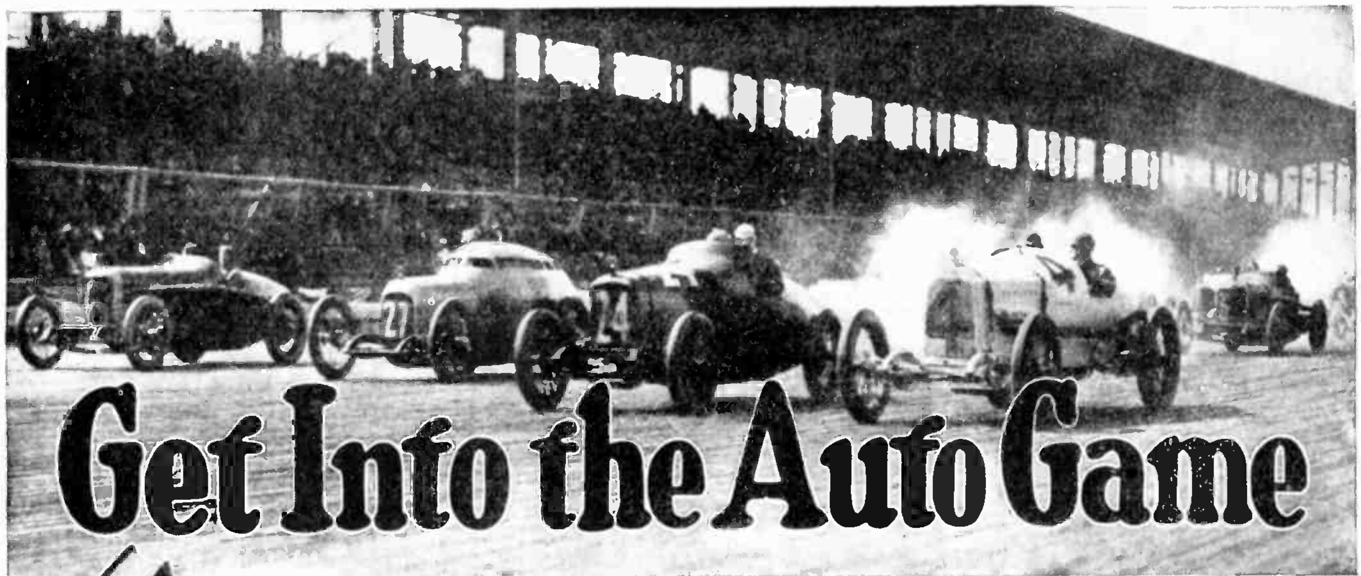

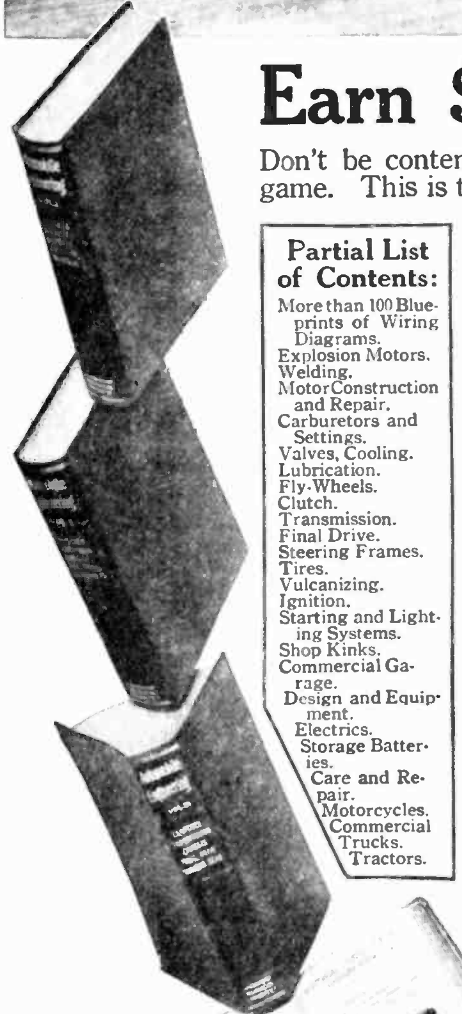

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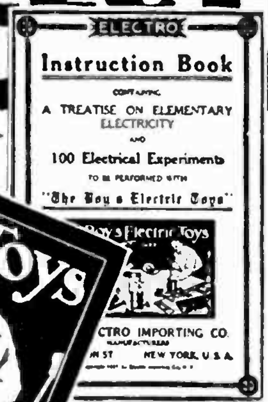

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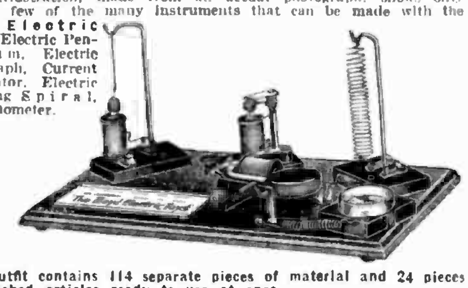

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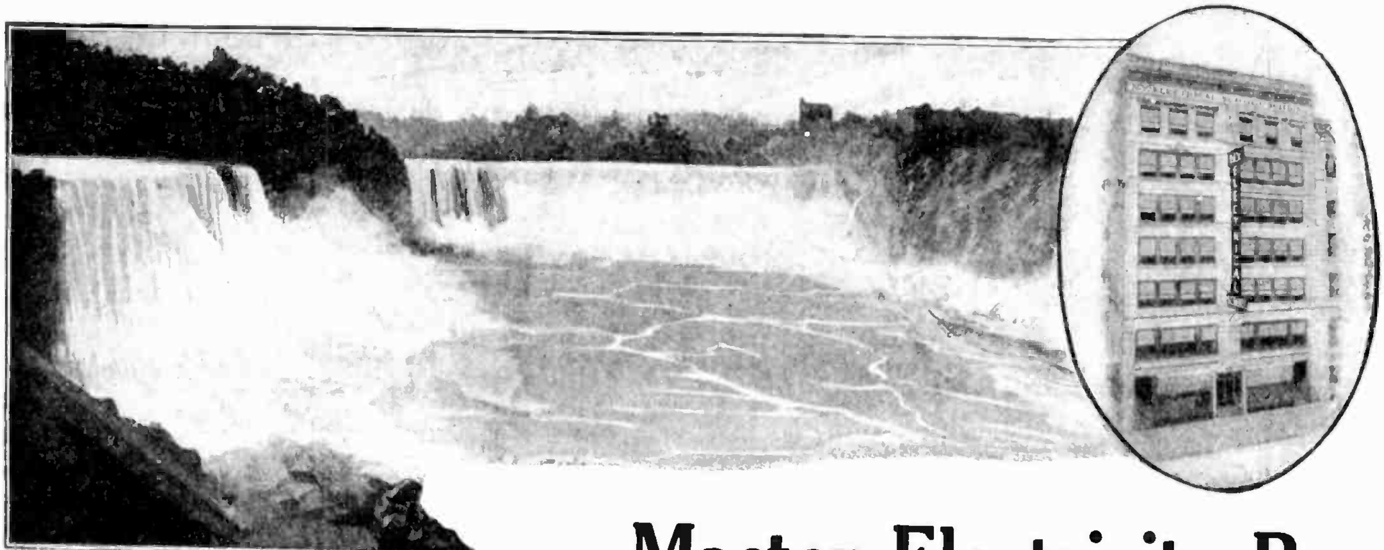

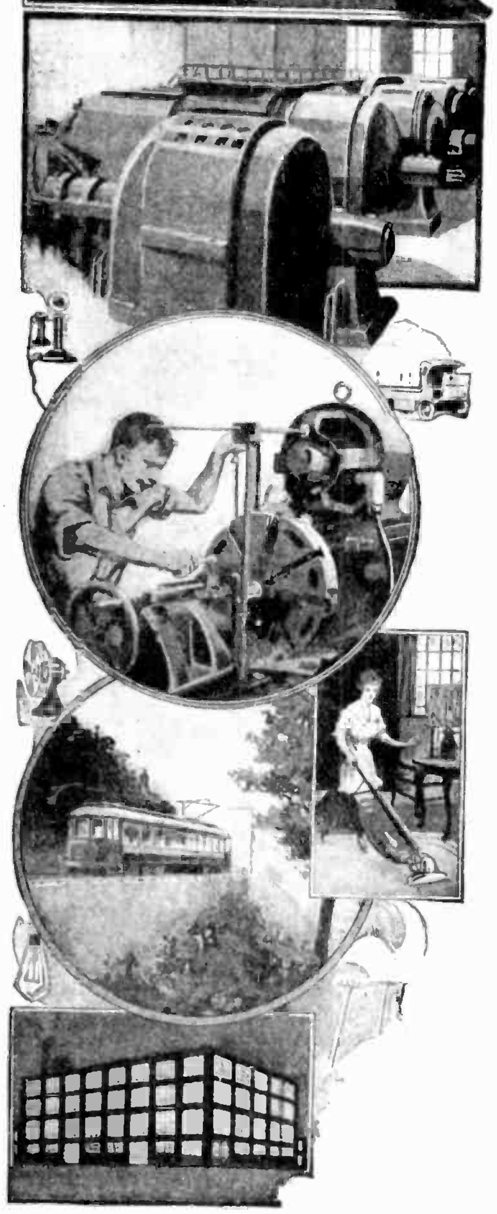

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Volume X
Whole No. 111

Science and Invention

H. GERNSBACK,- EDITOR
H. WINFIELD SECOR,- ASSOCIATE EDITOR
T. O'CONOR SLOANE, Ph.D.- ASSOCIATE EDITOR

JULY
1922
No. 3

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

Evolution

THE other day there was discovered in Scandinavia a certain variety of amber in which there was found embedded hundreds of ants. Through the crystal-clear amber there could be studied the particular kind of ant, a species well-known in Europe, and which still exists in certain parts of the world. Of course, there is nothing so very remarkable about this find, until we mention that this particular kind of amber must be at least several million years old. It can be proved from geological data that this amber must at least date back to the time when the Dynosaurus still was roaming upon the earth.

Minute examination of these ants proves conclusively that not only are they exactly in every particular as we still have them today, but anatomically at least, they have not changed either in size or in any other manner, shape or form. Offhand, there seems nothing peculiar about such a statement, but it seems very strange that such a highly cultured insect such as the ant, should not have changed whatsoever in such a great lapse of time.

To be sure, the piece of amber tells us nothing as to the former habits of these ants, no pre-historic ant hill having been found intact. Physically, we know that the ant did not change, and if we may use the term "mentally,"—for ants certainly have a very high degree of intelligence,—we are not at all sure that the pre-historic ant was the same "mentally" as it is today.

Evolution is a curious thing. It seems as if certain species of animals are standing still physically as well as "mentally" for thousands upon thousands of years. Take for example the cat. While we know that perhaps several hundred thousand years ago our present domestic cat was wild, still as far as human history goes, the cat has not changed. The cat of the old Egyptians ten thousand years ago was practically the same cat as we have it today. Apparently not much change in evolution here. The cat, then as now, caught mice, hunted birds and did all the other various tricks which the present day cat does. One might argue that ten thousand years in the life of any animal specie is comparatively nothing, but it may be doubted that the cat one hundred thousand years from now, providing it lives under conditions similar to what it lives now, will be much different from the cat we know today. It is almost certain to predict that it will not be able to talk, or read, or acquire other very startling habits. In this, however, we may be entirely wrong.

Thus, for instance, there is no good reason why the human being is what he is today. The human seems the great exception in the animal kingdom for in a comparatively short time, geologically speaking, he has undergone remarkable changes. We do not refer to mental changes, but to physical changes. Thus, the skulls which we excavate show that for instance, the pre-historic caveman of the Neanderthal type was structurally a different sort of a man than modern man. There has, for instance, been very much less physical change in the cat in an equal period of time. Should we attribute this change entirely to the brain?

There seems to be no question that civilization has a tremendous influence upon the physical make-up of man. Of the animals that change their habits most, man seems to rank first. A cat does the same things for generations after generations, for centuries after centuries. Man on the other hand, due to the thing which we call civilization changes his habits ever so often. He is either an agriculturist and does heavy manual labor, or he is an office worker where he has little opportunity to use his body and muscle. We can readily understand that if a family were farmers for centuries after centuries, they would produce an entirely different sort of man than a family which were producing nothing but office workers generations after generations.

What does all this prove? It simply goes to show that as always in evolution, environment is in all cases the outstanding factor. It is the reason why the grasshopper who for thousands of years has lived among green foliage, acquires the green color from its environment.

It may be doubted if the human brain has changed much from that of the caveman. The old Egyptians and the old Romans, you may be sure, had as good a brain as man has today, and as a matter of fact many seem to contend that their intelligence in many things was far ahead of ours. They certainly were ahead as far as physique is concerned, and we are not at all sure that civilization has benefited the race physically. Man is apt to pride himself unduly as to his brain development. It is not always a thing to be proud of, and we are not quite certain that the ant does not stand on a much higher plane of civilization than man. Anyone who watches an ant colony for a certain length of time probably will come to this conclusion.

H. GERNSBACK.

NOTICE

With this issue SCIENCE & INVENTION goes back to its old size 9 x 12 inches. When in 1920 SCIENCE & INVENTION reached a circulation of 200,000 copies, it became necessary to print the edition on a rotary press. Unfortunately at that time no rotary presses that could print a magazine of the size 9 x 12 could be secured, and we had to content ourselves with printing a magazine 11⅝ x 8⅛". We realize that this was not satisfactory, but until very recently it was not possible to make a change to print the larger size.

We hope our readers will be pleased to see the return of the old size under which the magazine was established. We are now again able to give larger margins on the paper, and the book altogether is made much more readable than was the case during the past two years.

THE PUBLISHERS.

Can the "Lusita

THE VIEWS OF LAKE, WILLIAMSON, LEAVITT

By JOSEPH

THE steamship *Blakely* was scheduled to leave the United States not later than June 1st. She is commanded by Captain C. S. Richards and fully equipped with eight diving suits, the invention of Benjamin F. Leavitt, who holds the world's salvage record for 175 feet and the world's deepest dive of 361 feet. The *Blakely* is off to remove the gold aboard the ill-fated *Lusitania*. It is estimated that the treasure aboard the sunken *Lusitania* is over five million dollars in specie, in addition to cases of silver and valuable jewelry, valued at $3,750,000. She lies in 285 feet of water off the coast of Ireland on hard bed rock and her location is accurately known, having been determined by soundings. The suits are constructed of heavy armor as shown in one of our photographs. Each suit contains its individual air supply. An oxygen tank capable of delivering the required amount of gas in proper amount and at proper pressure is secured to the back of the bronze armor. Inside of the apparatus is a tank of caustic potash, which absorbs the expired carbon dioxide. Consequently the diver breathes in a mixture of gases comparing closely with the air, when he is placed within the apparatus and the sections are locked in much the same manner as the breach of a gun is secured. About four-fifths of the air present is nitrogen. This is not absorbed by the human system, and is breathed over

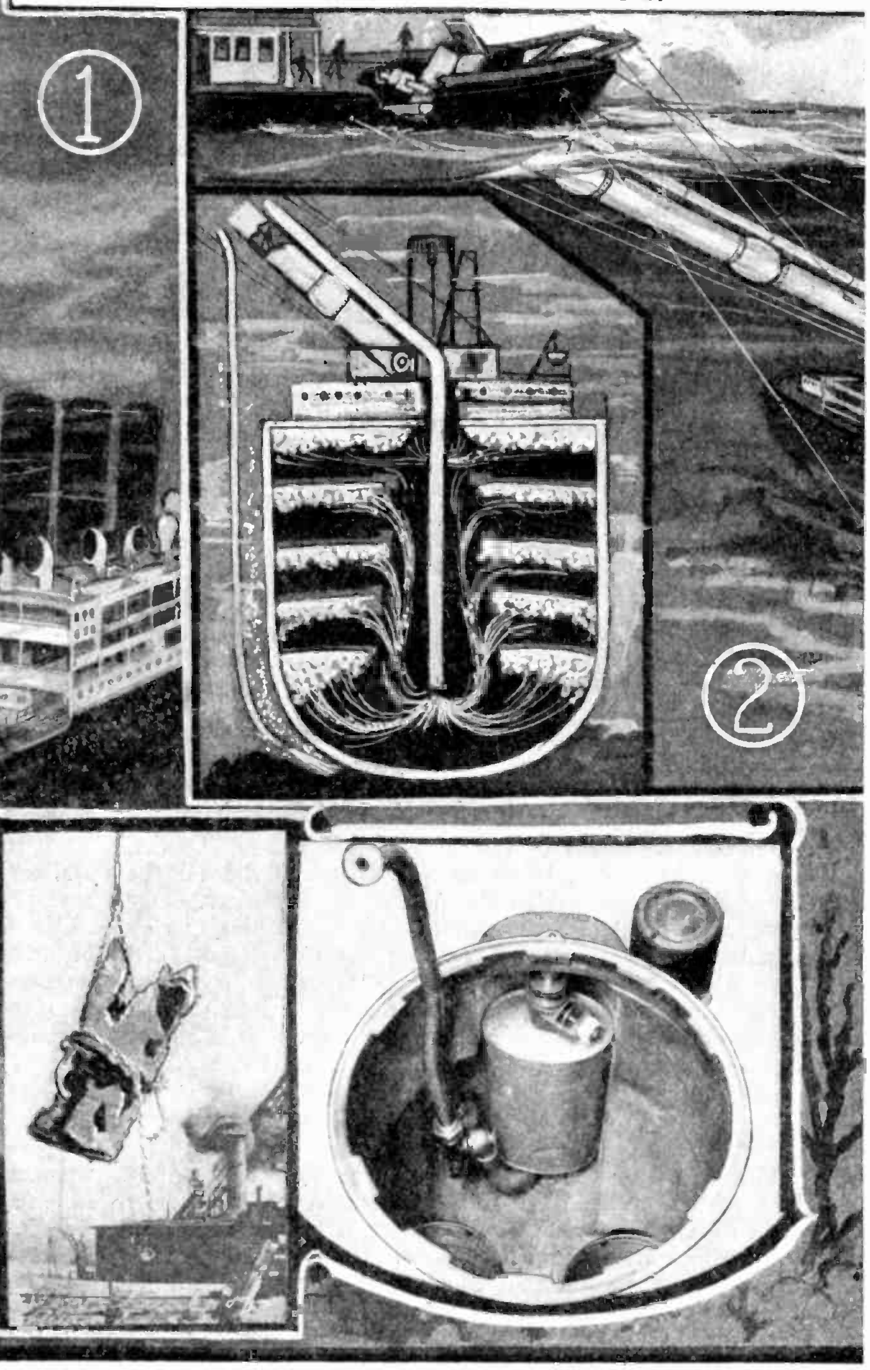


Fig. 1 Illustrates the Method Used in the Present Recovering of Moneys from the Lusitania. The Photo Insert at the Left of the Same Figure Illustrates the Leavitt Diving Armor, and the Three Photos Below from Left to Right Show a Diver Before Going Overboard; a One-Ton Chunk of Copper Ore and the Diver's Breathing Apparatus.

nia" Be Raised?

AND OTHER EXPERTS (SPECIAL INTERVIEWS)

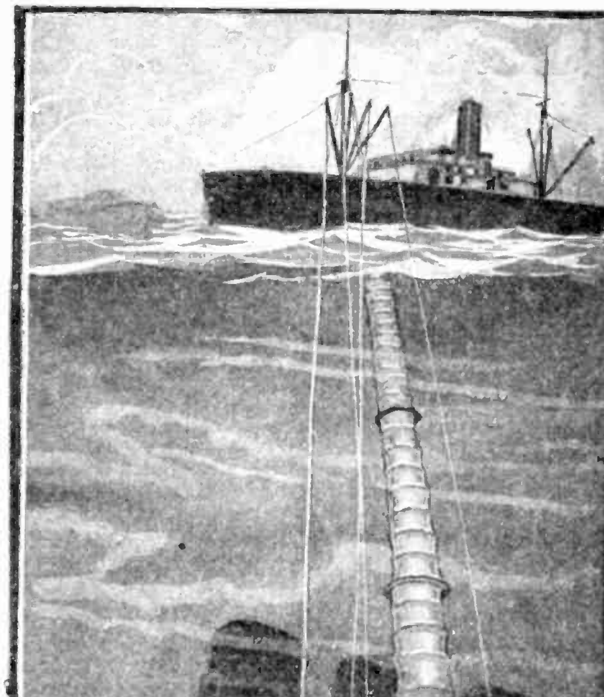
H. KRAUS

and over again. The arms of the diving suit are fastened to the body in ball bearing sockets. The movement of the hands or rather of the tongs gripped by the hands, is rather limited, but sufficient to enable the diver to operate at the great depths to which he is to descend. Electric light supply to the diver below is furnished by the tender above, in the form of 1,000 watt incandescent lamps, covered on the outside with pyrex glass protectors. On actual test this glass has been able to withstand a pressure of 2,000 pounds per square inch, equivalent to a depth in water of nearly a mile. This cable has a telephone cord running thru its center, so that the diver below is at all times in communication with the surface vessel.

Captain Charles E. Richards, the master of the *Blakely*, is so sure of the position of the sunken ship that he claims he can drop right down on top of her deck. Mr. Leavitt says: "We will go to the bottom and place a very light charge of dynamite in a circle above the purser's strong box, as it is necessary that I drop vertically down into the hold or other parts of the vessel which I intend to reach, it being quite difficult to tow our heavy armor around. Movement is limited, I will grant, but it is not impossible, and if I recall correctly, I can manage to take 11 or more steps per minute. This

(Continued on page 301)

Fig. 2 Illustrates the Method which Simon Lake would Employ to Raise the Vessel, Pumping a Mixture of Molten Paraffin and Balsa Wood in the Same. Fig. 3 Shows Captain Charles Williamson's Method of Attaining Great Depths, and a Photograph Insert Taken from the J. E. Williamson Motion Picture Production "Wet Gold," made Possible by this Apparatus.



Unique Double-Deck Subway

A FEW months ago or, to be exact, in the April issue, an article by H. Gernsback appeared, describing his plan for double-decking the cars in the large city subways, such as those in New York, where the traffic conditions are almost unbearable in the rush hours, and now comes Bernarr MacFadden, well known New Yorker, who has taken out a patent on a unique double-deck subway car system, which is shown in the accompanying illustration.

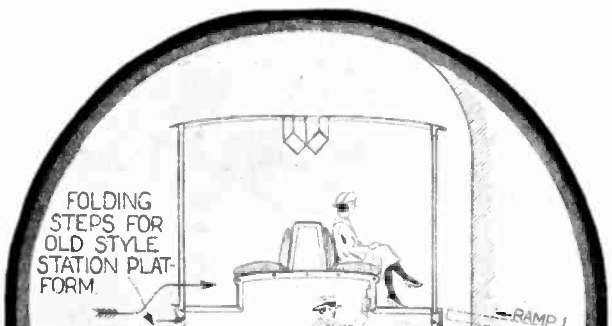
Mr. MacFadden has brought out several ingenious ideas to permit the building of these double-deck subway cars in such a fashion that they will not have to be a great deal higher than the present cars. The floor level of the subway cars now in use is about $4\frac{1}{2}$ ft. high above the tracks, and thus a lot of space is wasted compared to the system here shown, where the car wheels are caused to occupy space up under the seats, as one of the sectional views clearly indicate. The inventor also points out that it is not necessary to have the first floor ceiling the full height of the car all over, but this can be made the normal height in the central part only, as illustrated, this in turn helps to lower the ceiling height on the second deck, as becomes evident. The mirrors shown in the sectional drawings are to enable the motorman to see when all the doors are closed.

The folding steps midway up the side of the car and just under the upper deck doors, are for use at old style stations to permit passengers to ascend to the upper car decks, while passengers desiring to pass to the lower car floors may do so via the folding steps also shown in the picture. As the car leaves the station where these steps have been in use, the motorman pulls a lever which causes them to collapse and fold up flat against the steel partitions, as the drawing indicates.

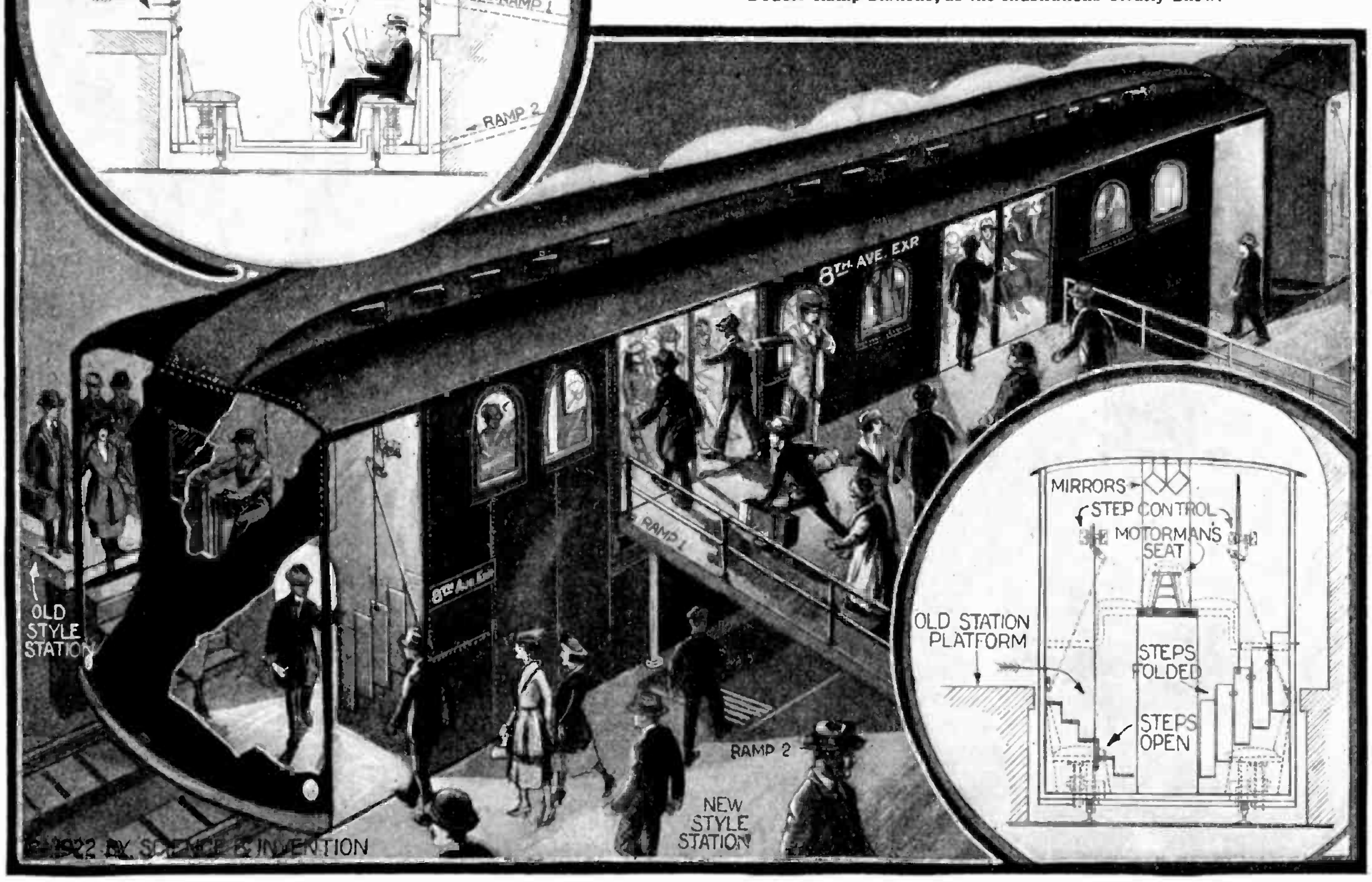
No doubt with this system a greater number of people can be handled than might at first be imagined, particularly when the double ramp system shown in the large view and described in Mr. MacFadden's patent, is brought into play. The upper ramp or inclined platform serves the two or more doors opening on the second car deck, while the downward inclined ramp serves the main end doors for passengers bound for the lower deck. These ramps are repeated along the length of the train. The cars would be propelled by the third rail system in the usual manner, and the operation of the folding steps could be taken care of either by compressed air or by electro-magnets or by both.

This scheme of double-decking the subway cars has many commendable features about it, one of the principal considerations being that it could be adopted by degrees without obstructing traffic; the new double-deck cars according to this plan, being fully provided for discharging or taking on passengers at old stations, as well as the new double-deck stations, provided with ramps, etc. In this way it is possible to build the new double ramp stations one by one and still take care of the traffic at the old stations, while the reconstruction work is going on. In some cases the subway tracks would have to be lowered, while in others, where considerable street material remains above the subway, the ceiling could be raised and the tracks left as they were.

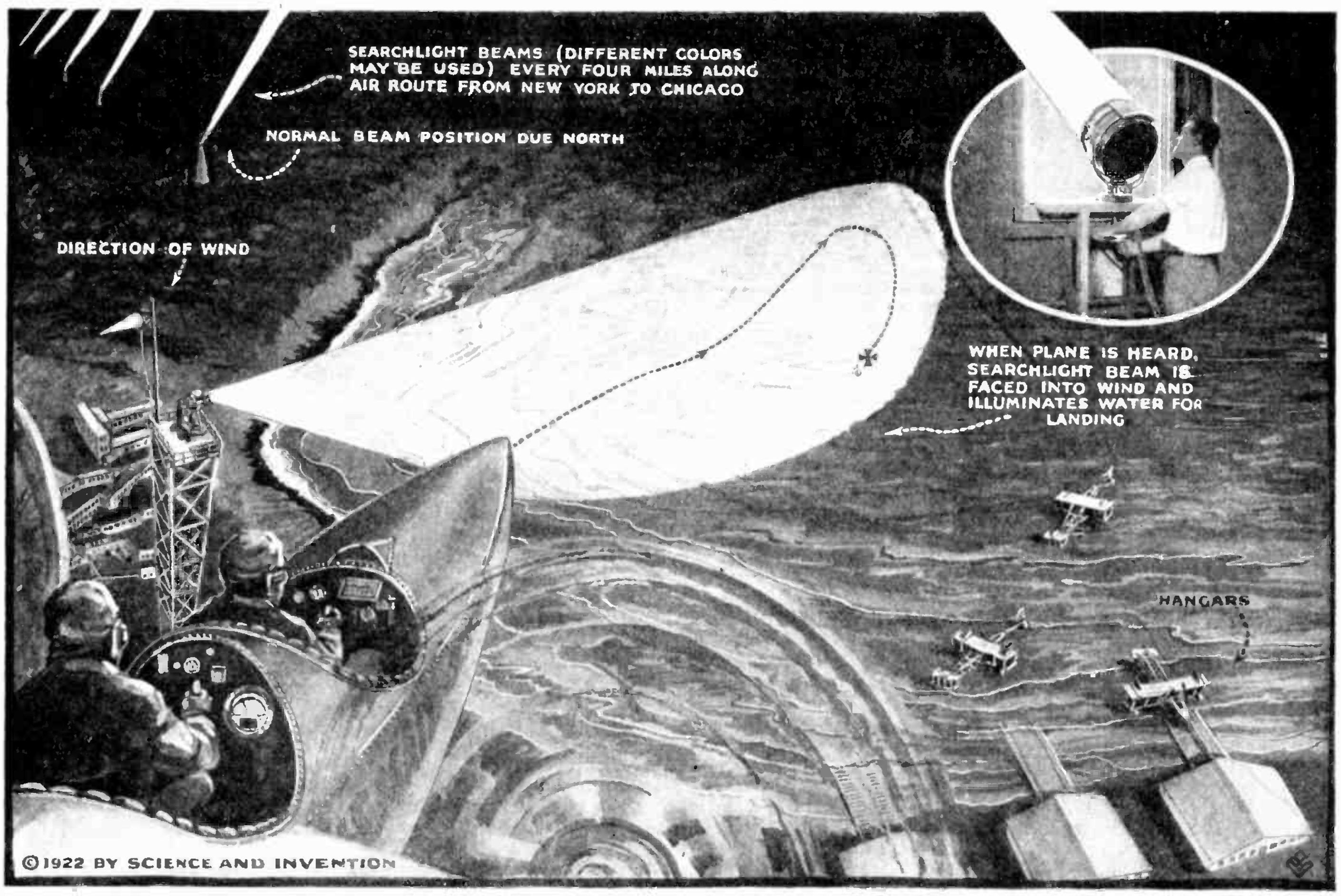
Some people seem to have the idea that it would cost more to adapt the subway for double-deck cars than it would to build a whole new subway, but to us this does not seem the case, and we have some good reasons for believing otherwise. For one thing, some of us, no doubt, remember the large double-deck trolley cars run on Broadway, New York City, and no special extra heavy tracks were installed or any other change made whatever, altho some readers have told us that extra large tracks and what not, would have to be installed, entailing an unreasonable expense. The double-deck cars would of course, be about 60 per cent. higher perhaps, and would therefore, manifest a somewhat greater tendency to swing over at the top when rounding curves, but as pointed out in the article describing Mr. Gernsback's scheme, this is readily taken care of by placing a series of small wheels alongside of the car midway between top and bottom, these wheels rolling against support rails on curves, and in fact, these rails could be run along thru the straight sections of track in case the cars happened to careen or swing out a little more than ordinarily at high speeds. The double-deck trolley cars were built quite closely to the design shown by Mr. MacFadden, that is, the wheels were placed up under the seats or in an equivalent position, bringing the main floor on almost a level with the street or just a few inches above it.



In the Larger Cities where the Traffic Congestion has Become Almost Unbearable in Many Cases, a Solution to this Problem Seems to Lie in Double-Decking the Subway Cars after the Manner here Proposed by Mr. Bernarr MacFadden. The Height of these Cars Does Not have to be Much Greater than the Present Subway Cars, Particularly as the Lower Floor is Brought Down Near the Track Level, by Having the Wheels Placed up Under the Seats, as the Diagram at the Right Shows. The Inventor has Provided Means for Adapting these Cars to Serve Both the Old Style Subway Stations, as Well as the New Double Ramp Stations, as the Illustrations Clearly Show.



First Aerial Lighthouse

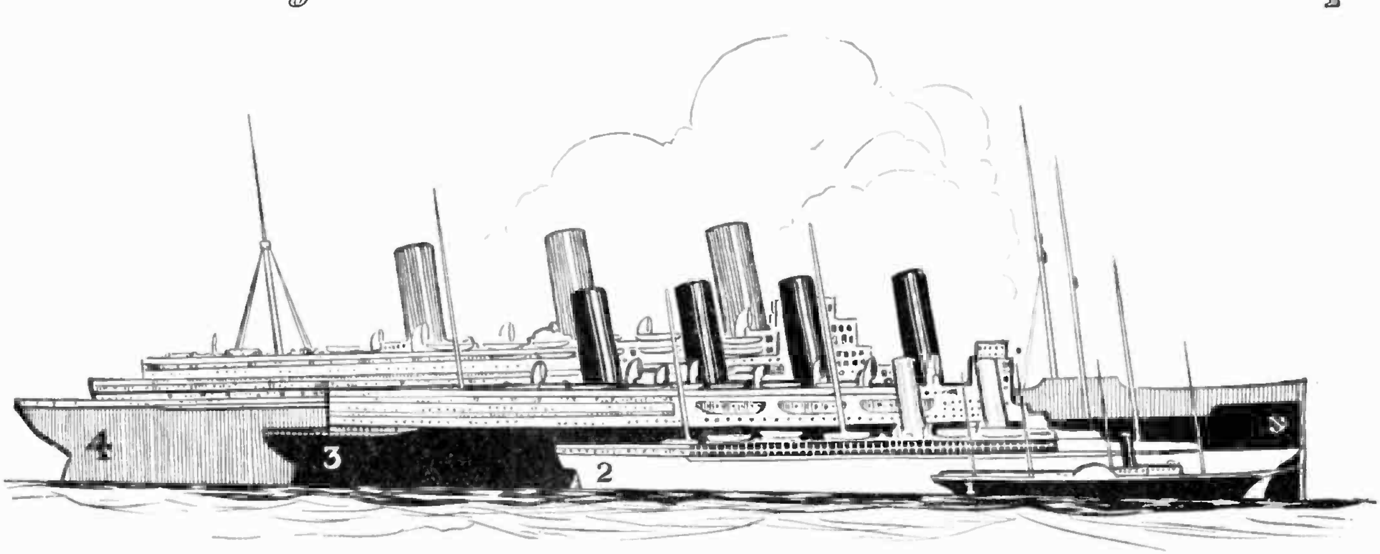


At College Point, L. I., Near New York City, the first Aerial Lighthouse in America was Recently Put into Service. The Searchlight Beam is Pointed Upward at an Angle of About 60 Degrees, but upon Hearing a Seaplane Approach, the Operator Swings the Light Beam into the Wind, Indicating the Wind Direction to the Aviator, and Illuminating the Water to Facilitate Landing.

THE first aerial lighthouse in this country was recently opened at the American Airways' seaplane base, College Point, L. I. This aerial beacon will be under the supervision of the United States Lighthouse Service, and will be operated thruout the summer. The light will be kept burning from sunset to midnight. This beacon is the first of a series to be erected along the air route from New York to Chicago. These will enable aviators to make night flights in safety, as they will mark out an illuminated path, and will be placed but a few miles apart.

This light is a fourteen-inch Navy type searchlight and will throw its beams upward at an angle between 45 and 60 degrees and due north. As soon as an airplane is heard approaching after dark, the light will be swung due north to a point directly in the wind by the lighthouse attendant, which will enable the flyer to know just where to land. The water will also be illumined by this light, so that any obstructions in the path of the descending plane will be clearly seen by the aviator.

S. S. Majestic—World's Greatest Ship



The Above Comparison Illustration Shows the S.S. "Majestic", 956 feet Long, Compared with 3—the "Mauretania," 790 feet Long; 2—the S.S. "New York" (1888), First Twin Screw Steamship, 627 feet Long; and 1—the "Great Western" (1838), First Steamship to Cross the Atlantic, and Having a Length of 236 feet. The "Majestic" is the Largest Ocean Steamship Yet Built, and Recently Completed Her Maiden Trip Between Southampton and New York. If the Woolworth Building Were Laid on its Side in this Comparison Picture, it Would Only Stretch to the Length of the "Mauretania," and this Will Give Some Idea of the Tremendous Size of the "Majestic" Which is Nearly One-fourth of a Mile Long. (See page 282.)

Airplane Wings Tested by Trailing

By CARL H. BUTMAN

LANGLEY was probably the first to tackle the problem of mechanical flight scientifically; he calculated the requirements mathematically to determine the lift and the drag, or resistance, of a wing in the air. He experimented with model wings which he whirled by a revolving arm, measuring the lift and drag to secure the necessary factors essential to flight.

Some years later models of wings and miniature planes were placed within a tunnel-like structure in a stream of air, their reactions being measured and the results multiplied by a factor to secure data for full-sized wing surfaces. Attempts to test larger model wings were also made by towing them from automobiles, but though helpful, all these methods were lacking in the essential accuracy necessary for a designer to predict the performance of a full-sized wing in flight. The early methods, and indeed the present system of wing-tunnel tests, are quite unsatisfactory because the methods and equipment do not even remotely approach the actual flying conditions.

What was required was a method by which a wing in actual flight could be tested, and it has just been announced by the National Advisory Committee for Aeronautics, that a new method has been definitely tried and proved practical with a model wing.

The method has been found so beneficial to airplane designing that before very long it is planned to test a full-sized airplane wing carried below an airplane in flight. It will be the first time that such a thing has been attempted, but is the final step in the development of a new and practical method of testing the performance and lifting properties of airplane wings by trailing them in flight.

Representatives of the Advisory Committee trailed a solid spherical body below an airplane in motion and measured its lift and resistance without much difficulty. Next they tried a solid wooden wing model, and finally they came to the actual test of a model aerofoil or wing itself. By means of suspension wires, the wing, with a tail to keep it headed into the wind, was carried beneath a plane, and its characteristics were measured by instruments within the cockpit of the supporting airplane. Figure 1.

Ideally it would be best to test a complete airplane in flight, but only two methods are known to be possible: First, to suspend a plane below a high bridge in a strong and steady wind, which, however, is difficult to secure as the wind changes in force and direction so frequently; second, to suspend an airplane below another and tow it through the air, just as the model wing was towed and its performance measured, but so far this has not been attempted. It is not impossible, however, although the Committee deems it wiser to test a full-sized wing first.

Approximating as nearly as possible true flight conditions, the investigators of the Committee constructed a model wing as shown in Figure 2, covered it with fabric, gave it a single longeron and a vertical rudder to keep headed into the wind, then they suspended it by three wires at a distance below the plane which insured safety and where it was free from interference from the "wash" of the propeller.

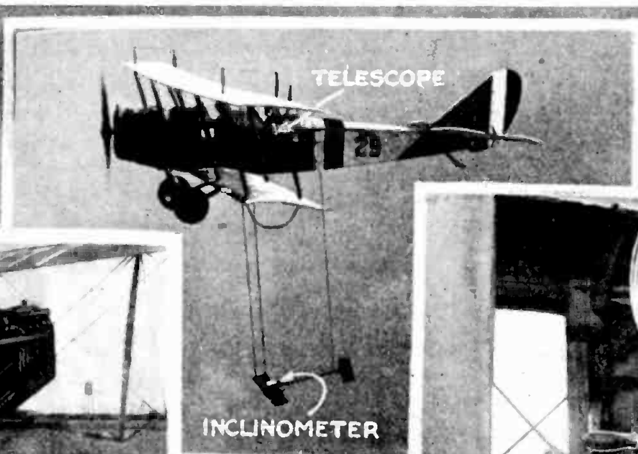
The wing was suspended upside down, so that the lift would become a downward pull, keeping it away from the carrying airplane, the amount of the pull being equal to the lift of the wing if it were not inverted, but right side up. The lift of the wing was measured on spring balances directly through the suspension wires, and its resistance or drag was recorded by the angle the suspension wires made with the vertical. See Figure 3.

At first the method may appear a little difficult, as it would be impossible to leave the ground or land with the wing hanging below, but before starting the observer reels up the wires until the model wing is hauled close against the bottom of the plane. Figure 4. It is lowered to the proper distance for test when the plane is safely in the air. In the early trials with the test wing, some difficulty was experienced by the pilot and observer in managing the wing, and on two occasions the model got beyond their control. Breaking away from one of the wires, it slashed about in the air, colliding with their plane which it damaged, also threatening their lives. Remedial changes were made, however, and today the wing is handled in the air with a minimum of danger to the fliers.

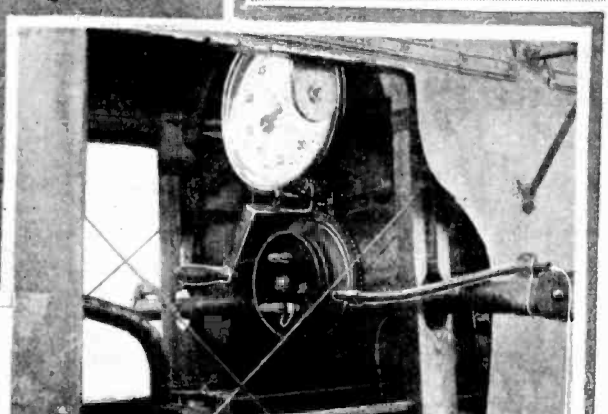
This method of testing wings by trailing was originated by Mr. F. H. Norton, Chief Physicist in charge of aeronautical research at the Committee's Laboratory at Langley Field, Va., and the tests were carried out by him with the assistance of Test Pilot Thomas Carroll of the Laboratory staff. To date over twenty flights have been made with a perfected apparatus carrying a model wing six feet in length by a foot wide, the results obtained checking accurately with the known performance of a full sized wing of similar proportions in a standard airplane.

Calm air conditions are necessary to give the best results and the path of flight must be in a straight line, Mr. Norton explained recently. For the purpose of demonstrating the possibilities of the new method, however, he said that he and Pilot Carroll made several flights on days when the air conditions were far from ideal, negotiating turns with the wing suspended below.

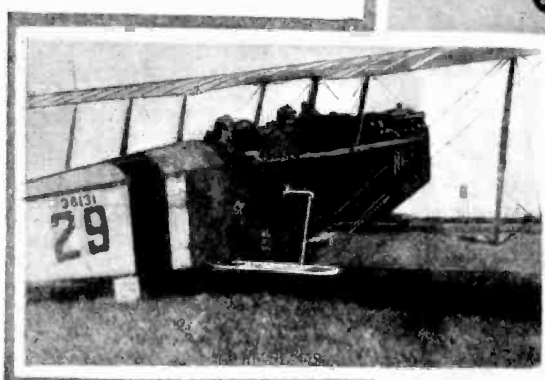
It was found possible to vary the angle of the model wing to the wind by lowering or raising the rear suspension wire, the angle of the wing being read with the aid of a telescope, from a small spirit level mounted on the wing model.



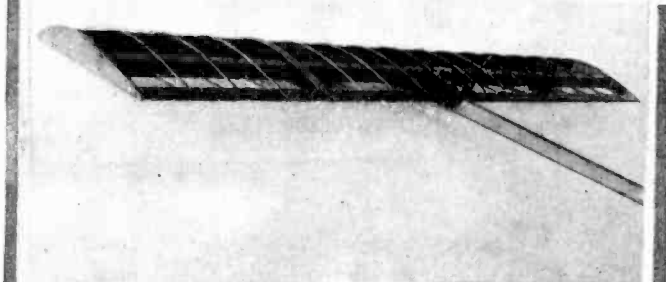
Testing Model Airplane Wing in Actual Flight by Suspending the Test Wing from the Plane by Steel Wires, these Wires Connecting with Suitable Recording Instruments. The Angle of the Suspended Plane was Read by Looking Thru a Telescope at an Inclinometer on the Wing, Fig. 3



View Below Shows Balance Assembly and Wire Reel Together with Recording Gages, for Ascertaining the Pressure or Pull of the Miniature Wing Being Hauled Along in Actual Flight under the Airplane. The Fabric has been Cut Away from the Fuselage to Show the Instrument. Fig. 1.



View Above Shows Close-up of Airplane Making Test with Miniature Wing, the Test Wing Being Here Drawn up Close Against the Under Side of the Fuselage or Body, Preparatory to Taking Off or Landing. Mr. Norton Appears in the Rear Seat, while Pilot Carroll is Sitting Forward. Fig. 4.

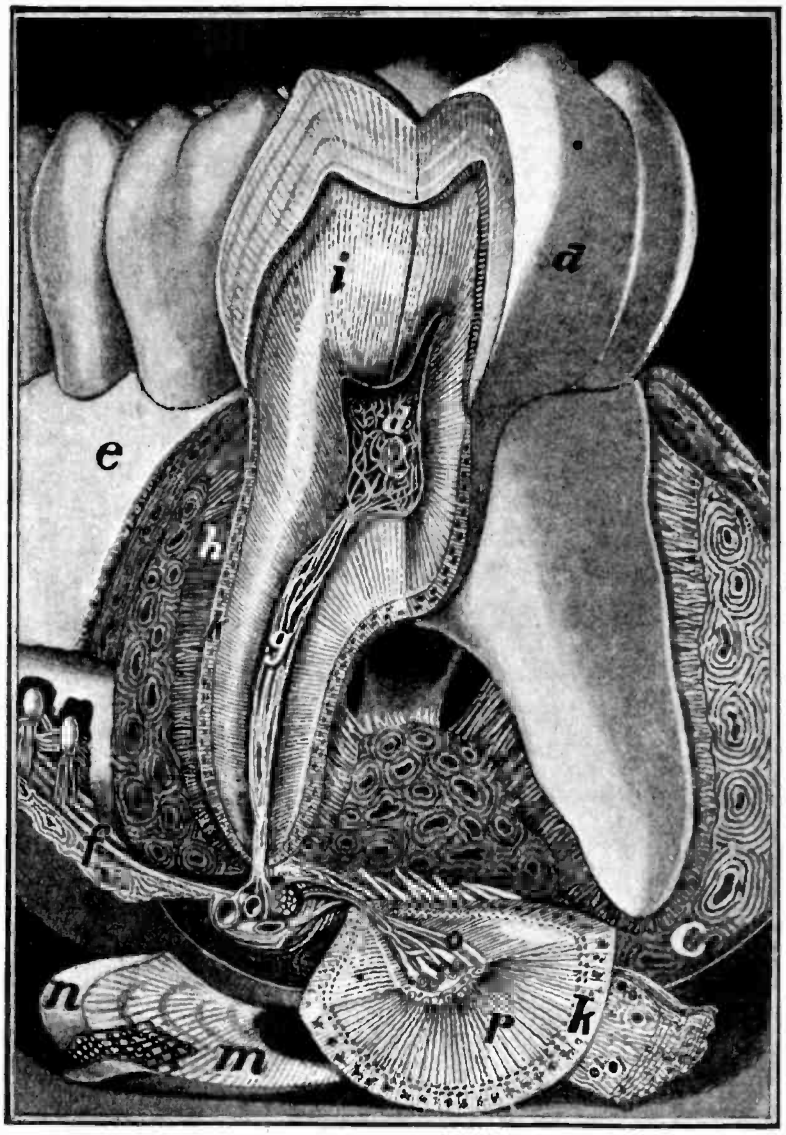


At the Left Can Be Seen the Model Wing Used in Tests so far Made by Trailing with an Actual Airplane, no Covering Being Shown Here. Accurate Data is Obtainable in This Way Only, Say Experts, and it is Hoped by the Investigators that an Extra Large Airplane can be Secured, so that They Can Undertake the Testing of a Small Complete Airplane by this Suspension Method in Actual Flight. Fig. 2.

What Is A Tooth Made Of?

THE teeth, the chief organs of mastication in the human being, are adapted not only for grinding the food, but also for cutting and holding the same. Sometimes they are put to other uses not intended by nature, but we will not enter upon such uses in the present discussion. Each tooth consists of a crown (the portion of the tooth above the gum), a root or fang (the portion located in the jaw bone), an intermediate part called the neck, which is the narrow section covered by the gum. Entering upon the structure of the tooth in greater detail, we find that there is an enamel covering the crown.

This enamel is the hardest substance in the human body. It varies in thickness, being thickest at the cutting surface, and diminishing as it approaches the root of the tooth. The enamel consists of 97 per cent. of inorganic matter, the remainder being organic. In structure, we find that the enamel of the tooth is composed of hexagonal enamel prisms arranged perpendicularly to the surface of the dentine. The dentine will be described further on in this article. Each enamel prism or fibre has a wavy tortuous course with its inner end fitted into a slight depression in the dentine. The prism maintains the same diameter thruout its length, much the same as the shaft of a hair, but is quite wavy. As a result, near the surface of the tooth, shorter additional prisms are found, which are called supplementary prisms. These prisms are seemingly held together by an inorganic transparent cement. If a tooth is sectioned, that is, cut into thin slices and examined under a microscope some brown striations will be seen running almost parallel with the surface of the tooth. Their cause is still in doubt, it being believed that they represent the successive positions of the enamel cap. Other lines visible, if the tooth is examined by reflected light, are apparently due to the various directions taken by the different bundles of enamel, well marked near the surface of the dentine, and becoming fainter as one approaches the surface of the enamel.



The Enamel of the Tooth Shown at A is Also Seen in Cross Section. Note Its Wavy Structure. The Root May be Seen Extending into the Jaw Bone, C. D is the Lace Work of Blood and Nerve Vessels. E Represents the Gum, While F Shows the Blood and Nerve Trunks Sending Branches (G) up into the Tooth thru the Root. H is the Peridental Membrane Holding the Root of the Tooth to the Jaw Bone; I the Dentine; P Shows the Dental Sheaths Extending from (O), the Pulp Cavity, to (K) the Cementum, or Enamel Layer. Here One Finds Star Shaped Cells and Their Branches. N and M Indicate the Hexagonal Prisms of the Enamel of the Tooth, Showing Clearly Their Wavy Course. The Brown Striations May also be Seen.

The dentine forms the bulk of the tooth and gives it its shape. It represents ivory to a very great extent, and is yellowish white in color, quite a bit harder than bone. It is covered thruout either by ivory or cementum (the latter is the covering surrounding the dentine of the root or fang). Dentine contains about 72% of inorganic matter and the remainder organic matter. Looking upon this part of the tooth in greater detail, we find that it contains dental sheaths, matrix and dental fibres. The dental sheaths, which extend in a curve or spiral course from the pulp cavity to the enamel above, or cementum below, diminish in diameter as they pass outward from the center. They are delicate tube-like masses, which are practically indestructible, existing long after the matrix has been destroyed. The spaces in these tubes are called dental canaliculi, likewise terminating at the enamel or cementum, by either joining with each other, ending bluntly, or opening into interglobular spaces.

The dental fibres are still in discussion. Some investigators claim that the fibres are processes of flat shaped cells called odontoblasts, which are the cells from which dentine is originally derived. Others claim that they represent connective tissue, surrounding nerves.

The matrix, not so hard as the dental sheaths, surrounds them. It is not so abundant near the pulp cavity where the sheaths are packed closely together, but further out, as the sheaths decrease in diameter, the matrix increases. Here irregular spaces may be found, which are the interglobular spaces alluded to heretofore.

There is a bonelike substance that covers the root of the teeth called cementum, containing 66% inorganic matter, and 34% organic matter. It is thickest at the very end of the root, and becomes gradually thinner as it approaches the enamel.

The dental pulp occupies the pulp cavities chamber and root canals. It is rich in blood and nerve supply. There are different types of cells found in every tooth, the odontoblasts being only one of the varieties, but for those more interested in this subject, who intend to study it to a greater degree, we would suggest any standard work on histology. The arteries and nerves enter the tooth thru the root.

The peridental membrane serves a very important function in the tooth, or rather immediately outside of it. It holds the tooth in place; it rotates it, returning it to normal position if it has been slightly displaced, and on one side forms the cementum and on the other the bone. This membrane covers the roots of the teeth, and lines the sockets in the jaw. It is thickest at the root and gum, and thinner in the middle.

Gathering Camphor

All the world needs camphor. It is used in the making of celluloid articles, while the photographic and cinematographic trades could not get along without it. Not least, it is employed in the making of certain high explosives.

"We get some idea of the value of camphor," writes Harold J. Shepstone, F. R. G. S., in the *London Graphic*, "when it is stated that a tree with a basal circumference of 12 feet will yield about 50 piculs of camphor (approximately 6600 pounds, or about three tons, which at the present market price, is worth about $5000. At present about 3,000,000 pounds of camphor and some 2,000,000 pounds weight of camphor oil are exported annually.

"To obtain this, some 10,000 trees are felled yearly. As soon as the trees are cut down they are chopped into chips, and these are subjected to a crude process of distillation, more or less on the spot. The chips are placed in a retort over boiling water, and as the camphor vaporizes it passes through pipes into submerged vats, which are so arranged that cool water from a mountain stream can run over them to accelerate crystallization. After camphor has crystallized the vats are opened, and the product is placed on wooden troughs to allow whatever free oil there may be to drain off. This oil will yield 90 per cent of crude camphor in the process of refining. The crude camphor is now packed in tins and carried down precipitous mountain paths on coolies' backs to the railway line, whence it goes to the government refinery at Taihoku."

Einstein Relativity Explained in "Movie"

NUMEROUS attempts have been made to render Einstein's theories of relativity intelligible to the man in the street—the plain ordinary citizen who knows no mathematics and no physics beyond what he has been exposed to in the course of an ordinary schooling. The net result of these efforts has been merely to convince the man in the street that Einstein is not for him. One Professor Nicolai, however, a university professor of some note in Germany, has made a fresh attempt to get the relativity ideas across, using the motion picture as his vehicle. The relativity film is, like all educational pictures, largely of the animated cartoon variety. It has been taken up by the entire German film industry as a standard piece, and has been exhibited with huge success in numerous German cities. No complete version of it has reached this country, but we have a few isolated strips of three consecutive panels each, which give a very good idea of what the film is like.

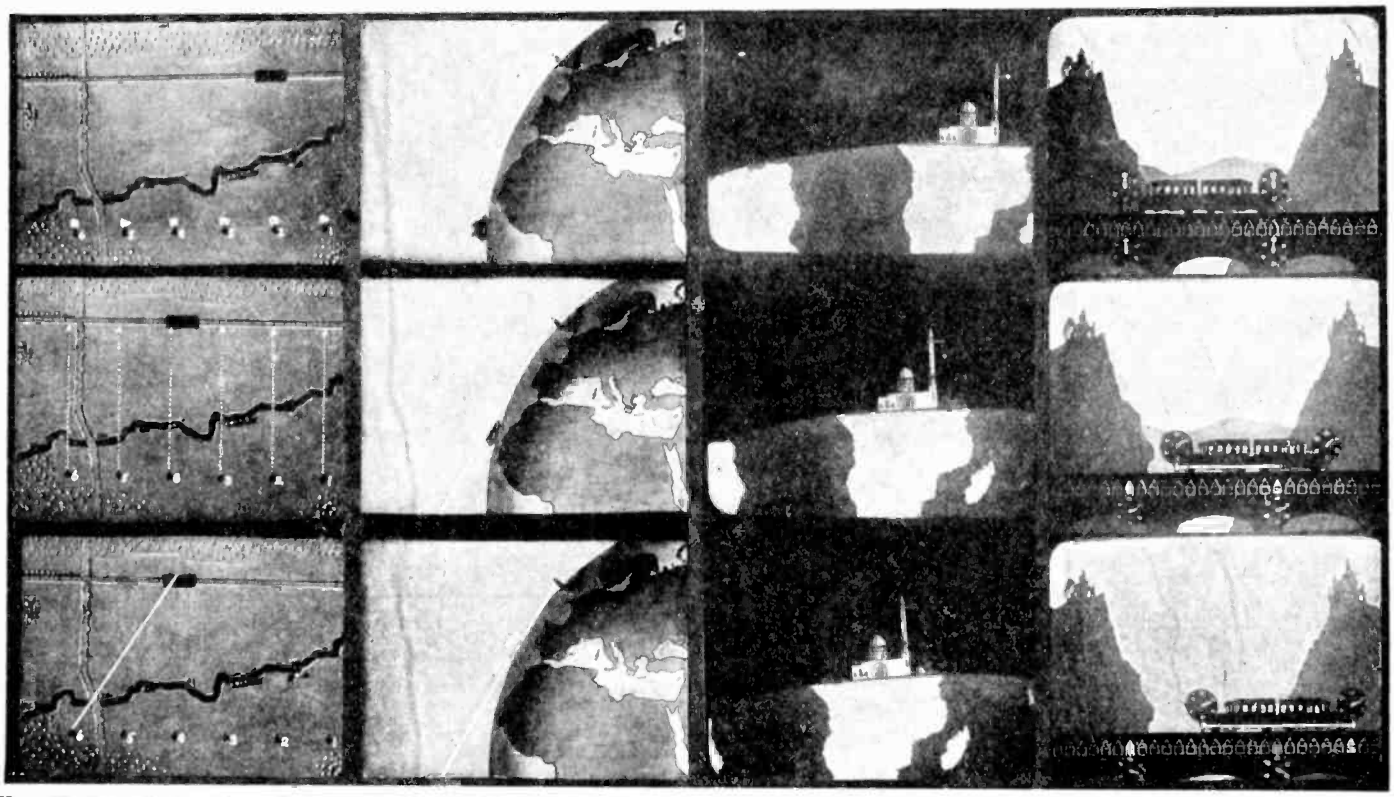
All the books on relativity, and all the lectures, start with a number of simple illustrations. These have no immediate bearing upon the Einstein ideas, but are designed merely to lead up to those ideas by showing the reader or the listener that things are not always as they seem, and that they do not always seem the same. The film attacks the subject in the same way; one of its opening episodes deals with a phenomenon that is familiar to every schoolboy, in his geography book if not in reality. A light-house is shown, apparently at Plymouth or Southampton, or perhaps at Land's End—one can hardly tell, for sure, from our photographs. A ship is sailing away to the west, and of course the further it goes the less of it is visible from the light-house, until finally it disappears completely below the horizon. The ship is shown moving off around the shoulder of the world; and the line of vision or the horizon of the observer in the light-house is shown too. The audience is looking down at the scene from a point far out in space and so gets a general view of a large part of the earth's surface, with the ship and the light-house drawn, cartoon style, far out of proportion because they are the part of the picture in which we are interested. The observer in space—that is to say, in the audience—can see the ship; the observer in the light-house sees it all, partly, or not at all. The experiences of the two, gained from different viewpoints, do not agree.

In this case we are pretty certain that the observer in space is right and the observer on the light-house wrong—the ship is there, whether or not the latter can see it. A somewhat more elaborate demonstration of the fact that appearances are deceitful comes in a later episode. Here we have a car, moving along a straight track, over a countryside that strikes the American eye as peculiarly German. Six riflemen are lined up beside the track, behind a concealing hedge. As the car comes opposite them they all fire simultaneously, each man shooting straight ahead and across the track rather than aiming at the car. One of the bullets strikes the car, pierces its nearer side, passes thru, and out the far side. During the fraction of a second that the bullet consumes in passing across the car, the car moves forward a short distance; the hole by which the bullet leaves the car is therefore not square across from the one by which it enters. In fact, if a person in the car should attempt, by lining up the course of the bullet from its two holes, to decide where it came from, he would be deceived. His line would be a diagonal one, rather than one perpendicular to the track; and it might actually point at one of the riflemen who did not hit the car, while it certainly would fail to point to the one who did hit it.

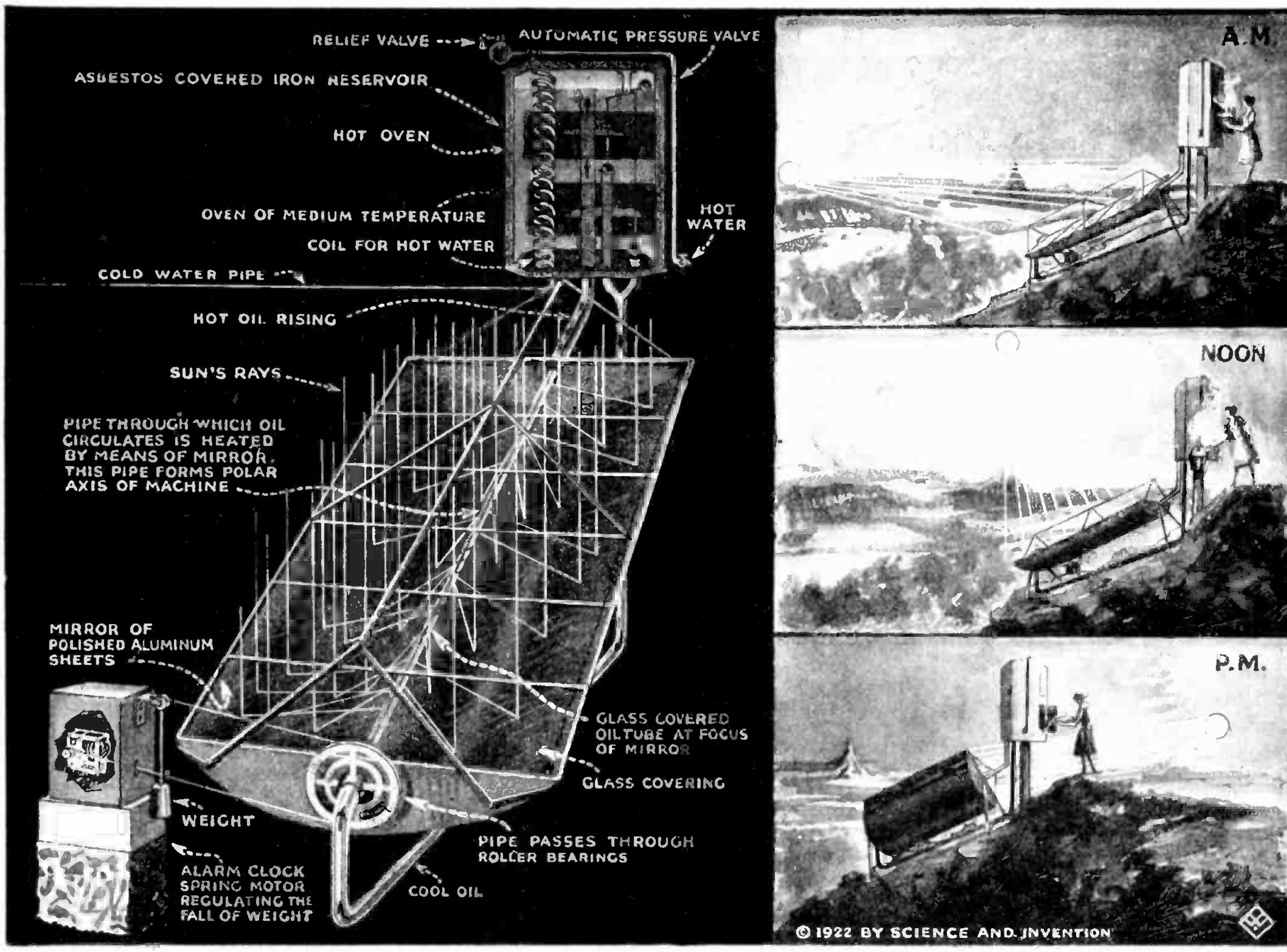
This demonstration brings us a little nearer real relativity. For suppose the shades of the car are all drawn, so that the passengers cannot see out of the car at all; and suppose the car is moving with perfect smoothness. The passengers will have no way then of knowing whether they are moving or not, and hence no way of correcting their estimate of the direction from which the bullet came. Again a super-observer out in space somewhere, who does not share the *motion* of the car or the *state of rest* of the riflemen, could arbitrate the matter and decide which man really had shot thru the car; but without this interposition, the riflemen and the passengers could never agree on this point.

When we get a little deeper into these phenomena that appear different to different observers, we find one that is even more ambiguous than that this one in which we can hardly find any basis at all for saying that one observer is right and the other wrong. The picture this time is of a ball dropping from a tall tower. The ball, speaking from the

(*Continued on page 277*)



Here We See a Few Specimen Strips Selected from a New German Motion Picture, which is Intended to Demonstrate in a Clear Manner Just How the Einstein Theory Works. At the Extreme Left We See a Car Moving Leftward; When the Car Arrives Opposite the Riflemen, They All Fire and While the Bullet from Rifle No. 4 Pierced the Car, It Would Appear Afterward that Rifleman No. 6 Was the One Who Hit the Car—a Case of Relative Motion. The Second Picture from the Left Demonstrates that an Observer in Free Space Would See the Ship Sailing Around the Globe, While an Observer in the Lighthouse Would Not See It—But the Ship is There, Nevertheless. The Second Picture from the Right Illustrates the Falling Ball Experiment—to a Person on the Earth, the Ball Appears to Drop in a Straight Line; but to an Observer in Free Space, the Ball Would Describe a Pronounced Curve. The Picture at the Right Shows an Imaginary Railway Used in the Einstein Movie, and Several Amusing Paradoxes Concerning Its Relative Velocities Are Discussed in the Story Herewith.



By Means of This Solar Cooker, Mr. C. G. Abbot, Assistant Secretary of the Smithsonian Institute of Washington, D. C., Made It Possible for His Wife to Cook Practically Everything Without Using Oil, Coal or Wood Fuel. The Accompanying Article Gives Considerable Details for Building the 7 Ft. by 10 Ft. Curved Mirror, the Reflecting Surface Being Preferably Formed of Polished Aluminum Sheets. The Three Small Views at the Right Show How the Mirror was Turned Automatically by Clockwork, so as to Always Face the Sun. The Glass Covered Tube Passing Along the Focus of the Mirror, as Well as the Circulating Pipe and Oven Units, Were Filled With Oil.

Cooking By Solar Heat

MR. C. G. ABBOT, Assistant Secretary of the Smithsonian Institution at Washington, D. C., devised some time ago a cooking and water heating device, operated solely by the sun's heat during the day.

This sun-stove was erected at the Observatory on Mt. Wilson, California, and was used there with a great deal of success. The successive illustrations in the accompanying picture show how the reflecting mirror rotates by a clock-work mechanism, so as to follow the sun from morning until night. As the accompanying photo indicates the large wheel at the base of the mirror is connected by a piece of piano wire with a weight, in such a fashion that it tends to turn the mirror towards the west. This wheel is constantly restrained, however, by a second piano wire leading over the wheel to a clock, which permits it to rotate only at the proper speed, in such a manner that during the whole day the image of the sun falls upon the oil heating tube at its focus.

The two compartment oven opening on the north is shown at the top of the arrangement and a double valve device is fitted with a float as shown, so that the circulation in the oven oil tank will occur either from the tube at the center of the reservoir or else thru the tube at the bottom. At first the heating of the tank is taken care of by the circulation thru the pipe at the center, the quantity of oil in the lower part of the reservoir being unaffected. At a certain predetermined temperature, the oil in the tank expands sufficiently to raise the float and reverse the valves, with the result that the circulation of oil is thru the lower tube; this results in the concentration of heat in the upper part of the tank when it is too cool, and permits the volume of heat to extend automatically after the upper part has become sufficiently hot. Also the upper oven is the hotter one, and the lower of a lesser temperature, giving two degrees of heat for baking and boiling. The water was heated by allowing it to circulate thru a pipe coil placed in the oil reservoir, as the drawing shows.

Fruit and vegetables were canned very successfullly and one of the interesting points, especially to women who abhor cooking of any kind in the hot summer months, was the fact that this Nature-stove was conveniently placed just outside the kitchen door; yet no heat to warm the air in the room was present to make matters more uncomfortable, as is the case where practically any other type of stove is used directly in the kitchen. And think of it—the initial expense of installation is the only one—after that you cook for nothing, just like our aborigines.

The mirror can be made in several ways and in Mr. Abbot's experiments it was originally intended to have the reflecting surface formed of polished aluminum sheets, but these were not available for the experiments at the time, and thin sheet steel covered with tinfoil was tried. The trouble with the tinfoil was that it blistered and it proved difficult to cause the foil to adhere tightly to the steel. Polished aluminum reflects about 75 per cent. of the light thrown against it and should prove ideal, permitting one to bake bread easily and do everything in fact in the cooking and preserving line, except frying.

The mirror measured 10 ft. long by 7 ft. wide, and was built upon a frame of small steel angle and channel-bars, made up of five sections, each 2 ft. long. The top of the curved mirror was covered with window glass to keep out dust, rain, etc. Placed across the top of the mirror and directly in its focus is the heat absorbing pipe, which warms the oil circulating thru it, this pipe measuring 1½" in diameter and forming the polar axis of the machine. The mirror was mounted on roller bearings on trunnions, the oil pipe passing thru the hollow trunnions.

All parts of the oil piping system outside the mirror were wrapped with a thick layer of heat insulating material, and the mirror was also covered on the back with several layers of heat insulators, such as cotton, and this in turn covered with galvanized iron. The oil pipe running along the top of the mirror was enclosed in 3" glass tubes to reduce convection and retain the absorbed heat in the vicinity of the oil heating tube. The iron pipe within the glass tubes was painted with lampblack. The heat absorbing value of the black painted tube may be taken at about 95 per cent. The reservoir and pipe system was filled with gas engine cylinder oil of high boiling point, and in the earlier experiments a temperature of 130° Centigrade was readily obtained in the oil tank. The pipes leading from the bottom of the oil reservoir were 2¼" in diameter. The iron oil tank placed above the mirror holds about forty gallons, and it was enclosed in a layer of heat insulating material, comprising asbestos, cotton and wood, protected on the outside by galvanized iron sheeting.

Detail of Vacuum-Thermo Treatment Chamber is Shown in the Drawing at Left.

The Degree of Electrical Heat Produced From the Wire Molded in the Glass Vacuum Chamber, Can be Regulated to Suit Each Case.

Heat and Vacuum To Cure Ills

IT has been well known to medical science that artificial heat when applied to any part of the human body increases the blood circulation in the part subjected to the heat in question, and that this increased circulation of the blood enables it gradually to absorb and carry off various forms of congestion.

It has also been long known that placing any part of the human body in a closed vacuum appliance and gradually exhausting the air therefrom would quickly increase the circulation of the blood in the part or organ so enclosed.

An apparatus of the type shown in the illustration for the vacuo-thermo treatment of bodily ills has been invented and patented by one Jean F. Webb, Sr., New York City.

The body of the enclosing chamber in which the leg or other part of the body is enclosed may be made of rubber, metal or bakelite, the inventor suggests, in which continuous wire coils of nickel-alloy or other resistance wire material, of suitable size to carry the electric current needed, are imbedded or molded in the walls, to act as resistance coils for generating the desired heat. In the illustration herewith, the appliance shown is made of a heat resisting glass in which the electric heating wires are imbedded, and the glass is annealed in the same manner as a fire glass is made. The transparent glass causes the effect of the vacuum or heat treatment to be visible to the patient in self-treatment; the said treatment can be regulated as desired and in the manner hereinafter explained.

A "Free Pendulum" Clock

REVEREND WILLIAM O'LEARY, a native of Ireland, and Professor of Science in Dublin, has perfected a clock, utilizing the principle of a free pendulum, which keeps absolutely accurate time. His reason for perfecting this clock was for observatory work, and experiments involving the use of a seismograph. The observer had many occasions upon which he wished to have a clock that would keep absolutely correct time. He tried all of the various makes of high grade time pieces, and found that each one of them had a certain amount of variation. He therefore decided that he would make a clock himself. The method which he decided to adopt was that of the absolutely free pendulum.

So-called free pendulum clocks have been put on the market at various times before, but have not actually lived up to their name. Many of these types depended upon the pendulum closing an electric circuit. This, however, does not constitute a perfect movement.

The clock makers' ways of making highly accurate gears and works was dispensed with, and his first model was made from the works of an alarm clock, using the principle of the free pendulum. It was possible to have works that would vary as much as three-quarters of an hour in the course of a day and still keep absolutely accurate time. This may seem like a very ambiguous statement, but is nevertheless true, owing to the fact that

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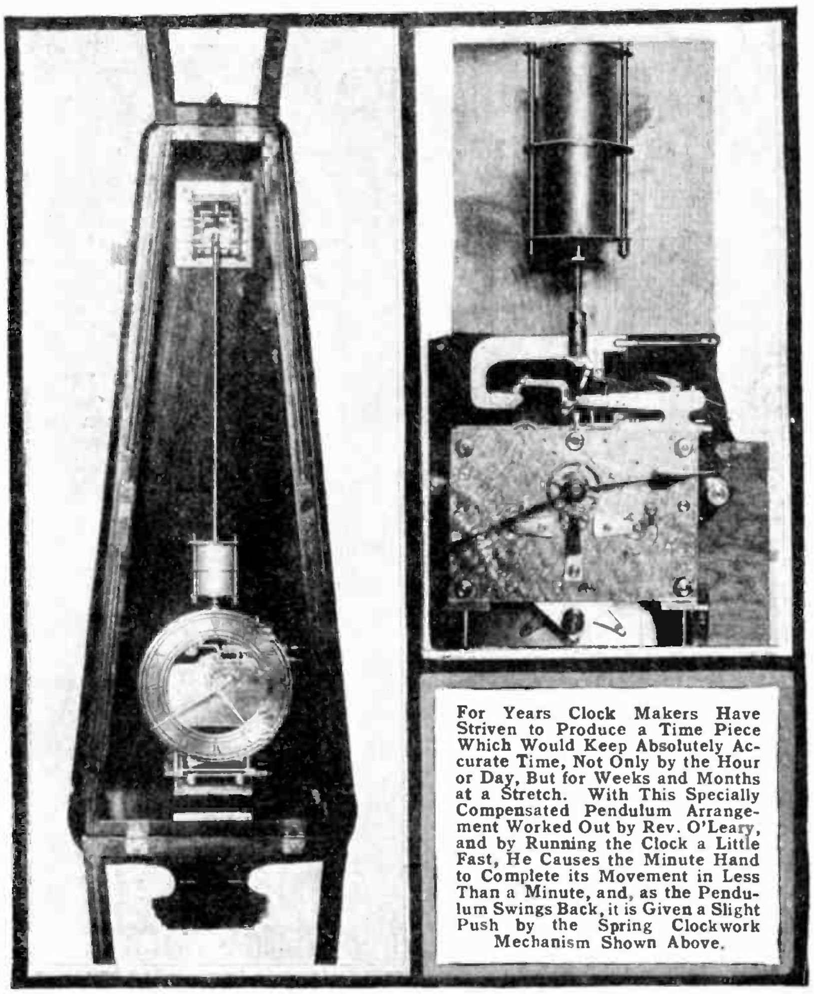


For Years Clock Makers Have Striven to Produce a Time Piece Which Would Keep Absolutely Accurate Time, Not Only by the Hour or Day, But for Weeks and Months at a Stretch. With This Specially Compensated Pendulum Arrangement Worked Out by Rev. O'Leary, and by Running the Clock a Little Fast, He Causes the Minute Hand to Complete its Movement in Less Than a Minute, and, as the Pendulum Swings Back, it is Given a Slight Push by the Spring Clockwork Mechanism Shown Above.

The Coal Bin of New York City

By CHARLES N. HOLMES

The Coming Winter Would Seem to be Fraught With Great Difficulty in Obtaining Sufficient Coal, Owing to the Prolonged Coal Strike. The Tremendous Amount of Coal Used by a Large City Such as New York, in Even One Day, is Here Shown Graphically, by Mr. Wall, Staff Artist. A String of Ocean Liners End to End and Encircling the Earth at the Equator Would be Required to Carry the World's Yearly Coal Output of One Billion Tons. The Twenty Million Tons of Coal Used in New York City in One Year, is Indicated by the Large Conical Pile, Shown in Comparison With the Eiffel Tower.

COAL is divided into three classes: anthracite (hard), bituminous (soft) and lignite (a fuel intermediate between peat and true coal). Chemically, coal is chiefly composed of carbon, hydrogen, oxygen and nitrogen. For example, anthracite coal contains, on an average, about 90 per cent. carbon, and bituminous coal has much less carbon and a large percentage of hydrogen. Respecting specific gravity, a cubic foot of water weighs about 62½ pounds, and a cubic foot of *heavy* anthracite about 100 pounds, equivalent to 22.05 cubic feet per metric ton of 2,205 pounds.

Coal is of vegetable origin, widely distributed. The coal beds in Great Britain cover an area of nearly 12,000 square miles, and, within the United State, there are several large coal areas. These American coal areas are, namely, the Appalachian fields in Pennsylvania, Ohio, Virginia, Kentucky and Tennessee, the Illinois fields, those in Michigan and Rhode Island, and, also, extensive deposits in the Western States. It is very probable, when all of the coal reserves in our country have been discovered, that they will occupy, approximately, half-a-million square miles, or about 1/6th the area of the United States.

The World's total coal reserves are enormous, over 7 trillion tons, of which amount nearly one-half is situated within this country. The World's annual coal production is estimated at about one billion metric tons (a metric ton being about 2,205 pounds), the United States producing (1921) 449,000,000 tons. Most of us have heard more about Pennsylvania coal than about the coal in other states. Indeed, Pennsylvania has been mining coal for over a century. As far back as 1820, that state shipped 365 tons of anthracite to market, and, in 1919, almost 67,000,000 tons. In fact, from an anthracite district in Pennsylvania, containing less than 500 square miles, there has been a total production approximating 2 7/10ths billion tons, and there is still a lot of coal unmined in the Keystone State, for it is estimated that Pennsylvania still possesses 16 billion tons of anthracite and 109 billion tons of bituminous coal.

What a Coal Strike Means to a Great Metropolis

As we should expect, all big cities are large consumers of fuel, particularly New York, and it is interesting to estimate the approximate size of the metropolis's coal-bin. Of course, New York's coal-bin holds a varying amount, but its contents should be estimated when it is full. That is, the metropolis's bin contains exactly the total amount of coal consumed annually within the boundaries of Greater New York.

To begin with, the City's gas and electric lighting companies—its public utility corporations—use yearly about 7,000,000 tons of coal. Then, the municipal government requires annually about 400,000 tons. Also, there is the heating of houses, tenements, apartments and hotels to be considered. This heating would approximate 6,000,000 tons. The fuel used by department stores and office buildings, as well as that consumed by factories, would approximate 5,000,000 more tons. And, finally, fuel is used by theatres, transportation companies, for domestic purposes, etc., an amount equalling, at least, 2,000,000 tons. It is true that fuel oil has, in many cases, superseded coal. However, a conservative estimate of the size of New York's coal-bin—the amount of coal which the City consumes annually—approximates 20,000,000 tons.

That is to say, the metropolis uses yearly about 40 billion pounds of soft and hard coal, or about 110 million pounds a day, nearly 4,600,000 pounds an hour and about 38 tons per minute. At this rate of consumption, the City of New York would use in a century 2 billion tons. Accordingly, New York consumed (1921) about 1/25th of the total production in the United States and 1/60th of the World's total production. If a railroad should ship into this city, each month, 430,000 tons of coal, it would take that railroad almost four years to supply New York with enough coal for one year. If each of its citizens were to be given 3 1/3 tons, he would then possess his share of the coal imported into the City. And, were New York's 20 million tons of soft and hard coal to be used in building a highway, 189 feet wide by 5 feet thick, such a solid highway would extend from the City of New York to the City of Philadelphia.

The Future of the Inventor

By H. GERNSBACK

MEMBER OF AMERICAN PHYSICAL SOCIETY (ADDRESS DELIVERED BEFORE THE NATIONAL INSTITUTE OF INVENTORS)

IT is indeed an honor to speak tonight before such a select gathering of illustrious inventors, and I hope I shall not bore the assembly unduly with the few ideas I desire to bring forward here. It seems to me that the future of our inventors lies mainly in their own hands. *The National Institute of Inventors* has gone far towards making invention a recognized art, the same as other important arts, as we understand that term today. The successful inventor is an artist of the highest rank and he is losing rapidly such appellations as crank, nut, etc. Inventors of all ages have been more or less handicapped, for the simple reason that they have always been ahead of the times. As a rule, people do not understand them and do not appreciate their art, for such it may be called. Slowly the world awakes to recognition of the inventor, and soon the government itself will take greater cognizance of him. We have today the Patent Office

(*Continued on page 267*)

40,000 Degrees of Heat!

By GERALD L. WENDT

ASSOCIATE PROFESSOR OF CHEMISTRY, UNIVERSITY OF CHICAGO

Tungsten Changed to Helium by Electrical Explosion

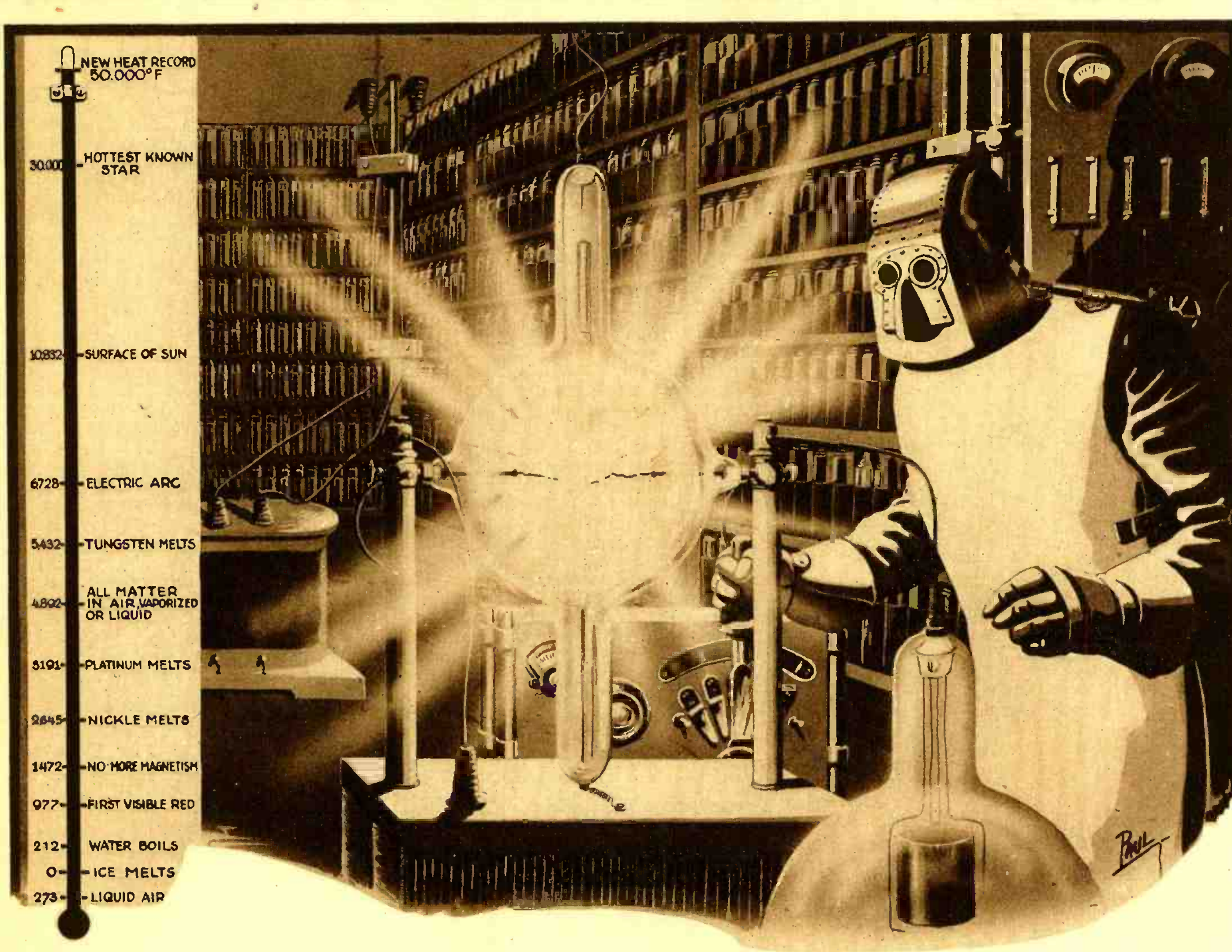
WE have hardly become accustomed to the solar system idea of the chemical atom, with all the mass concentrated in a minute nucleus at its center and electrons revolving about it, before the very man who gave us that idea and proved it, Sir Ernest Rutherford of Cambridge University, has taken the next step and has decomposed the atomic nucleus. Not even that is ultimate and impenetrable, as the atom itself was once supposed to be. And today it seems that even so crude an agent as mere heat can effect the decomposition of such heavy atoms as those of tungsten and produce from them atoms of the gaseous element, helium.

After Rutherford had shown that by bombardment with alpha particles from radium, individual atoms of nitrogen can be partly decomposed, the fragments knocked off in the collisions being nuclei of hydrogen atoms, it was not a long guess that the reason why the heavy elements, the metals particularly, are lacking on the very hot stars is because the collisions of the atoms at the prevailing temperatures of perhaps 20,000°C, or 35,000°F, are so violent as to have the same effect as the swift alpha rays in Rutherford's experiments, namely to shatter the atomic nuclei and break them into the smallest possible bits. Hence when Dr. J. A. Anderson of the Mt. Wilson Solar Observatory devised in 1920 a method for reaching temperatures hotter than those prevailing on these stars, the chemist had a promising new weapon for the attack on the problem of the true nature of the atom.

The method consists of charging a large electrical condenser to a voltage of 30,000 to 100,000 volts and discharging this charge instantaneously thru a very fine wire which is thereby exploded with a blinding flash 200 times as bright as sunlight and the vapor attains a temperature above 20,000°C (or a temperature of 36,000 to 40,000°F), as determined both by the light intensity and the fact that the pressure developed is 800 to 1000 lbs. per square inch. Photographs with a rotating mirror show that the explosion lasts only 1/300,000th second. The mechanical effects are striking. When the wire is exploded within a glass tube the latter disappears in fine bits, and if the tube be filled with water, that, too, is completely dissipated. In the experiments conducted by Mr. Clarence E. Irion and the writer, the explosions were produced within especially constructed Pyrex glass bulbs of 300 cubic centimeters capacity which withstood the explosion and permitted the analysis of the gases remaining.

The electrical connections are shown in the accompanying diagram. T is a six kilowatt transformer operating on 220 volts, a.c. and capable of carrying 40 amperes in the primary for short periods. It is of the closed-core type, with three layers of fifty turns each of No. 6 copper wire in the primary and 36 sections of 710 turns each of No. 28 copper wire in the secondary. This was capable of providing 100,000 volts. At A are two small high-capacity condensers to catch any back-kick on the primary in case the large high-voltage condenser accidentally became short circuited through the secondary coil. R is a *kenotron* hot-cathode rectifier which cuts out half the a.c. wave and gives a direct charge to the large condenser at C. This last was built from 100 plates of ¼-inch Florentine pressed glass, with tin-foil on one side and mounted on a wooden frame with ¼ inch of solid paraffin cast between adjacent plates. This condenser has a capacity somewhat less than 0.25 microfarad and will hold 30,000 volts without brush discharging. S is a spark gap which acts as an automatic switch to close

(*Continued on page 264*)

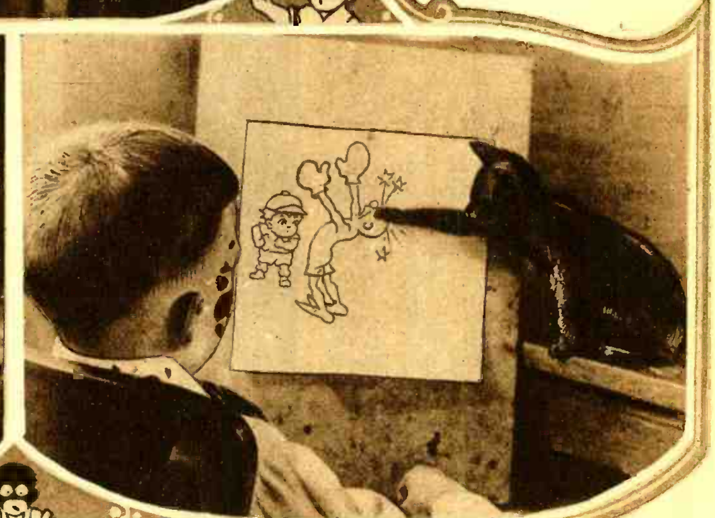


40,000 Degrees of Heat—Greater Than That of the Hottest Star—Accompanied by a Blinding Flash Two Hundred Times as Bright as Sunlight—This Is the Latest Accomplishment of Science in Experiments Conducted by Clarence E. Irion and Professor Wendt. A Powerful Electrical Condenser Charged at 100,000 Volts Potential, and Made to Discharge Thru a Fine Tungsten Wire, Caused It to Change Into Helium, Due to the Terrific Electrical Explosion Resulting, Marking Another Step Forward in Man's Mastery of the Atom.

The Illustration Below at Left Shows the Intensive Action of a Game of Ball, While Little Bobby Bumps is Smashing Them Out as Fast as the Youthful Pitcher Can Put Them Over. Not Much Work for Fido to Do In That Case. Friend Cat Seems to Show His Enthusiasm Like a Regular Fellow. This Newest "Animated Movie" Is a Mystery to the Uninitiated, In That Living Actors Interchange With the Pen and Ink Characters.

At the Left, We Have Mr. Hurd Bringing Forth His Family of Many Colors and Combinations; a Number of the Little Characters He Uses in His Plays.

Below at Right, Feline Sympathy and Enthusiasm Seem to Have Gotten the Best of Our Very Black Kitten, Who Cannot Stand and See This Big Stiff Imposing Upon the Youngster, and Accordingly Proceeds to Swat the Pen and Ink Drawn Man With His Very Much Alive Paw.



Miracles of the Silver Screen

By E. M. STEVENSON

THE gingham dog and the calico cat, side by side on the table sat, and the story goes that before they got thru with their argument there was fur and mud stuffing scattered to the four corners of the room. Only, in this day and age, the stage is set with a different cast,—two boys, a dog, a very live and black kitten, and a handsome prize fighter. The properties, I should think, a ball, bat, broom and a bottle of very black ink.

With the scintillating rays of a mercury light beaming its benignant approval on these playmates of a make-believe world, a comedy-drama of marked human interest is enacted and projected on our screen, which drags from our calloused unbelieving soul a gasp of joy and wonder at the sight of a small boy and that real live and very black kitten, playing with little paper comrades, that live and move and have their being at one and the same time with their human creator.

Our childhood paper dolls come to life, and, oh, how lively and smart they are.

The curtain rises while our heart goes out to the little boy we see sitting, not a little disconsolate, alone, with a drawing board and pen and his bottle of exceedingly black ink. Soon his face brightens, and he begins to draw.

He is a small boy wonderfully clever, as you will agree before the tale is finished.

From the swiftly moving point of his facile pen, the blank whiteness of the paper is possessed of a very wideawake looking lad about the size of little Tom Thumb.

Our young artist seizes him by the scruff of the neck and lifts him to the table, where he proceeds to cut up all manner of capers: let us call him Bobby Bumps. Shortly he stops inquiringly, and asks in an injured tone of voice, "Where's Fido?" Righto, and in a few strokes a saucy little bull pup looks around, then at sight of his young master, bounds gleefully off the page and romps around him, perfectly happy, even as you and I.

What do not he and we see as interesting parties to the antics of our little visitors from a mystic world? We seem to hear the "cat's meow" uttered by his royal black highness. At first he seems asleep, but now alert he ofttimes makes a playful swipe at the little dog that dislays the greatest curiosity in that mammoth black animal of a prehistoric age that sits looking down on him with such a baleful glare. Nothing daunted, he accepts the challenge and soon this terrific animal, our own dear and very black kitten, is looking out from behind the family broom, while little Fido jumps at him from first one side and then the other. You'll see how it's done later.

A shrill whistle from Bobby recalls him, and Fido scales the side of the big desk to his beloved master. Ah, he knows. Bobby has a bat and ball. That means but one thing to him—Bobby at the bat, Fido the catcher, while the real live youngster pitches. Bobby displays great skill with the hickory stick and keeps the pitcher busy spearing his long drives, while the cat looks on and cheers "Atta boy!" We'll tell how it's done soon.

Like sha..es of darkest night, this young kitten sits blinking his amber almond eyes knowingly and beaming with feline pride at the extraordinary creations of his own youthful master. This particularly brilliant young man's eyes have developed a queer mischievous look, and Bobby finds himself back on the page, watching in unfeigned wonder the growing figure of a prize-fighter taking shape from the wizard's pen. But wait, it got "so fur but no furder," a pair of legs, a pair of arms and gloved hands moving like flails. Good night, it's not fair. Poor little Bobby is jumping about trying to avoid the terrible punishment of these arms, with no chance to hit back. For shame, 'tis well the Marquis of Queensbury can not see this flagrant abuse of his favorite sport. A frantic whistle brings Fido, whose comet-like attack keeps the fighter's legs dancing. Bobby whips out a pencil, draws a stairs behind the boxer, then climbing them, quickly finishes drawing the man's body, and with all the concentrated fury of a catamount, this small bit of a lad proceeds to trounce the big stiff. Oh, delight, sweet essence of succulent seductiveness, what a scrap! Suddenly our black, oh very black kitten, sitting on the edge of the desk, becomes so enthusiastic at the happy turn of the tide, he fairly beams with joy, and in a burst of glorious spontanety and with a warlike meow, makes a lightning downward sweep of a mighty paw, and the prize-fighter goes down for the count.

Yes, I should think you all would like to

(*Continued on page 276*)

A Tunnel Through the Earth!

By CLEMENT FEZANDIE

WHAT would happen if a tunnel were bored through the centre of the earth to the other side, and a passenger allowed to fall thru in a suitable car?

Most persons would answer: "The car would fall to the centre of the earth and stay there." This answer is wrong. Others would say: "The car would fall to the centre of the earth, with gradually increasing speed, until it reached the centre, and there its acquired velocity would be so great that it would go straight thru to the other side of the earth before stopping."

This answer would be correct if the tunnel were bored thru the axis of the earth, from the North Pole to the South Pole, but such a tunnel would be of no use, as there are no passengers or merchandise to be transported from Pole to Pole. If a tunnel were bored in any useful spot, say from Australia to New York, neither car nor passenger would ever reach the center of the earth, except in the form of a gas!

Again the question arises as to what would be the effects of gravitation on the passengers in the car. Most people would claim that he would have his full weight at the start of the journey, and that his weight would gradually diminish until, at the very center he would weigh nothing at all, and then his weight would begin to increase again. This answer is altogether incorrect.

Then there is the question as to whether, when gravitation ceased to act, the objects in the car would attract each other—whether, for example the chairs would follow the passenger around as iron follows a magnet. Sir Isaac Newton gave the answer to this problem in his "Principia" but I doubt if many readers could give the correct answer offhand.

An allied problem arises as to whether a body without weight can be thrown any distance. Give a baseball pitcher a feather to throw, and he will be unable to throw it more than a few inches. If it had no weight at all, could he throw it a single inch?

Similarly, the passenger in the car, while retaining his full muscular force, tries to jump from the bottom of the car to the top. If he has no weight, would it be possible for him to jump a single inch against the resistance of the air which we suppose to be in the car?

Another question: "If the passenger can normally lift a weight of one hundred pounds, what is the limit of his lifting power when objects have no weight at all?"

Other interesting problems are the time required for the body to fall thru the earth and the greatest velocity it would obtain, and what sensations the passenger would experience during the descent.

Some thirty years ago I made a careful study of the entire subject, and incorporated my results in a story for boys entitled, "Through the Earth," which first appeared as a serial in *"Saint Nicholas,"* and was afterwards republished in book form by "The Century Company."

The book has long been out of print, however, and the problems involved in the subject are so numerous and so interesting that I think it worth while to recapitulate here the solutions of the various questions.

The first problem, of course, comes in the digging of the tunnel. To bore a hole eight thousand miles deep, even though but 30 feet in diameter, is no easy matter. Yet the total amount of material to be excavated is not very great. If digging proceeded at the same time from both sides of the earth—say from New York and from Australia, the total amout of material to be removed would be only one-tenth of a cubic mile in each of the two tunnels, that is to say, one-fifth of a cubic mile in all. It would be a smart engineer, however, who could succeed in making both holes meet properly in the centre of the earth.

In my story the excavation was effected by means of a specially constructed auger or boring-tool that descended as the work progressed, and whose cutting edges were continually replaced automatically by new ones. The tool was worked by electric power obtained from the waves of the ocean.

The tunnel was lined with a tube of a new substance which I called "carbonite" and which possessed the strength and lightness requisite for the purpose.

The Car Was Started Thru the Tunnel Which Passed from One Side of the Earth to the Other, When the Subject of the Experiment Climbed to the Ceiling of the Car and Then Let Himself Drop Head Down, Toward the Bottom. To His Surprise, the Subject Never Reached the Floor, the Act of Dropping Having Started the Car on Its Journey, His Body and the Car Then Dropping at the Same Speed The Calculated Time Required for the Entire Fall Thru the Earth from Australia to the Receiver on the New York Side Was 42 Minutes, 13.4 Seconds. The Car Is Hauled Up the Last Mile in New York by a Clutch and Cable System, as Shown in the Drawing.

This tube was always kept in a state of fusion at the top, and was allowed to descend slowly into the tunnel as the boring progressed, new molten matter being added at the top.

As the work advanced, and the internal heat of the earth began to make trouble, special devices were attached to the tube, which converted the heat into electricity, this electricity being conducted thru the tubes to Australia and New York where the current was sold for heating, lighting, and transportation purposes, the sums realized netting a fortune after paying for all the expenses of building the tunnel.

Finally all obstacles are overcome and the tunnel is built. Then comes the problem of exhausting the tunnel of air. A column of air four thousand miles high would obviously render the experiment impossible, as the air at the centre would be under a tremendous pressure. So Doctor Joshua Giles—the originator of the tunnel—pumps out all the air possible, and then gets rid of the remainder by means of chemicals that have an affinity for the oxygen and nitrogen.

(*Continued on page 272*)

Doctor Hackensaw's Secrets

By CLEMENT FEZANDIE

(Author's Note. Our chemists to-day are able to produce many organic substances synthetically. Is it too much to expect that, in the not very remote future, we shall find the means of endowing this organic matter with life, and producing the one-celled animals and plants that are the lowest forms of life known? And once we have produced these unicellular types, what is to prevent us from going further and grouping these into more and more complex forms, until we are at last able to reproduce forms similar to those of our higher animals, which are after all but a collection of organs and tissues built up out of the simple cells?)

"SILAS," said Doctor Hackensaw, impressively, "I am going to show you to-day, the greatest invention that has ever been made by man!"

"Good gracious, doctor," cried Silas Rockett, "what in the world can it possibly be?"

"Silas," continued the doctor, solemnly, "I have invented—'LIFE!'"

"Invented *life?*" echoed Silas, puzzled.

"I suppose it would have been better to say that I have *discovered* life, tho that would scarcely express the idea. I have discovered the secret of life, and have invented means for infusing life into inert organic matter."

—No. 7—
The Secret of Life

"You mean that you have discovered 'spontaneous generation'?"

"You may call it that, if you wish. If you recollect, it was Pasteur's attempts to produce spontaneous generation that led him to the study of ferments and of hydrophobia. But he never succeeded in producing life, and I have!"

"Is it possible?"

"Yes, I began with the lowest forms of life—the one-celled animals and plants that are so much alike, that scientists are not yet agreed which to call animals and which to call plants. It is here that life evidently originated on our planet, and from these low forms it split up into the two great kingdoms; one branch evolved into plants, the other into animals.

"From the very start I realized that I was faced with *three* problems, not one. First, I must analyze protoplasm, and after learning its chemical constituents, I must learn to manufacture inert protoplasm. Second, I must learn how to confer on this inert protoplasm the properties of irritability and contraction which constitute life."

"What!" cried Silas Rockett in amazement. "Is life nothing but the irritability of our cells and their power of contracting?"

"Practically, yes. Herbert Spencer has given a long definition of life, which you will find in the dictionaries, but, as a matter of fact the basis of life is the irritability of the cells and their power of contraction. Of course, for growth, it is necessary that the cells should feed—that is, that they should absorb and assimilate nourishment. They must also reproduce themselves—one cell must grow larger and then split into two or more cells. This is the way all increase takes place in plants and animals."

"Well, what about the third problem?"

"The third problem, after producing living cells, is to build them up into complex tissues and organs—in other words to produce higher forms of life from the lower."

"And you have succeeded?"

"Yes, but only after years of experimenting. Of course, I did not wait to solve the first problem before I tried the others—I carried on all three sets of experiments at once, and curiously enough, I solved the third and most complex problem first. And here, too, contrary to my expectations, I found it easier to work with animal substances than with plants. The sap in plants is less complex than the blood of animals.

(*Continued on page* 268)

"There sat Hoochie on a low chair, surrounded by living toys of the most wonderful kind. In her lap she held a miniature elephant the size of a kitten. By the side of her chair stood a three-headed dragon, coming like a dog to be patted by its master. On her shoulder stood a fairy queen . . . . while near by stood a miniature Centaur making eyes at a living mermaid. In some of the flowers was to be seen a perfect live seahorse, while on the stalk of one flowering plant there grew a living baby of tiny size . . . . "

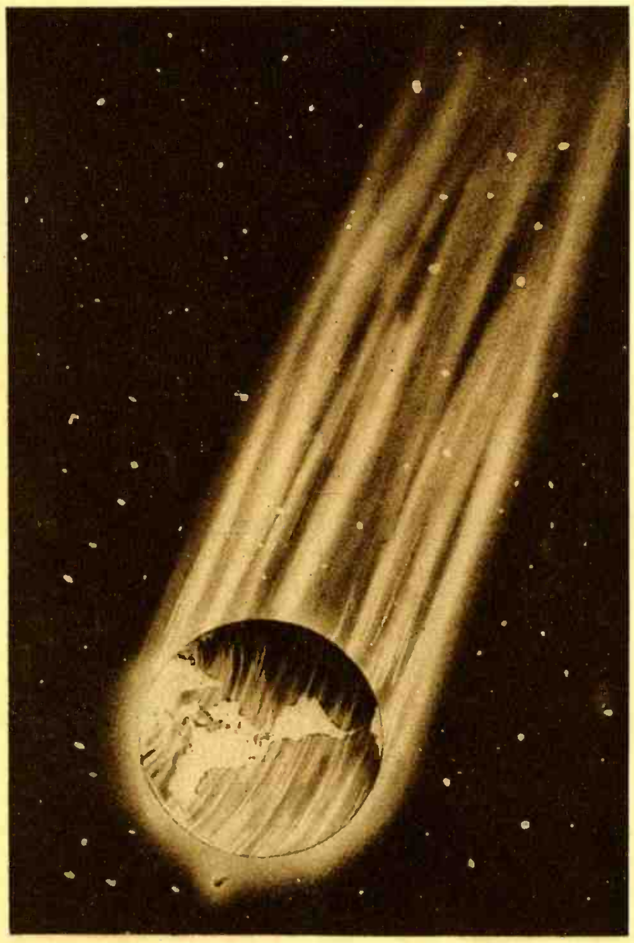
Popular Astronomy

By ISABEL M. LEWIS, M. A.

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

The Earth Viewed From the Moon

IF it were possible for human beings to migrate to the moon and take up their abode in that mysterious world we may imagine them settling exclusively in one hemisphere that they may enjoy the aspect of our own planet ever visible in the heavens, presenting to their view a disk four



This Shows the Aspect of the Earth When Viewed at a Considerable Distance Out in Space. The Earth Is Losing Continually Part of Its Atmosphere Into Space, and While This Does Not Amount to Very Much, It Is Sufficient to Be Seen, Were We Located at a Distance Where We Could View the Earth in Such a Position as Shown in Our Illustration. Here the Earth would Be a Wondrous Sight, and while the Tail Behind the Earth would Not Be of Such Great Luminosity as That of a Comet, Nevertheless, It would Be Clearly Discernible.

times as great in diameter as the moon presents to us, and oscillating slowly to and fro against a sky of inky blackness. About four-tenths of the moon's surface is never seen from the earth, because the moon always keeps the same face turned toward us, completing one rotation on its axis in approximately the same time that it takes to complete one revolution around the earth. Upon another four-tenths of the lunar surface the earth never sets and over the remaining two-tenths of the surface it alternately rises and sets. If we should choose a position on the moon's surface near the center of the visible disk we would be most favorably located for observation of the earth-disk which would be nearly in our zenith thruout the month. If we dwelt near the edge of the visible disk of the moon, whether at its poles or in equatorial regions, we would see the earth nearly in our horizon. In the course of a month the dividing line between the visible and invisible portions of the moon's surface would shift to and fro and the earth would alternately rise above and sink beneath the horizon.

The phenomena of a rising and setting earth when viewed from a point near the edge of the lunar disk and the slight oscillations of the earth back and forth are due to what is known as the *librations* of the moon. The moon's axis of rotation is tilted to the plane of its orbit about 6½° and as a result we can see beyond the poles of the moon by this amount in the course of one revolution of the moon around the earth, just as the tilt of the earth's axis to the plane of its orbit permits the sun to shine beyond its poles 23½° in the course of one revolution of the earth around the sun.

This amount by which we can see beyond the poles of the moon in the course of a month is called the *libration in latitude.*

Also the moon rotates on its axis at a uniform rate, but moves around the earth at a non-uniform rate, owing to the fact that it is moving in an ellipse and therefore travels more rapidly when it is nearest the earth, or in perigee, than when it is farthest from the earth, or in apogee. It follows that for certain positions of the moon in its orbit we see considerably beyond its western edge while in another part of its orbit the moon is so turned with respect to the earth that we can see considerably beyond its eastern edge. This is called the *libration in longitude.* Its greatest possible value is 7¾°. It is owing to these librations of the moon that the earth is visible *always* from only four-tenths instead of one-half of the moon's surface and is visible at irregular intervals from an additional two-tenths of the surface. Another effect, as we have said, is to produce the slight swinging back and forth of the earth-disk, as viewed from any one position on the visible surface of the moon, in the course of a month.

A nearly stationary earth-disk of enormous size is not the only marvel of the lunar heavens. The markings on this disk are constantly changing in appearance owing to the rotation of the earth on its axis. The outlines of continents and seas can be readily discerned, tho they are often temporarily concealed by drifting clouds, and they are carried across the visible disk in twelve hours by the earth's rotation. In addition the disk shows in the course of a month all of the phases of the moon tho in the reverse order. When the moon appears *full* to us the earth would appear *new* to an observer on the moon and when we see a crescent moon the lunar observer sees a gibbous earth, and vice versa.

At "new earth," as the lunar visitors might call it, the huge earth disk would usually appear directly above or below the sun. The night side of the earth would be turned toward the lunar observer. It would be surrounded by a halo of reddish light, nearly one-sixteenth of the earth's diameter in width, produced by the shining of the rays of light from the sun thru the earth's atmosphere. The earth-disk would also be illuminated by a weird light, a blend of the auroral displays near the polar regions of the earth with the light from a full moon shed over the entire disk. Since there is no diffusion of light in the lunar sky owing to the extreme rareness or total absence of a lunar atmosphere this magnificent spectacle of a new earth is projected against a sky of inky blackness and it would be possible to see at the same time both earth and sun one above the other with the coronal streamers extending to either side of the sun for a distance of several times its own diameter—a vision such as is never granted to terrestrial inhabitants! The diffusion of sunlight by our own atmosphere makes it impossible for us to see the new moon except on the occasion of an eclipse of the sun, and so faint is the coronal light that it is completely concealed from view by the glare of sunlight except on the occasion of a total solar eclipse.

Usually, as we have said, the sun is visible above or below the earth at the phase of *new earth.* Twice a year, as a rule, however, when the moon crosses the plane of the ecliptic at or near the time of full moon the sun passes behind the earth-disk partially or entirely. The moon then passes into the shadow of the earth and we have for the inhabitants of the earth a partial or total eclipse of the moon and for the hypothetical inhabitants of the moon a partial or total

The Three Views Above Are as the Earth Appears in Its Different Phases as Viewed From the Moon. The First Illustration Is That When the Moon Has 0° Declination. The Second View Is When the Moon Has 28° Northern Declination. This Is the Maximum. The Last View Shows When the Moon Has 28° Southern Declination, This Being the Maximum.

eclipse of the sun. All who have observed a total lunar eclipse know that the moon is not invisible at such a time but shines with a peculiar coppery tint. This is due to the illumination of the lunar surface by the rays of sunlight which shine thru the earth's atmosphere and produce the reddish halo around the new earth of which we have spoken. The light from the coronal streamers, which now extend to a considerable distance on either side of the earth-disk, also shed some light upon the lunar surface. A total eclipse of the sun observed in this manner from the moon and the total immersion of the moon in the earth's shadow may last for fully two hours, and from the moment when the moon first dips into the earth's shadow until it passes completely out of it may be more than five hours.

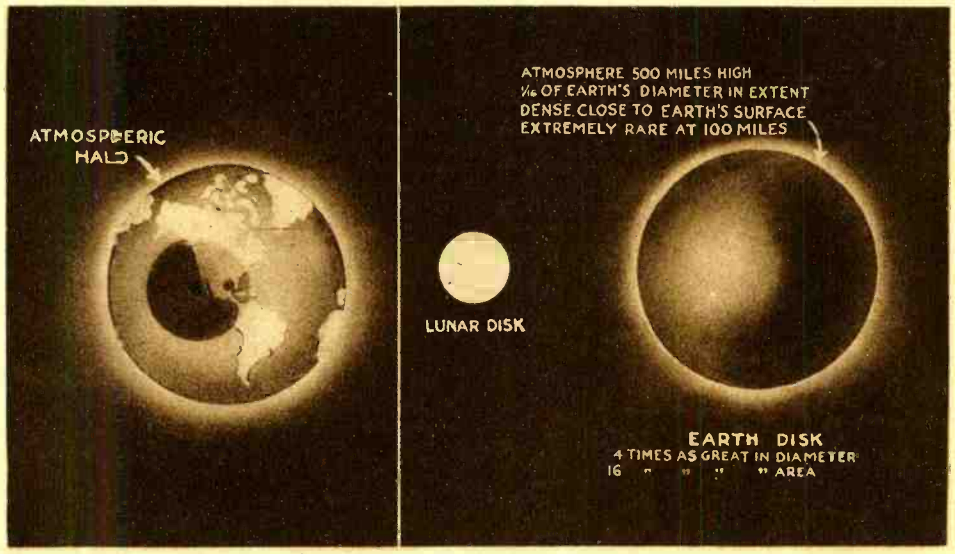
Shortly before and after "new earth" when the sun is a little to the east or west of the earth the lunar observer will see a faint luminous cone-shaped appendage of the earth directed away from the sun. This is an effect of sunlight shining thru the earth's atmosphere which extends in rare form to a height of several hundred miles above the surface of the earth.

The apex of this cone lies at a distance of nearly one million miles beyond the earth directly opposite to the sun, and here is formed the *gegenschein* or *counter-glow* which can be seen from our own planet under favorable circumstances. The light of this counter-glow is due, it is believed, to the reflections of sunlight from myriads of small particles or moonlets that are drawn into a cosmical whirlpool at this distance from the earth under the rival attractions of the earth and sun which are nearly equal at this point.

The light of this faintly luminous cone-shaped appendage of the earth is probably caused chiefly by the expulsion of rare gases from the earth's upper atmosphere, chiefly hydrogen and helium, by the force of light-pressure from the sun.

It is uncertain whether the zodiacal light, which may be seen as a faint band of light along the ecliptic at certain times of the year before sunrise or after sunset is produced by reflections of light from small particles revolving around the sun in the plane of the earth's orbit or by reflection of the sunlight to the earth from this luminous cone-shaped appendage of the earth.

A thin, brilliantly-lighted, earth crescent will now be seen along the edge of the disk nearest to the sun. The remainder of the disk will still be faintly illuminated by the light reflected from a moon that is now slightly gibbous, as seen from the earth. The earth crescent now increases gradually in size as more and more of the day side of the earth comes within the range of vision of the lunar observer. The sun draws gradually farther to the west of the earth and for an observer at the center of the lunar disk it is the afternoon of the lunar day, which lasts for about fourteen of our days or for one-half the duration of the moon's revolution around the earth. When the sun is ninety degrees west of the earth, the earth's phase is that of the half-moon. Half of the day side of the earth is visible and half of the night side. It is the lunar sunset for the observer at the center of the moon's disk, and for the next two weeks the sun will be on that side of the moon which is turned away from the earth. From that time on until it is the phase of *full earth* more



The Illustration to the Left Is the Earth as It Appears to a Lunar Observer at the Time of a Solar Eclipse. As Viewed From the Earth, the Small Black Dot in the Large Circle Is the Area Within which the Sun Is Totally Eclipsed. This Black Spot Travels Rapidly Across the Earth During the Eclipse. As Seen from the Moon the Large Shadow Circle Is Not So Dark Because the Sun Appears Only Partially Eclipsed. The Second Illustration Shows the Comparative Sizes of the Earth and the Moon as Seen from the Respective Bodies. In Other Words, to an Observer on the Moon the Earth Presents a Very Much Larger Appearance in the Heavens than the Moon Does to Us.

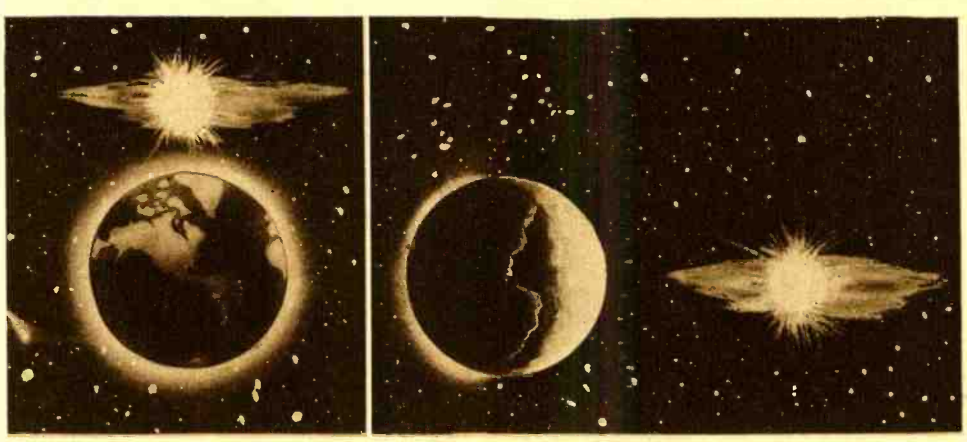
and more of the day side of the earth comes into view, and the earth is now in the gibbous phase. At the time of full earth, two weeks after the earth was *new*, the lunar observer sees all of the day side of the earth. The earth-disk is now brilliantly illuminated by the sun's rays. The sun is now shining on the side of the moon that is turned away from the earth. The night side of the moon is turned toward the earth and bathed in a flood of earth-shine, reflected from a brilliantly illuminated earth-disk, four times as great in diameter and sixteen times as great in area as the lunar disk. The moon is now *new* as seen from the earth and the earth *full* as seen from the moon.

Twice a year at this phase of new moon and full earth the sun passes partially or entirely behind the moon's disk. The terrestrial observer sees a total eclipse of the sun; the lunar observer sees the shadow of his own world creeping over a large portion of the earth-disk. If the eclipse is *partial* the dusky penumbral shadow spreads over seas and continents, and within this shadow the terrestrial observer sees a partially eclipsed sun. If the solar eclipse is *total*, the lunar observer would see a small round black spot, one hundred miles or so in diameter, flit rapidly across the earth from west to east in a period of about three hours on the average. Surrounding this central, black spot is the much larger dusky circular shadow of the penumbra, several thousand miles in diameter. Terrestrial observers located within the small central shadow experience a total solar eclipse while those who find themselves within the larger penumbral shadow see only a partial solar eclipse.

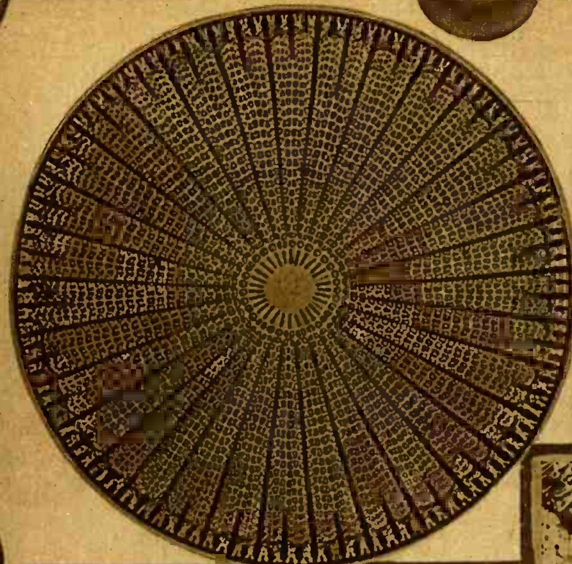
The appearance of the *full* earth to an observer on the moon would doubtless be a source of never failing wonder and delight. Tho no shadows would be seen under the vertical illumination of the sun at this time, the familiar outlines of continents and seas and great lakes slowly traverse the earth-disk from west to east, as the earth turns on its axis. Brilliantly luminous seas reflect the image of the sun. Dusky tracts of vegetation appear—our prairies, forests and tropical jungles. Our great deserts appear in reddish tints and our polar caps, lofty snow-clad mountain peaks and drifting clouds, temporarily concealing familiar markings beneath, appear as brilliant white patches or streaks in contrast to the dusky continents and glistening seas.

After the phase of full-earth the lunar observer sees the various phases pass over the face of the earth in reverse order, gibbous earth, half-earth, and crescent appearing in turn. At the third quarter, which is the phase of half-earth, the sun is ninety degrees east of the earth and it is sunrise for the observer stationed at the center of the visible disk of the moon. The eastern half of the earth-disk is illuminated by the sun and the western half is in darkness. The lunar observer again sees half of the day-side and half of the night-side of the earth. From now on the illuminated portion of the earth's disk is crescent in shape, the crescent narrowing as the sun once more draws in toward the earth. More and more of the night side of the earth comes into view and less and less of the day side. Finally, as the sun once more passes from east to west of the earth-disk at the time of new earth the crescent entirely disappears and all of the night side of the earth is again turned toward the lunar observer. The sun has completed its apparent circuit of the lunar heavens and the moon its actual circuit of the earth from new earth to

(*Continued on page 266*)

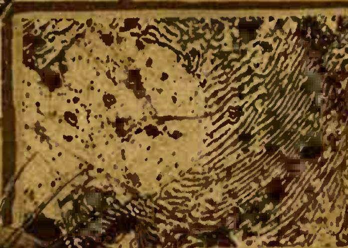


At Left: New Earth as Viewed From the Moon. Earth and Sun Are Both Visible One Above the Other. This Is a View Some Distance North of the Equator. At Right: The Crescent Earth. When the Earth Is in the Crescent Phase, the Sun Appears at the Side Next to the Crescent Not Far Distant from the Earth Disk. The Haze Along the Left Edge of the Earth Is the Atmosphere. To Get the Correct Effect of This Picture, Hold It at Arm's Length.

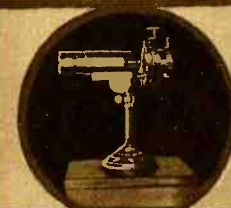


Note the Remarkable Symmetry of the Diatom Here Shown. Its Original Magnification is 3,000 and the Photograph Obtained Was Four Times the Size Shown Here. It Was Taken by W. A. Cornell.

With the Micro-telescope, this Photo of "Pouch Chuli" Himalayas Was Obtained. The Depth of Focus is Perfect. The Middle Distance is 30 Miles Away, and the Peaks Are 70 Miles Distant.

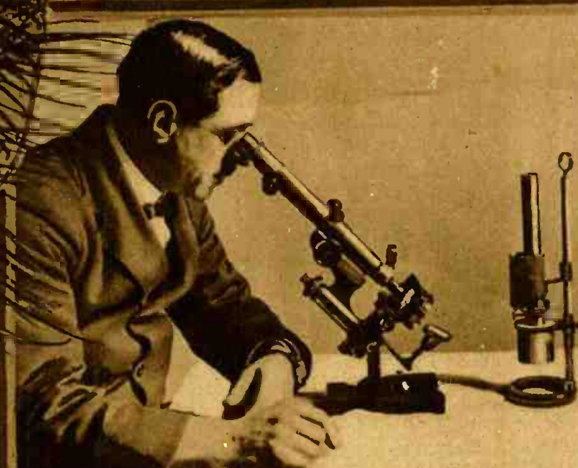


Annealed Steel Originally Magnified 1,500 Times. A 1/6-inch Objective Was Used With the Super-microscope.



Above We See the Super-microscope Attached to the Sub-stage of the Microscope. This Simple Attachment Does Away With the Oil Immersion Objectives.

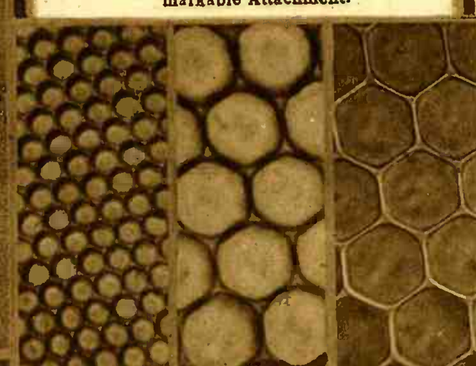
The Proboscis of the Blow Fly. It Would Be Impossible to Take a Photograph of the Whole Field at This Magnification, and Secure the Extreme Depth of Focus by Any of the Ordinary Methods of Micro-Photography



Super-microscope for Critical Work In Bacteriology Is Here Shown In Use. Scattered About the Borders of This Cut Are Actual Photographs of Diatoms Obtained With This Remarkable Attachment.

The Reflection of a Statue Taken Thru the Lens of a Blow Fly's Cornea, With Super-microscope. A Camera Without the Microscopic Eye-piece Was Used.

No, Dear Reader, This Is Not Italian Lace Hosiery. It Is a Natural Photo of a Diatom. The Lace-like Structure of Nature Rivals Any Produced by Man. Note the Truly Wonderful Regularity of the Subdivisions.



The Three Photos Above Show a Group of the Lenses In the Eye of a Blow Fly. Each Lens Is Contained In a Frame or Socket; the Two Enlargements Above Clearly Show the Framework.

Super-Microscope Reveals Nature's Wonders

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

A NEW development in the line of microscopy and tele-photography has been developed by two British scientists, Messrs. Cornell and Davidson. The full details of the new appliance are not available, but the general principles can be made clear by the aid of the illustrations which we give here. The general idea can be thus expressed. A microscope is mounted, so as to represent the eye-piece of a telescope. The stage, condensers, and reflectors, are all removed, and in front of the eye-piece a tube carrying a telescope objective is mounted. It will be seen that the apparatus is a combination of a telescope and a microscope. In the everyday microscope objects are held within a small fraction of an inch of the objective. In the new apparatus, this is done away with, and the objects to be inspected, may be several feet distant. The mounts shown in the illustrations can magnify an object at a distance varying from 4 ft. to infinity. A fly placidly standing on a lump of sugar can be inspected at leisure, and its photograph can be taken without disturbing him in any way. The same instrument can be turned upon the moon and perfect rendition of the surface will be given.

The invention is called the micro-telescope and the super-microscope. It bridges the gap between the two instruments, and at the same time makes it possible to introduce a camera and to take photographs under these wonderfully advantageous circumstances. It is perfectly evident that an insect photographed at a distance of 4 to 15 ft., and magnified many diameters in his perfectly natural state, will give a much better effect, than if he is impaled or cemented upon a microscopic stage to have his photograph taken while held motionless.

Another interesting application comes in metallurgy. The fracture of steel has often to be studied and photographed. This is done under the most disadvantageous circumstances with the ordinary microscope on account of the opacity of the steel, and on account of its highly irregular surface full of projections and depressions. It is virtually impossible to get some samples highly magnified. But for this apparatus, the sample is placed several feet away from the instrument, and the photograph to any reasonable degree of magnification is taken thus at long range, bringing out the crystalline structure and all the features upon the photographic plate. It is hardly going too far to say that as contrasted with old time methods, it is almost an approach to stereoscopy. The focus of the objective which is placed in front of the microscope, may vary from 3½" to 6".

A very interesting line of work which is done with this instrument is the study of the action of different substances exposed to heat in high temperature furnaces. As the apparatus can be placed well away from the furnace, the behavior of firebrick, their expansion and contraction, and the actions of alloys and steels when brought up to high temperatures, can be studied at leisure; the one essential is that a clear atmosphere is preserved within the furnace, as the least amount of smoke interferes with these observations. In these studies of expansions and contractions at varying temperatures, running up to white heat, the micrometer and cross-wires are very conveniently applied, so as to get true measurements of changes in dimensions.

The diameter of the objective is so large compared to its focal distance, that high illumination is secured. A clinical thermometer, such as used for taking the temperature of invalids, can be read at a distance of 20 ft. by unassisted daylight. On near objects, 20 to 50 diameters can be conveniently used. Sixty diameters may be conveniently applied to astronomical work, and as a very curious example of the capabilities of the instrument, the moons of Jupiter millions of miles away can be made clearly visible. It certainly seems a curious feature that the same instrument covers so great a range.

The metal fractures and inspection of test pieces which have been broken in the testing machine, can be minutely inspected, so as to see just what takes place when steel or other material yields perhaps to a tensile strain, or where it is broken transversely. Elaborate diaframing is used in some of the arrangements. The whole thing is so new that it is believed that its capabilities are not yet fully known, but we show enough in the very interesting illustrations to give our readers a good idea of what the instrument does.

Typewriter for Blind

By S. R. WINTERS

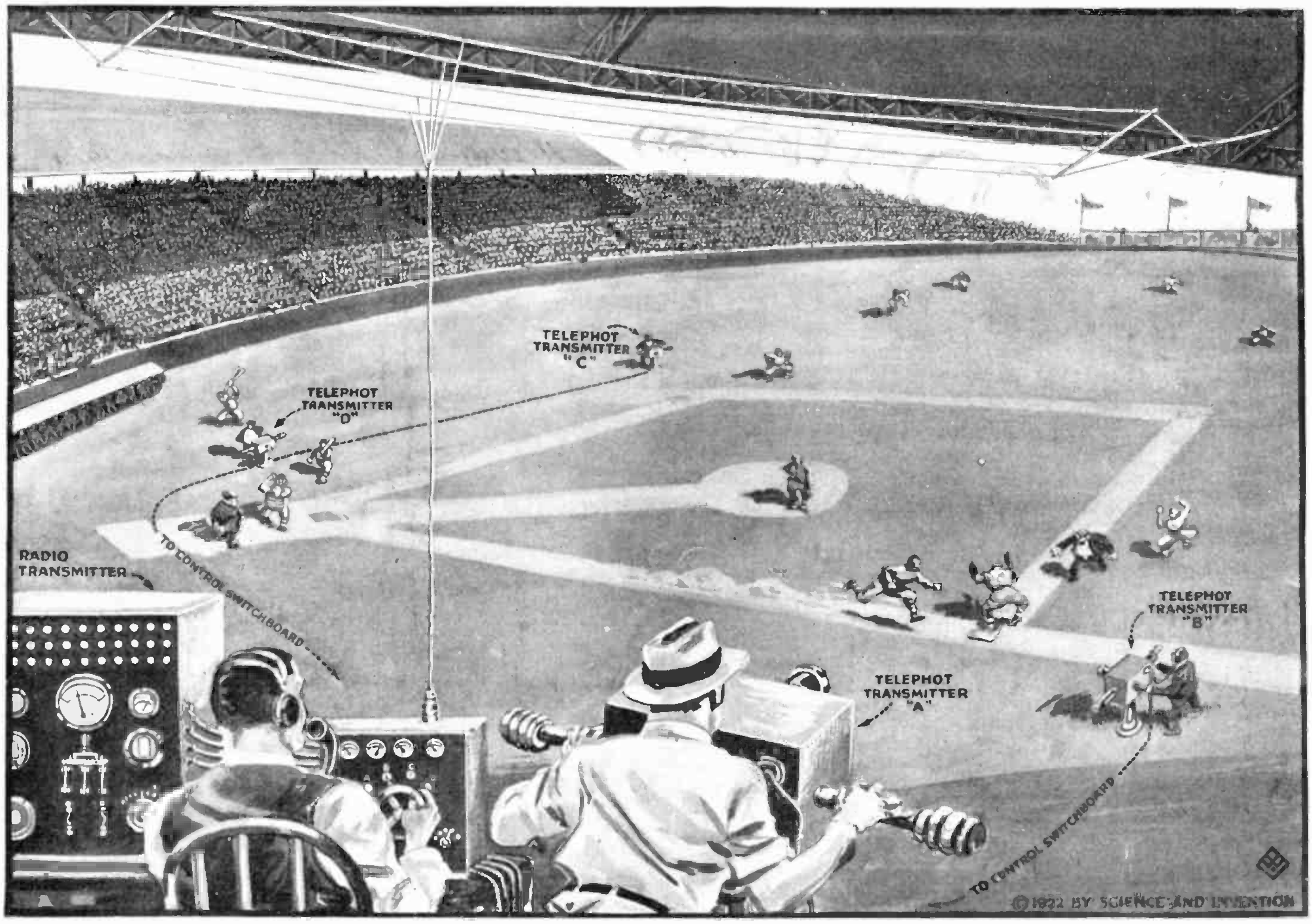
This Typewriter Has Been Fitted with the Simple Attachment Shown, Consisting of a Bar and Sliding Swiveled Stirrup, so that a Handless Person Can Operate It, One Arm Being Seen at the Left Resting on a Pad Secured to the Pivoted Arm Frame.

The Typewriter is Shown in Use by a Sailor Who Has Lost Both Hands as Well as His Sight. The Main Guide Bar is Pushed Back and Forth for the Different Rows of Keys, While the Right Hand Sliding Stirrup is Used to Press the Different Keys. A Click is Heard for Each Row and Letter.

RESOURCEFULNESS to a supreme degree is exemplified in the accomplishment of Carl Bronner, a student of the American Red Cross Institute for the Blind, located at Baltimore, Maryland. Despite the overwhelming handicaps of being deprived of both hands and bereft of sight, he has learned to operate a typewriter.

A machine of standard design is mounted upon a wooden base. Attached to the latter on both sides and to the typewriter itself are steel levers connected by a bar across the top of the key-board. These levers fit into four notches corresponding to the same number of rows of keys on the machine. On the bar, connecting the two levers, is a spring punch, which, as it travels its appointed course along this bar from left to right fits into notches corresponding to each key of the particular row at which the levers are placed. As the spring punch passes over the top of the key it clicks and the number of these sounds conveyed to the ears of the sightless operator and the position of the side-levers govern his writing.

To write "r," for example, the side levers are placed in the second notch from the top, the spring punch is moved from right to left until it clicks eight times.



In This Illustration We Behold How Future Audiences Will See a Baseball Game Thousands of Miles Away. Here We See a Common Radio Transmitter to Which Are Connected Several Telephot Transmitters. The Operators of the Telephot Transmitters A, B, C and D "Shoot" the Interesting Parts of the Game, But They Do Not Do This Simultaneously. They Merely Point the Telephot Transmitter into Focus While the Radio Operator at His Instrument Switches from One to the Other In Order to Get Those Close-Ups Which He Wishes. The Distant Audience Then Will See Whatever Close-Ups Are Selected by the Radio Operator. It Naturally Would Not Do to Have Just One Telephot Transmitter for the Reason that at Times, the Operator Would Be Either too Far, or Otherwise too Close to the Scene. By Having a Multiplicity of Telephots, This is Avoided.

The Radiophot. Television by Radio

Coming Inventions. No. 7

By H. GERNSBACK
MEMBER AMERICAN PHYSICAL SOCIETY

SCHEMES on television are not new. Inventors have busied themselves for several generations with this invention, but so far nothing of note has been produced. The writer, in the May and June, 1918, issues of the ELECTRICAL EXPERIMENTER discussed various ideas on television and showed what had been proposed by inventors heretofore. There are many patents in existence referring to the *telephot* (*tele=far; photos=light*), but so far there has been no inventor who actually was able to demonstrate a continuous view of a moving object by electricity at a distance.

It is not that it is impossible to do this, but the great cost of such an apparatus has been prohibitive. Furthermore, one of the greatest stumbling blocks is that in nearly all schemes shown in the past, it was necessary to have hundreds and even thousands of wires between the sender and the receiver. If, for instance, we wish to talk to our friend five hundred miles away over the wire all we need is a single wire, or two at the most, if we do not wish to use a ground or return circuit. If with the schemes proposed heretofore, we wish to see our friend at a distance, it means that we would have to string several hundred wires between the two points and the idea for this reason becomes at once impractical.

The author in this article proposes a somewhat more ambitious scheme of television not only over wire, but by radio. He wishes to state in advance that no apparatus has been as yet constructed along this line, but it is believed that the scheme here shown has possibilities that would seem inviting to our constructors who wish to take the time and trouble to build such an apparatus. Engineers are of the opinion that an apparatus of this kind will actually do the work with perhaps a few minor improvements.

The stumbling block with former telephots or television schemes usually was found in the selenium cell. This was so for the following reasons: When we desire to project a picture at a distance, it is first necessary that we have some instrumentality which changes the intensity of the electric current in the same ratio as the intensity of the light that falls upon the instrument changes. A picture, as is well known, is made up of various points. Pick out any half-tone illustration in this journal, view it under a magnifying glass, and you will see that it is made up of light and dark dots. The dark dots give the picture its dark tones and the light dots give the half-tones and the white paper shades into unison with the dots.

The selenium cell has long been thought the best instrument to translate changes in the intensity of light into electrical current impulses. Imagine a screen made up of several thousand selenium cells. A picture falling upon this screen will thereby resolve itself into the various components of the picture itself. Then some selenium cells will receive more light, others less, etc.

The electrical impulses are then sent out over the wires to be reconstructed later into a picture at the receiver. The trouble with the selenium cell is, however, that it is sluggish. In other words, the selenium cell takes a large fraction of a second in which to change its resistance. Light is instantaneous, and all reconstructed selenium pictures are always lagging behind; if we actually could obtain a reconstructed picture, it would be imperfect.

This trouble is done away with in the author's radio television scheme whereby instead of the selenium cell, we make use of photo-electric cells. There have been lately developed a number of such cells, which are available and which are highly light-sensitive. Moreover, they are not sluggish in action as are selenium cells. In other words, *they vary their resistance almost instantly* as the light falls upon them, or as it is removed.

Referring to our main illustration, the author's scheme resolves itself into the following. At the transmitter we have an ordinary camera-like box in the back of which we have a great number of tiny photo-electric cells. Each cell responds according to the strength of light and shade. The lens in front of the camera picks up the view and throws it inverted upon the group of photo-electric cells in the rear. All dark parts of the picture, as for instance, the shoes of the baseball player will, therefore, *not* affect the light sensitive cells *and these remain inactive*. The other parts of his body, as for instance the white uniform, will affect only those cells upon which rays of light from the white fall. These cells then send their impulses into a vacuum tube modulator and synthetizer. This vacuum tube modulator is a regulation radio transmitter such as is used in all broadcasting stations today. Each photo-electric cell is made to operate a separate vacuum tube, and each of these vacuum tubes sends out its own wave. For instance, photo-electric cell number one will send out on a wave, let us say of 500 meters; photo-electric cell number two transmits on a wave of 500¼ meters; photo-electric cell number three sends out on a wave of 500½ meters, and so on down the line.

From the radio transmitter all of these waves are sent out from one and the same aerial, which is quite feasible, for it has been demonstrated years ago that one aerial can be used to send out many messages, each on a different wave length, and there is no trouble in doing this very thing today. To resume, what have we done in our transmitter? We have transformed light impulses into electrical ones. These in turn are being shot out into space at different wave lengths, each retaining its own identity.

Now let us see what happens at the receiver. The distant aerial picks up all the different waves on a regulation radio receiving outfit, which, of course, must be able to tune very sharply; otherwise, it will not be possible for us to receive a clear picture.

In our television receiving box proper, we have the following: There is a bank of inductances with their respective condensers, together called the wave analyzer. These inductances and condensers are tuned circuits, and each picks out its own wave length and responds. In the circuit of each inductance and condenser, we have also an audio frequency amplifier, which operates an electro-magnet, similar to a telephone receiver. This wave analyzer is already in use today and is not a new development at all. Any owner of a vacuum tube set knows that he can tune in or out almost any wave length that comes along, within reason. It is also possible by means of certain arrangements to let several people listen in to several broadcast concerts from different stations, all on the same outfit. This already has been accomplished.

Coming back to our wave analyzer, let us see what happens now. Inductance number one, condenser number one, and audio frequency amplifier number one, are tuned to a wave length of 500 meters. This circuit, therefore, will respond only to 500 meters wave length, and to no other wave. Consequently, when at the distant sender, photo electric cell number one is energized, it sends out a wave at 500 meters, which wave is received in our wave analyzer, and will only affect inductance number one, condenser number one, and audio frequency amplifier number one. All the other inductances, condensers, and amplifiers are not affected because they work on different wave lengths.

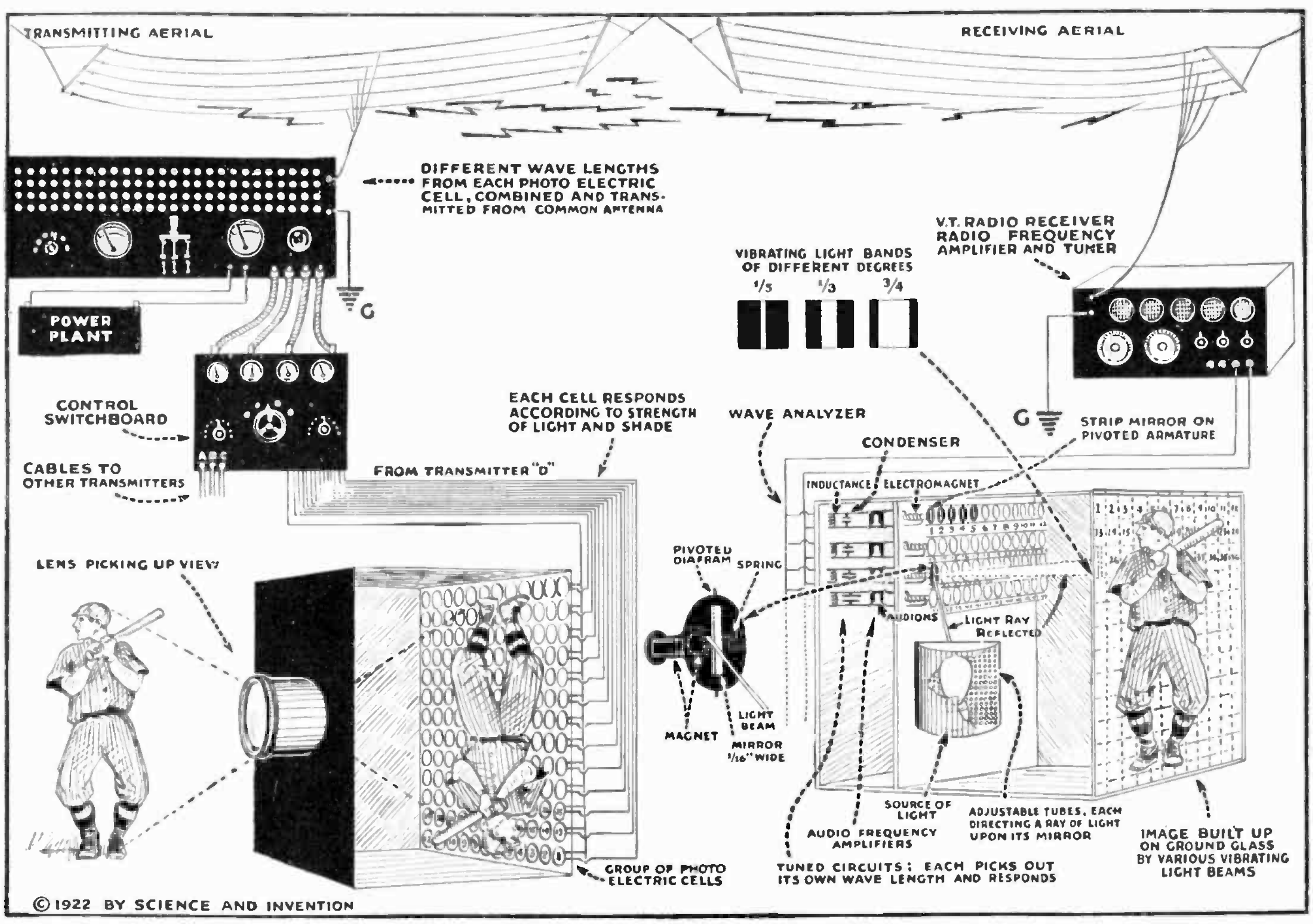
We shall now see how the picture is reconstructed. The electro-magnets connected with each of the many audio frequency amplifiers are equipped with pivoted diaframs in the center of which are mounted vertical strips of mirror, which are very narrow. These mirrors may be 1/16th of an inch wide, or thereabouts. The best width will probably be found by experimenting. From a common source of light also shown in our illustration a single ray of light falls just outside of each mirror. See diagram. The common source of light may be a powerful tungsten lamp enclosed in a box perforated with many holes. Each hole lets a ray of light pass and each hole sends a ray of light upon a different diafram.

The instant that the audio frequency amplifier energizes the electro magnet the diafram in front of it begins to turn on its axis, and the ray of light normally at rest begins to vibrate back and forth. This ray of light falls upon a ground-glass plate in the rear of the receiver.

At this point, we wish to call the readers' attention to the fact that the diafram in front of the electro magnet is not the ordinary telephone diafram but is one that is pivoted. In other words, the more current flows in the electro-magnet, the more the diafram will turn. Of course, this diafram is attached in such a manner that it will not turn thru a great angle. A small fraction of a degree is sufficient. It can be readily understood that we have here to do with a lever action, and if the mirror turns only a minute angular measurement or less, the beam of light that plays on the ground glass will move for quite a distance.

If the diafram vibrates violently, the flat pencil of light will illuminate a square upon the screen which is predetermined by experimentation. If the diafram does not

(*Continued on page 290*)

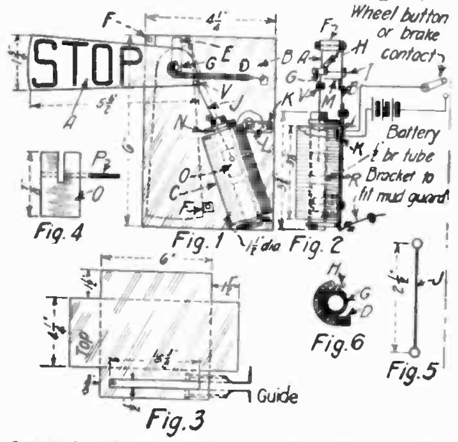


This Shows the Modus Operandi of the Latest Proposed Telephot Scheme. First We Employ a Group of Photo-Electric Cells Which Are Light-Sensitive, and Which Transmit Light Impulses into the Radio Transmitter. Whenever Light Falls Upon the Photo-Electric Cells, These Cells Transmit an Impulse. Where No Light Falls, as for Instance the Socks of the Baseball Player, Such a Photo-Electric Cell Remains Dark, and Consequently Sends Out No Impulse. All the Cells Send Out Impulses Which Are Transmitted at Different Wave Lengths from a Common Transmitting Antenna. These Are Picked Up at a Distant Receiving Aerial, Where We Have Also an Instrument Which Consists of a Great Number of Inductances, Condensers, Audio Frequency Amplifiers, and Electro-Magnets. Each Such Unit Responds to a Certain Wave Length. In Front of the Electro-Magnet, Which is Energized, We Have a Pivoted Diafram. On the Diafram We Have a Narrow Mirror. When the Diafram is at Rest, the Light Beam Falls Upon it, and Just Misses the Mirror. The Smallest Vibration of the Mirror, However, Intercepts a Light Beam From a Common Source, Which Light Beam Plays Upon the Ground Glass. The Combination of All These Diaframs in Reflecting Each One a Light Beam, Reconstructs a Picture on the Ground Glass, as Shown.

MOTOR HINTS

First Prize $25
ELECTRIC "STOP" SIGNAL

An electric "stop" signal can readily be made by the average home mechanic if the instructions given below are followed. The base as well as the cover of this signal can be made of tin, or better still, of galvanized sheet iron. The dimensions of the base of the signal arm are given in the drawing. The pivoted hole at the base of the arm G has a copper or brass tube bushing soldered to the arm. A small hook H, Fig. 6, is



Details for Making an Electric "Stop" Signal for Your Auto. The Swinging Arm is Actuated by a Solenoid Magnet.

soldered on the bearing, as shown also in Fig. 2. A bearing hole is drilled in the base, B, about 1 inch from the top, and the same distance from the left edge. On the same side is a hole thru the arm bearing. A metal brace, E, is bent so that the hole is ½ inch above the base, as shown in Fig. 2; this brace has a hole thru it the same as G, the bottom of this support being soldered or riveted to the main base, B. A stove bolt is passed thru the bearing of the signal arm thru brace E and the hole in base B, the end of the bolt being riveted to prevent the nut working off. D is a small spiral spring about 3 inches long, intended to keep the arm from swinging outward on rough roads. FF represent small rubber bumpers to limit the arm motion.

The solenoid or electro-magnet C, actuating the signal arm comprises a brass tube ½ inch in diameter by 3¾ inches long. On this tube, two 1½-inch diameter fibre washers are fastened tightly 3⅛ inches apart; the bobbin is then wound with 75 ft. of No. 20. D.C.C. magnet wire, for six volts, or 100 ft. No. 24 D.C.C. for 12 volts. The coil may then be thoroly soaked with melted paraffin wax or else shellac, and allowed to dry.

The soft iron armature is about ⅞ inch long, and should slide easily within the brass tube. It has a slot cut into the top and a hole drilled thru crosswise as shown in Fig. 4, to secure the connecting rod J, formed of a piece of iron wire ⅛ inch in diameter. A much stronger pull from the magnet will be obtained by tightly fitting a soft iron core in the bottom of the brass tube, this core extending nearly to the center of the coil. The pulling power of the magnet can be practically doubled by running a yoke around the coil, made from soft iron about 1 inch by ⅛ inch.

A slot is provided in the side of the cover thru which the signal arm can swing. For night signaling a small battery light can be arranged within the cover to throw a ray of light along the *stop* sign whenever it is operated, and some signals of this type have an electric light at the end of the arm. The signal may be operated by a button on the steering wheel, or automatically by a contact fitted to the brake pedal.

Contributed by
GEO. W. SALSMAN, Jr.

NOTICE TO CONTRIBUTORS

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

ELECTRICITY ON THE CAR

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

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

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

The following prizes will be paid:

FIRST PRIZE	$25.00
SECOND PRIZE	15.00
THIRD PRIZE	10.00

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

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

Second Prize $15
ELECTRIC CIGAR LIGHTER

Herewith is shown a novelty to be attached to the dash near the instrument light, with flexible wire of sufficient length to be used as a cigar lighter. It will do to start a fire or to warm the hands, by wiring in circuit on any automobile that has a storage battery, with current regulator or direct to battery. Owing to the low resistance of the heating coil, it requires about twenty amperes for red heat.

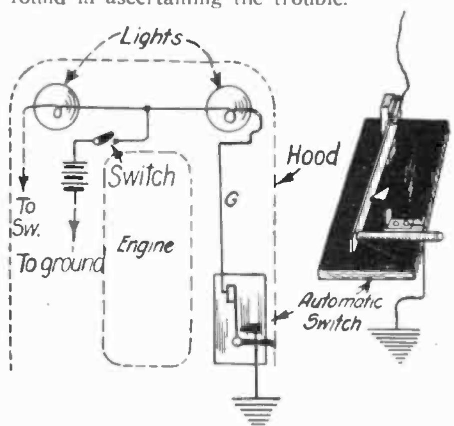
After connecting, press down on the stem, which acts as a switch, and passes current to the coil. In a few seconds the coil is hot enough to light a cigar or cigarette, by pressing the same against the wire coil, and drawing air thru same, as when using a match. The longer the contact is made, the higher the degree of heat obtained. I used common iron stove pipe wire for the heating coil, and put each end thru an asbestos, mica or bakelite base, and fitted a short piece of brass bushing over each end, and soldered unions with external wires. A stiff piece of copper or brass forms a switch spring held in contact with a short contact pin, by depressing the watch stem, which has a spiral spring placed around it.

Contributed by
DR. E. T. SONENDRIKER.

Electric Cigar Lighter Built into a Watch Case. It Works from the Car Battery.

Third Prize $10
RAISING HOOD LIGHTS ENGINE

One does not realize, perhaps, how convenient a light about the engine of an automobile really is until some dark night when the engine suddenly stops and difficulty is found in ascertaining the trouble.



Raising Either Side of the Hood Illuminates the Engine.

I have arranged two lamp sockets to hold battery lamps on the dash just under the engine hood, one on each side of the motor. A cut-out switch is mounted on the dash with the rest of the switches, so that the engine lights will not flash on if the engine hood is opened and raised during the day when they are not needed. As darkness approaches the dash switch is closed, and then if the engine hook has to be raised to look for trouble or adjust the carburetor, etc., the automatic spring switches fitted near the base of the hood cause the lamps to light. The dash switch need not be closed until one is about to get out and raise the engine hood.

The automatic switches operated by the engine hood are readily made from spring brass or phosphor bronze, fitting the longer spring shown in the drawing with a wood or fibre block at the lower end, which is depressed by the engine hood when locked in place with the usual hood snaps, so that the two springs are out of contact. The minute the hood is raised on either side the spring moves outward, and against the short upstanding contact spring, which is connected to the frame of the car.

Thus the circuit is completed thru one lamp or the other, depending on which side of the hood is raised.

Contributed by PHILIP A. BAKER

Auto Theft Prevention Hints

By Fred C. Allen
(The man who knows all their tricks)

Here are some hints that will help the man who has just bought a car and has not as yet had the opportunity to have a theft prevention device installed:

Shut valve off on gas tank.

If forced gasolene feed is used, take out pump plunger, and put it in pocket.

If Stewart Vacuum System is used, drain tank and open exhaust suction line.

Disconnect one wire from battery terminal, then lock battery box.

Disconnect switch wires under cowl.

Disconnect ground wire.

(*Continued on page 294*)

The Amateur Magician

By JOSEPH H. KRAUS

Japanese Lanterns and Parlor Tricks

PROFESSOR HARGRAVE had been on the road for quite a while, and I must frankly admit that I missed his congeniality, his keen sense of humor, and his ability to puzzle and trick me, which ability I greatly admire. He was playing before a small audience in Washington, when I seized the opportunity to impose upon him for another article, which imposition he would never admit.

After what seemed to be an age, I managed to enter upon the precincts of the Carleton Club, whose limited members made me feel distinctly out of place. Of course, I had no right to be there, being neither a guest nor a member, but then there are a lot of places to which one goes, knowing full well that he should not have been there.

Hargrave greeted me more cordially, saying, "I am going to introduce a new trick this evening for the first time, and altho I have no doubt it will go thru without a hitch, I would like you to scrutinize the presentation intensely. If you will, I would prefer that you take a seat at the extreme left of the small platform here, so that you will be able to see how the trick is performed to better advantage than the others in the audience. I would like you to assist me further, and when in the disappearing glass stunt I say 'Gone,' I wish you would call out 'Up your sleeve.' Don't forget 'Gone' will be your cue."

So saying, he excused himself and proceeded to get his apparatus in readiness preparatory to the rising of the curtain due in ten minutes.

I hustled out to occupy the seat he had assigned me, so that I would not have to request a change.

The Disappearing Goblet

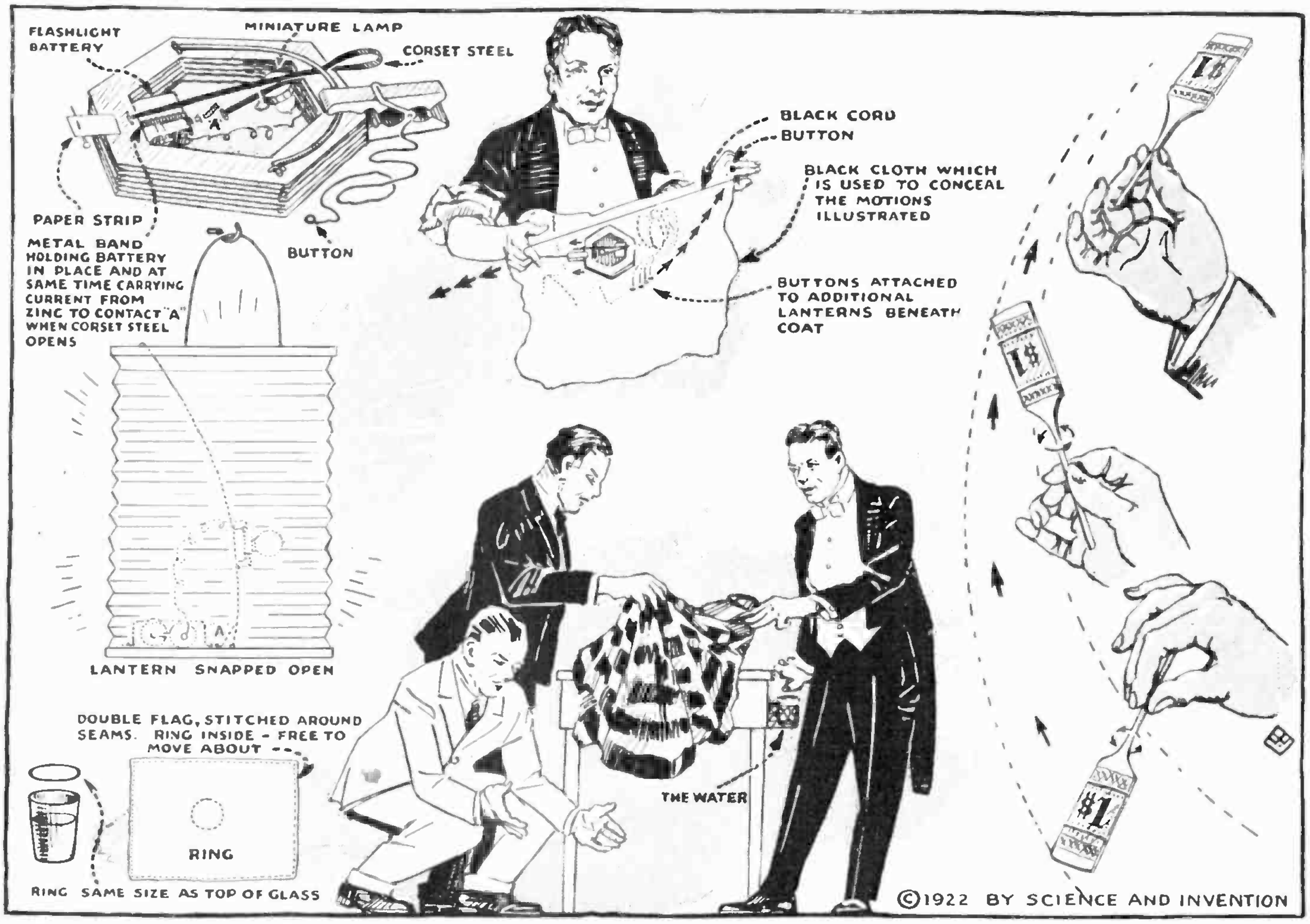
The curtain rose promptly at 10:00 o'clock, while members of the club were still drifting in, in groups of twos and threes. After a rather brief talk, Hargrave introduced several of his older tricks, some of which have been described in past issues of this magazine. Securing a glass of water from an assistant, he proceeded with the trick here described, saying, "There is no doubt but that some of you think that I have trained assistants helping me in many of these tricks. I will ask your President or Secretary or any skeptic in the audience to step upon the platform to assist me for the next presentation. I also want the services of a good ball-player. Is there anyone in the audience who can catch a ball?—What, no volunteers? Surely, there is some one amongst you who—that's it—step right forward, sir! You are the President, I presume!"

The gentleman referred to had arrived upon the platform and nodded his head in affirmation to Hargrave's inquiry.

"Who is a good ball-player?" Hargrave asked of the President, who in turn beckoned to one of the members to come up on the platform. Hargrave then proceeded. Waving a heavy silk flag, he placed the glass of water upon the table and covered it with the flag. He then requested the President to grasp lightly the edge of the glass of water, yet with sufficient grasp to lift the glass up from the table, the flag of course covering it. Directly after the President had walked to the front of the platform, he said, "Now when I say *three* I want you to drop the glass of water. This gentleman here is to catch it without spilling a drop. I would suggest that in dropping the glass, you release your hold suddenly, opening your hand rapidly, so that the glass will fall straight downward. I shall hold on to the flag." With these instructions, he extended the President's arm so that the glass which he was clutching under the flag was far away from his body. The catcher crouched down and extended his hands to receive the glass while Hargrave grasped the end of the banner. "One—two—three," the signal was given. The President opened his hand suddenly. Hargrave snapped the flag away, and the catcher stood there, his mouth open, his hands open, and the glass nowhere to be seen.

"Gone!" I was not quick enough to grasp my cue, so Hargrave repeated it for my benefit. The truth of the matter was that the trick mystified me and I was watching it intently, not paying any attention to what was being said, for Hargrave once taught me not to listen to what the performer has to say. Chatter is very distracting, sometimes completely masking the method of performing a

(*Continued on page 280*)

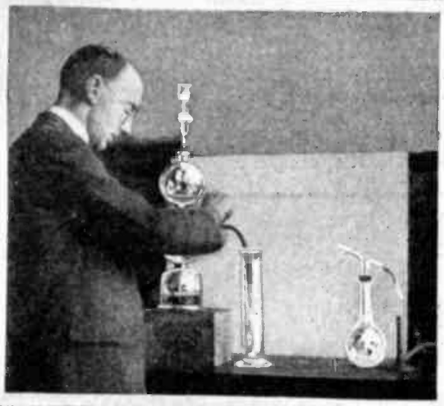


The Japanese Lanterns, Many of Which Are Pinned to the Inside of the Performer's Coat, Are Removed from in Back of a Cloth or Flag, the Flag Being Waved Each Time to Show that Nothing Is Concealed Behind It. Removing the Clamp Permits the Lantern to Snap Open, Simultaneously Closing the Circuit to the Light. The Disappearing Glass of Water and the Method of Making It Vanish are Clearly Demonstrated in the Lower Center Portion of the Above Illustration. By Rotating the Paddle and Swinging It at the Same Time, the Same Side of the Paddle Is Kept Uppermost, and the Rotating Movement Being Unobserved Makes It Possible to Change an Object Mounted on One Side of the Paddle to Another on the Opposite Side. This Clever Deception Is Shown at the Right of the Above Illustration

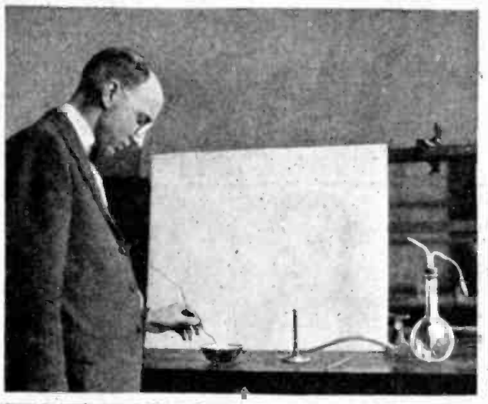
Practical Chemical Experiments

By Prof. FLOYD L. DARROW

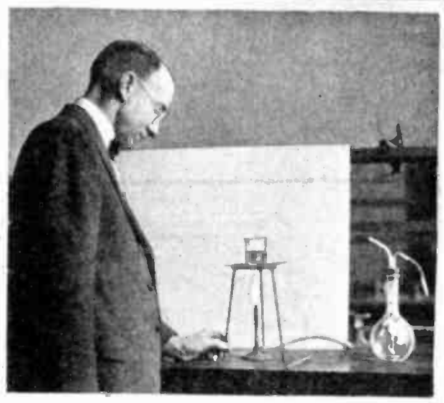
QUALITATIVE ANALYSIS—THIRD PAPER



Preparing Yellow Ammonium Sulphide.



Separating Antimony by Means of a Platinum and Zinc Cell.



Precipitating the Copper by Boiling the Solution with Iron Filings.

IN the preceding paper we had just completed the preliminary experiments on the metals of Sub-Group A in the Hydrogen Sulfide Group. In the following paragraphs we shall take up the systematic separation of the metals of this first Sub-Group A and then consider the metals of Sub-Group B.

Separation of Metals of Sub-Group A: In an Erlenmeyer flask of about 250 c.c. capacity place 10 c.c. each of solutions of mercuric chloride, lead nitrate, bismuth tri-chloride, copper sulfate and cadmium nitrate. Dilute this with about an equal volume of water, warm over a Bunsen burner and pass hydrogen sulfide into the solution in a slow stream of bubbles for several minutes. This will precipitate the sulfides of these metals, and the warming will hasten the action. When you think the precipitation is complete, filter and wash the precipitates on the filter paper by passing hot water through them three or four times. A suction filter will be very much to your advantage in this work. If too great suction is used, however, the tip of the filter will be drawn through and the work will have to be repeated. Sometimes doubling the thickness of the filter paper will prevent this. A perforated platinum cone to fit the funnel will, of course, do the trick, but its expense is usually prohibitive.

At this point it is very important to test the filtrate for complete precipitation. In the particular separation, which you now have under way, this is not so important, but when the succeeding groups must be considered, all of the metals in the hydrogen sulfide group must be completely precipitated. To make this test dilute a small portion of the filtrate with about four times its volume of water, warm and pass hydrogen sulfide again. If a precipitate appears, hydrogen sulfide must again be passed into the whole filtrate, followed by filtration, washing, and a second testing for complete precipitation.

Separation of Mercury: The precipitates upon your filter contain the sulfides of mercury, lead, bismuth, copper and cadmium. You will now separate and identify each of these metals in turn.

First, make a spatula by softening a six-inch length of glass tubing in the flame and pinching it flat with forceps. Hold it in the smoky flame until covered with soot and then allow it to cool and wipe off the soot with paper.

With this spatula remove a quantity of the precipitate to a test tube or small beaker. Now add from 1 to 5 c.c. of dilute nitric acid and boil as long as anything seems to dissolve. Dilute with a little water and filter, saving the filtrate, for this contains all of the metals but mercury. That is the sulfides of lead, bismuth, copper and cadmium dissolve in dilute nitric acid, but mercuric sulfide does not.

The residue, partly on the filter paper and probably partly in your test tube or beaker, will consist principally of black mercuric sulfide. Boil it in a test tube with from 1 to 2 c.c. of dilute aqua regia made by adding 3 parts of concentrated hydrochloric acid to 1 part of concentrated nitric acid and diluting with a little water. If an insoluble residue still appears, filter and then add to the filtrate a little of a solution of stannous chloride. The mercuric chloride formed will be reduced to a white precipitate of mercurous chloride and with enough stannous chloride to free mercury. This separates and proves the presence of mercury.

Separation of Lead: The filtrate obtained after dissolving the sulfides in dilute nitric acid will contain the nitrates of lead, bismuth, copper and cadmium. Add to it a few drops of dilute sulfuric acid and evaporate in a porcelain evaporating dish until only a few drops remain. Stop, however at the first appearance of white fumes of sulfuric acid. The lead will be precipitated as lead sulfate. Now rinse the precipitate of lead sulfate into a test tube with water, adding a little dilute sulfuric acid to keep the bismuth in solution. After the heavy lead sulfate has settled, filter, catching the filtrate, which will contain bismuth, copper and cadmium. Wash the precipitate several times with water and then pour a solution of ammonium acetate through the filter several times. This converts the lead sulphate into lead acetate, and upon adding a little acetic acid and potassium chromate solution to the filtrate, a yellow precipitate of lead chromate will be formed. The precipitation of this familiar "chrome yellow" proves the presence of lead.

Separation of Bismuth: We have now removed two of the five metals. To the filtrate from the above process containing bismuth, copper and cadmium sulfates add ammonium hydroxide until a basic reaction is obtained when tested with red litmus paper. At the same time a basic oxide of bismuth is precipitated. Filter this precipitate off and save the filtrate. After washing the precipitate upon the filter once with a little water, drop upon it two or three drops of dilute hydrochloric acid. This dissolves the bismuth precipitate and the solution is allowed to pass through into a clean test tube. To this add 15 c.c. of water and a white precipitate of bismuth oxy-chloride will be obtained. The appearance of this precipitate proves the presence of bismuth. Of course we know that it is present in this case, but in an unknown solution its presence would have to be proved.

Copper: If the filtrate obtained after filtering off the basic oxide of bismuth is blue that fact proves the presence of copper. Even if only traces of copper are present, a blue color will be obtained in ammoniacal solution. Of course, in this case a blue color will be obtained, for we know copper is present.

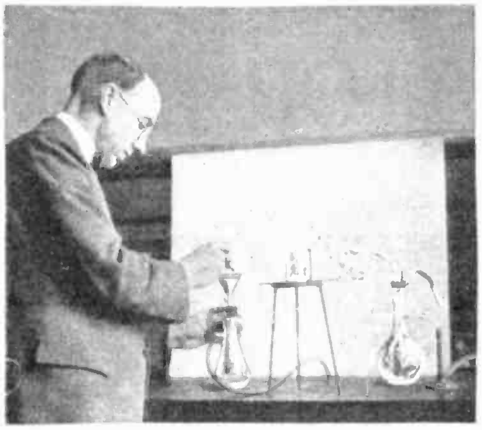
Cadmium: To the solution containing both copper and cadmium add dilute hydrochloric acid until the deep blue color just disappears. It is the ammonia present that gives with the copper the deep blue color and when this is neutralized the color disappears. Now add some iron filings and boil for a short time. This will precipitate the copper in metallic form, thus getting it out of solution. Now add a few drops more of dilute hydrochloric acid and then pass hydrogen sulfide. A yellow precipitate of cadmium sulfide will appear. Although iron sulfate is also present the hydrochloric acid prevents iron sulfide from precipitating.

Thus we see that by taking advantage of differences in solubility, one by one we have separated and identified these five metals.

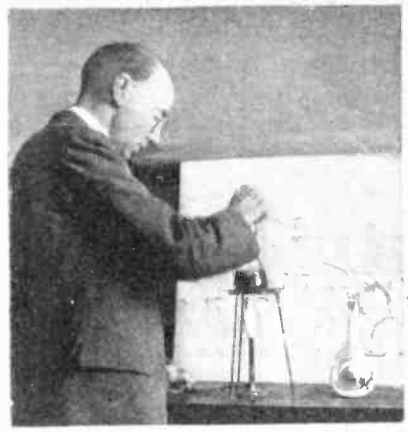
Sub-Group B: The metals of this division of the hydrogen sulfide group are arsenic, antimony, tin, gold and platinum. These metals are distinguished by the fact that their sulfides are soluble in yellow ammonium sulfide, while those of Sub-Group A are not. Again we have a difference in solubility. From this solution in yellow ammonium sulfide the sulfides of these metals may be reprecipitated again by the addition of dilute hydrochloric acid.

Preparation of Yellow Ammonium Sulfide: Into about 500 c.c. of strong ammonium hydroxide in a tall, narrow cylinder or bottle pass hydrogen sulfide gas until it has been saturated. This will take some time and the gas should be passed in a small continuous stream of bubbles. When you think this solution has been saturated, which will take at least from one to two hours, add an equal quantity of ammonium hydroxide and then dissolve in it a little powdered sulfur. You will now have a clear yellow solution.

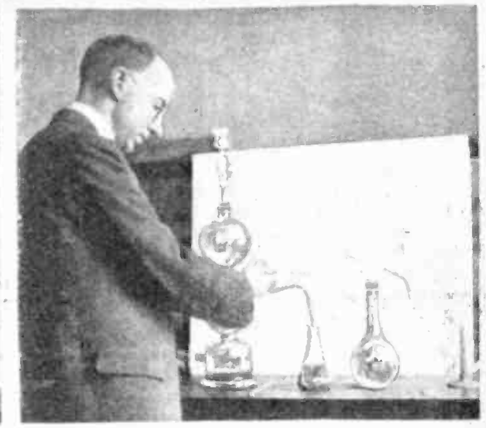
Arsenic: Dissolve a little arsenious oxide by boiling with hydrochloric acid. Dilute this with a little water, warm and pass into



Removing the Precipitate with a Spatula.



Warming a Solution of Metallic Salts Over a Bunsen Burner, Preparatory to Precipitation.



Converting the Metallic Salt to a Sulphide Precipitate with Hydrogen Sulphide Gas.

it hydrogen sulfide. Yellow arsenious sulfide will be precipitated. Filter and transfer a little of the precipitate to a test tube with your spatula. Add from 5 to 10 drops of yellow ammonium sulfide and warm gently. The precipitate will dissolve forming ammonium sulfarsenite. Now add dilute hydrochloric acid until the solution gives an acid reaction. This will reprecipitate the arsenious sulfide. We are here doing this to learn the process. In regular analysis you will see the necessity for dissolving this sulfide and then reprecipitating it.

Now filter and wash the precipitate. Add 2 c.c. of concentrated hydrochloric acid and boil. Add a small piece of potassium chlorate and boil again. The sulfide will now dissolve forming arsenic acid. Make the solution alkaline with ammonium hydroxide and if any residue is left filter. To the filtrate add a little of a saturated solution of magnesium sulfate and shake vigorously. A crystalline precipitate of magnesium ammonium arsenate should appear. Frequently rubbing the inside of the test tube or beaker with a glass rod will hasten the precipitation. A tiny scratch on the inside of the test tube also has the same effect. The arsenious compounds will not give a precipitate with magnesium sulfate and ammonium hydroxide. Therefore, the necessity of oxidizing them into arsenic form by the addition of potassium chlorate and hydrochloric acid is evident.

Tin: Tin forms two series of salts—stannous and stannic. Warm a solution of stannous chloride and obtain a brownish precipitate of stannous sulfide by passing hydrogen sulfide until precipitation is complete. Filter and wash the precipitate. Then dissolve it in yellow ammonium sulfide and reprecipitate with dilute hydrochloric acid. This converts the sulfide into stannic form. Filter and boil the precipitate with concentrated hydrochloric acid as long as hydrogen sulfide is given off. You now have stannic chloride. Dilute with a little water and add an iron nail. Upon warming the nascent hydrogen, which forms, will reduce the stannic chloride to stannous form. Pour off the solution into a clean test tube and add mercuric chloride solution. The mercuric chloride will be reduced and a white precipitate of mercurous chloride will appear, changing to metallic mercury upon adding more of the mercuric solution.

Antimony: Using a solution of antimony tri-chloride just as with arsenic and tin precipitate with hydrogen sulfide, dissolve in yellow ammonium sulfide and reprecipitate with dilute hydrochloric acid. Filter and wash the precipitate. Then dissolve by boiling with hydrochloric until all of the hydrogen sulfide has been expelled. You will now have antimony tri-chloride. Divide it into two portions. Warm one with an iron nail and you will obtain a black precipitate of metallic antimony. If you have a small piece of platinum place it in a porcelain dish with a piece of zinc upon it. Pour the second portion of the solution upon this. Immediately nascent hydrogen will be formed and the antimony chloride will be reduced to metallic form, leaving a black stain upon the platinum. To remove this stain wash thoroughly and then warm with a little nitric acid containing a drop of ammonium tartrate.

Gold: If you are fortunate enough to have a solution of gold chloride precipitate the sulfide with hydrogen sulfide. Dissolve it in a little aqua regia and to the solution add a mixture of stannous and stannic chlorides. Although the amount of gold present is very small, a purplish red precipitate known as purple of Cassius will be formed.

Platinum: When treated in the same way except that potassium chloride is added instead of stannous and stannic chlorides, a yellow precipitate will be obtained.

In the next paper we shall begin with the systematic analysis of Sub-Group B.

American Dyes Best

Dr. H. J. Conn, a bacteriologist of the Experiment Station at Geneva, Switzerland, and delegated by the National Research Council to effect a co-operative organization among different scientific bodies, educational institutions and other experiment stations, for the testing out of American-made dyes or stains for biological purposes, has issued a report on the progress of the work in which he states that, in general, the American stains are quite satisfactory and, in many cases, even superior to the German product which was used exclusively before the war.

A small but very important part of the textile dye industry is the manufacture of dyes or stains for use in the public health laboratory and elsewhere in the study and identification of bacteria and other delicate structures. In certain diseases, such as diphtheria, tuberculosis, etc., the physician in making his diagnosis depends to a large extent upon the appearance of cultures taken from the patient and stained with aniline dyes. The different disease-producing bacteria are so small and often so similar in appearance that they can be definitely identified only by their reaction to certain stains.

Before the war, the world was dependent upon Germany for these stains just as it was for most of its textile dyes. The stains were looked upon as being even more difficult to prepare than ordinary dyes, as the reactions between the stains and the bacteria are so delicate that, in order to give satisfaction in identifying bacteria, the stains must be quite free from foreign substances.

With the disappearance of German stains during the war, bacteriologists in this country were seriously handicapped in their work and the problem of producing satisfactory stains soon received the attention of leading chemists and bacteriologists throughout the country.

American manufacturers were encouraged to enter the field and, under the auspices of the National Research Council, the efforts of the several groups of scientists interested in the problem were coordinated. An attempt is being made to establish standards which will serve as guides to the manufacturers in the preparation of the stains.

Certain American-made stains have been tested under most severe conditions in a large number of laboratories and, for bacteriological purposes at least, are declared to be equal to, and in many cases, superior to the German stains. In fact, in those cases where careful chemical analyses have been made, the American stains have been found to be purer and to contain a higher percentage of color than the best German products.

Liquid Air Cracks Nuts

LIQUID AIR CRACKS NUTS

Liquid air for cracking nuts is the latest application of science. Experts at the National Bureau of Standards in Washington were appealed to for a method of breaking the shells of the chicha nuts, without damaging the kernels. They found that it took a weight of nearly a ton to crack the nuts, and that after that effort the meat of the nut was broken in many small pieces.

Then they applied liquid air to the problem. They did not freeze solid a piece of rubber and use it as a hammer, as is done in the classic stunt of physics, but they simply immersed the nuts in liquid air for thirty seconds and cracked them easily without damage to the kernels. Now the physicists are trying to find out whether this method can be applied commercially on a large scale.

Chicha nuts are grown in South America. Their dense strong shells were used during the war to make charcoal for gas masks and the oil from the kernels is a valuable food, similar to copra.

An Electric Railway For The Kiddies

By H. WINFIELD SECOR

IT does not necessarily entail a great deal of expense or time to build an electric railway for the kiddies, but simply a little ingenuity and the well chosen application of odd material frequently to be found lying about the place. The miniature locomotive and tender car or the small trolley car here illustrated can be driven by a 110-volt D. C. or A. C. electric motor, or a ¼ to ½ horsepower gasoline engine may be substituted. Chain or belt drive may be employed between the motor and the axle of the car, and where chain drive is used it will generally be found preferable to arrange a speed reduction gear with jack shaft as shown in one of the detailed illustrations.

The rails may be placed about eighteen inches apart, and several suggestions for building them are clearly shown in the accompanying figures, the form of rail used depending upon the materials available, and also upon the cost of the material, where it has to be purchased new. The builder may be fortunate enough to pick up some flanged iron wheels of small size, or otherwise they can be built of wood with a flanged piece nailed on to one side. The wheels used on a trolley car of this type built by the writer when a boy were turned up on a lathe from one piece of thick plank. Very good axles for the main wheels may be formed of one-inch pipe, the two wheels on the chain driven axle having to be pinned or held tightly in place by flanges and lock nuts, threaded on to the pipe.

There are in general two methods of supplying the electric motor with current, by using a trolley pole and wire, suspended above the track as shown in one of the illustrations, or again by using the well known third rail system. The trolley wire, if used, may comprise a No. 6 or No. 8 B. & S. gauge copper wire, or else a piece of telegraph wire, sweated into slotted brass supports, which are secured to the ends of pipe arms fastened on light poles along the track. It is usually more or less difficult for the amateur railroad builder to construct a circular or oval track, and where sufficient space is available it is strongly suggested that at first a simple straight track be laid. The car or locomotive can then be run in either direction, simply by reversing the electric motor. A series D. C. motor, which is preferable for use in this case, owing to its high starting torque, is reversed by changing the terminals of either the field or the armature, but not both. A double-pole, double-throw knife switch will enable the electrical bug to easily rig up this reversing scheme. If a single-phase self-starting motor is used, having a special starting winding on it, its direction of rotation is changed, simply by reversing the terminals coming from the starting winding at the connection block on the motor.

With regard to the driving arrangement between the motor and main axle, this, as aforementioned, may be accomplished with round or flat pulleys and belts, a rope drive with grooved pulleys having been used in some cases, taking care to make a tight, smoothly-spliced joint so that the rope will drive evenly; or a very good drive can be constructed from a bicycle chain, or better still, a motorcycle chain, with large and small sprockets, the smaller sprocket wheel being mounted on the jack shaft, as shown in the detail drawing of this feature. The driving connection between the motor and the jack shaft may be accomplished in one of several ways, using either two iron spur gears or else a chain and sprocket arrangement; if sprockets are used with a chain, the ratio of the teeth on them should be the same as the ratio between the two gears specified in the drawing herewith—i. e., 6 to 1.

For short railways, situated close to the house or other building from which the electric current supply is to be obtained, No. 14 or No. 12 B. & S. gauge insulated wire can be used. Where the railway is quite long, or situated a little distance from the house, heavier wires will have to be employed. By consulting Cushing's electric wiring manual, you will find directly from tables therein the size of wire necessary for carrying any current with a given voltage drop, or your local electrician will be glad to help you out in determining the proper size of wire to use, etc.

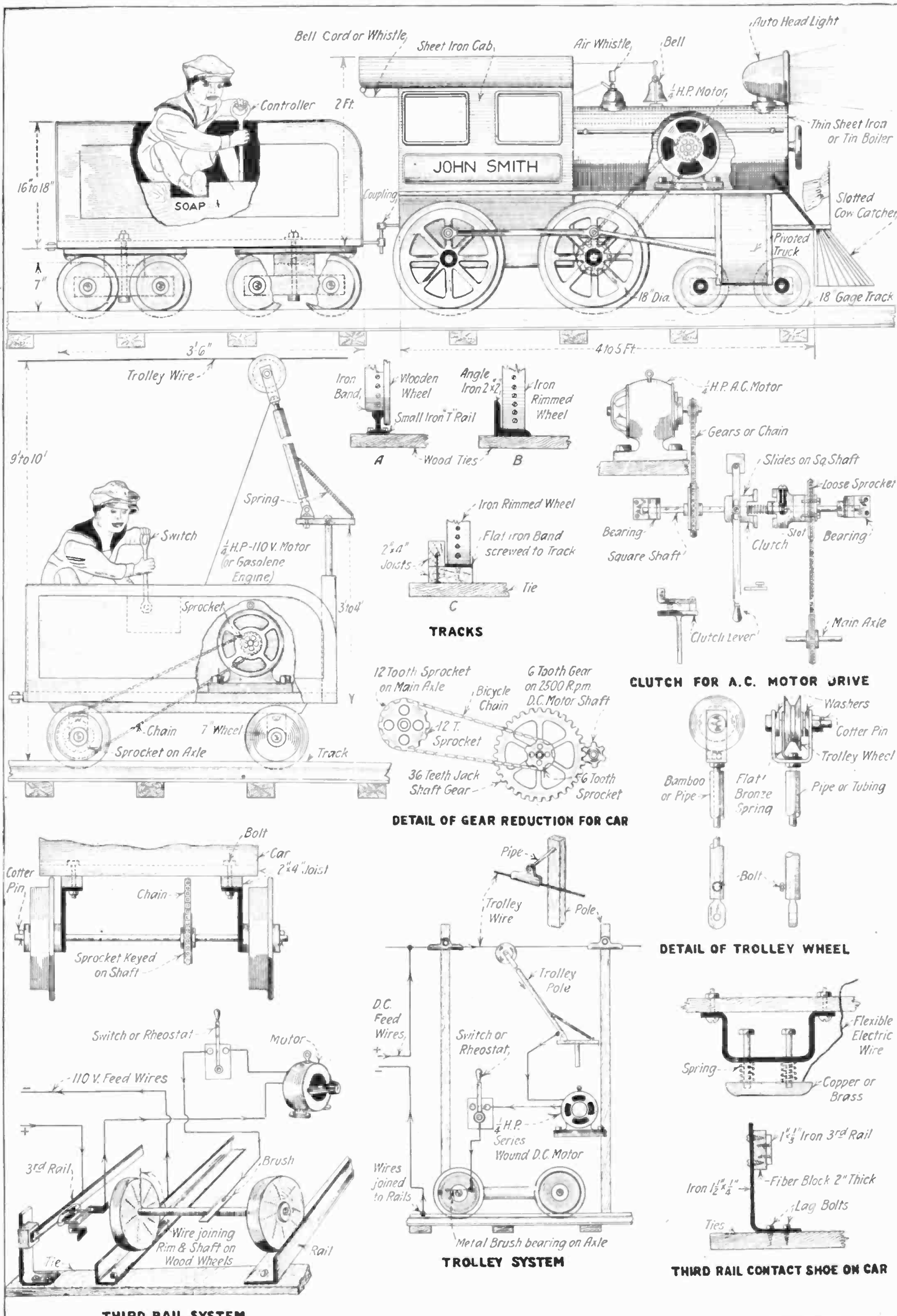
One of the accompanying diagrams shows how the trolley wire and track return circuit are connected up with the electric light circuit, and another diagram is given of the third rail connections when this method is to be used. The third rail, comprising a strip of band iron about 1 inch by ⅛ inch, for example, has to be carefully insulated, either by using regular third rail insulators, or else by screwing the band iron to fibre or other good insulating blocks attached to suitable iron or wooden supports as shown in the figure. With the third rail system a fairly flexible, spring actuated contact shoe is necessary, and this is mounted on the side of the car if the rail is supported at the side of the track as here shown, or else the shoe is mounted under the car if the third rail is placed between the two outer running rails, as is sometimes done. The latter is not very advisable, as a person is too liable to receive a severe shock when he happens to step on an outside rail and the third rail unwittingly. It is best to place a light wooden strip at the side and on the top of the third rail the same as the railroads do, for even when this is placed at the side of the main track, someone is liable to get a shock by stepping on both the common rails and third rail at the same time.

Where the trolley wire system is used, it will be found necessary to place this wire reasonably high, at least eight or ten feet, and as this wire is bare, the kiddies, and especially the grown-ups, should be thoroly warned not to touch the trolley wire at any time while the railroad power is switched on, or they will get a shock simply by standing on the ground and touching the trolley wire. Standing on the ground and touching the iron rails will not cause any shock however.

One point to be watched in arranging the wiring on the car or locomotive is to see that a first-class connection to the wheels is provided from the motor or switch and rheostat. No. 14 or No. 12 insulated wire should be used in connecting up the motor and trolley pole, etc., and a spring brass or other satisfactory contact brush should be arranged to bear against the main axle. If wooden wheels are used, then the iron rims of the two wheels, which are rigidly secured to the driving axle, should be electrically connected with the axle by a piece of No. 12 wire, so that the current has a first-class path from the third rail or trolley pole, down thru the motor, to the rails.

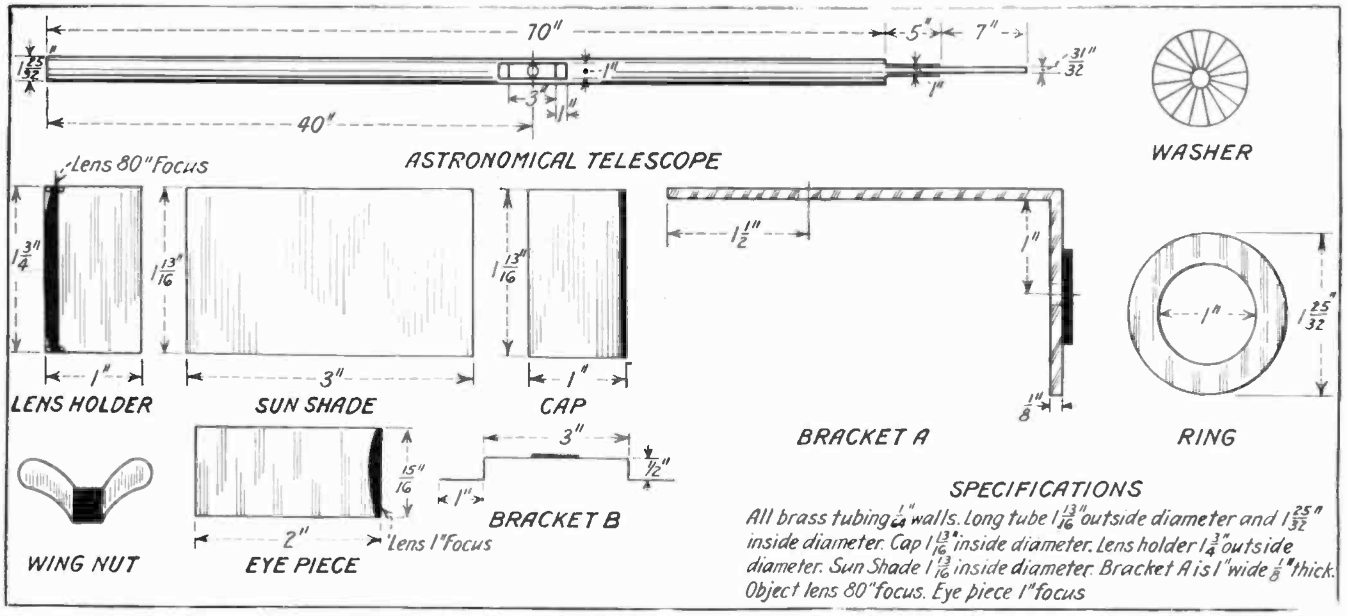
For the D. C. series motor, a rheostat may be used, and if the proper size of iron or German silver wire is used in building the rheostat, so as to stand the current without getting too hot, several different speeds may be obtained. If the rheostat is used simply for starting up however, the lever simply to be moved over the contact points progressively to accelerate the motor gradually, then smaller resistance wire may be used. No. 16 to No. 18 iron or German silver wire will usually be found suitable, where the rheostat is to be left on different points for various speeds.

The electric headlight may be a home-made arrangement made from tin or sheet iron, or again, it may very well be a small auto headlight. The headlight may have a low candle-power 110-volt lamp placed in it, and be supplied with current from the 110-volt service, or it may be a battery lamp lit from a few dry cells or from a storage battery. An oil or acetylene bicycle headlight may also be used. For the locomotive a compressed air whistle may be easily fitted up with an air pump and small tank in which to pump air, the whistle being blown by pulling a rope fastened to a valve in the air line supplying the whistle. An electric horn such as used on automobiles may be utilized instead if desired.



Home-Made Electric Railway for the Kiddies—Fun for Builder and Rider Alike

A Home-made Telescope



The Illustration Above Shows How to Build a Telescope Capable of Magnifying Eighty Times. With It the Mountains on the Moon can be Distinctly Seen When the Moon is in the First or Third Quarter. Jupiter's Moons and Saturn's Rings are also Visible, and Many Other Objects in the Sky are Clearly Discernible. The Main Telescope Tube Measures 70" in Length. The Telescope May be Mounted on a Camera Tripod, or on a Home-Made One Specially Devised for It.

MANY fellows want a telescope, but the purchase price is generally prohibitive. I decided to make one, and succeeded in doing so at a cost of less than $4.00. It has more than paid for itself in the pleasure I have received.

The telescope magnifies 80 times. The mountains on the moon are distinctly seen when the moon is in the first or third quarter. Jupiter's moons and Saturn's rings are also visible, and many other objects in the sky are clearly discernible.

The main tube is 70 inches long and 1 25/32 inches inside diameter. In one end of this a brass ring is inserted, which has a hole 1 inch in diameter. This is to hold the 5 inch tube which is soldered to the ring. The ring is then soldered to the long tube. A 12-inch piece of tubing 31/32 inches outside diameter should slide easily in the 5-inch tube. In this manner the telescope is focused. The eye piece is a small hand magnifier, having a 1 inch focus. It comes in a small tube 2 inches long and 15/16 inches outside diameter. This fits easily in the 12-inch focusing tube.

The object lens holder is made from a piece of tubing 1¾ inches outside diameter and 1 inch long. This fits in the long tube ⅞ of an inch, it being stopped only by a small pin inserted and soldered to the long tube. A small piece of the holder should be left sticking out of the long tube so it may be grasped and withdrawn for cleaning the lens. To keep the lens from falling out, a small copper wire is soldered around one end of the holder near the edge, care being taken to see that a smooth seat is made for the lens. The holder is sent to an optician to have him fit an 80-inch focus plano-convex lens to it. The lens is held in place by a brass spring coiled once around the inside of the holder. The spring wire should be about the same size as the copper wire seat holding the lens.

A cap is made from a piece of tubing 1 13/16 inches inside diameter and 1 inch long. A piece of sheet brass is soldered to one end of the tube, closing that end. This cap protects the lens when not in use.

The telescope is now assembled, and balanced on one finger to find the center of gravity. A bracket is made from a piece of sheet brass 6 inches long, 1 inch wide, and 1/16 inch thick. This piece is bent at right angles 1 inch from the end. It is again bent in the opposite direction ½ inch up from the first bend. This completes one side, and the other side is made in the same manner. This is now drilled in the center to hold a machine screw. A brass washer that has been sawed on one side to make it rough is soldered smooth-side to the bracket. The machine screw is now inserted. The bracket is then soldered to the telescope at the center of gravity.

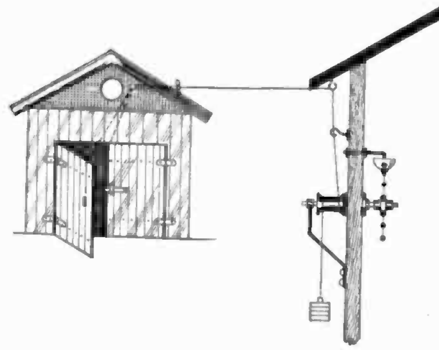
The mounting for the telescope is a large camera tripod. A piece of brass 6 inches long, 1 inch wide, and ⅛ inch thick is bent at right angles 2 inches from one end. A hole is drilled 1 inch from the short end and 1½ inches from the long end. A brass washer like the one mentioned above is soldered to the short end on the outside. This bracket is screwed on the tripod where the camera usually sits. The telescope is screwed on the bracket and tightened up with a wing nut. With this arrangement the telescope may be swung in any direction and set at any point. The telescope is sandpapered with the finest sandpaper and lacquered.

Contributed by H. A. T.

Currentless Garage Door Bell

A bell that can be placed just above the head of the bed will ring if the garage door is opened and which will awaken any normal man or woman, is described below.

Take a bolt about 1/3 inch in diameter, and about 6 inches long, with a round head and no square shoulders. Have the bolt threaded half way down, and then make a few dents in the unthreaded end with a cold chisel, so a spool which revolves with the bolt will not slip. Now drill a hole thru the wall where you want the bolt to be placed, and attach an upright bracket to the wall with nails. This should be drilled near its upper edge to fit the bolt. The bracket is then secured to the outside of the wall, so that if the bolt is pushed thru the hole in the upper end, it will "line up" with the hole in the wall. A washer should be put in place before doing this. Put another washer on the bolt from the inside, and screw a nut down on it, but not too tightly. Place another nut about ¾ inch from the end, and add another washer. The two wires, each of which is 6 inches long, are bent around the bolt and secured to the axle by a third nut. These wires should be tipped with pellets of lead.



This Garage Alarm Bell, Which May be Adapted to Many Different Requirements, Requires no Battery Whatever as It Works on Purely Mechanical Principles. When the Door is Opened, the Cord Attached to It Spins the Shaft Containing a Series of Hammers, Which Strike the Bell. Cutting the Cord Permits the Weight to Descend and Spin the Clapper Shaft, Thus Sounding the Alarm Also.

A large gong from a bell is removed and secured to the wall in any preferred manner, as illustrated. Now attach a small but strong cord to the spool, winding it several times around the spool, so that when unwound, it will turn the clapper to the right from the inside. Use as many eyelet or loop screws for the cord to pass thru in its journey from the garage to the house as thought necessary. Then bore a very small hole at the highest point on the front of the garage, and pass the cord thru it, and let it extend down to the opening corners of the garage doors from the inside. As many cords as desired may be fastened to sliding or hinged doors or windows, and tied to the main line passing thru the same hole at the top of the garage. A weight attached to the spool by means of stout twine, which latter should be wound around the spool several times, so as to take up the slack also acts as a thief preventer, in the event that the main line is cut, because as the weight drops, the spool revolves and causes the clappers to strike the gong.

Contributed by D. CHARLES WILSON

Experimental Electro-Chemistry

By RAYMOND B. WAILES

PART III.—MIGRATION AND SPEED OF IONS

ALTHO ions cannot be seen by any known means, several methods are available for detecting their presence and even their rate of motion or movement. Different ions, such as those of chlorine, hydrogen, or even of radicles (such as SO_4, sulphion), have different rates of movement.

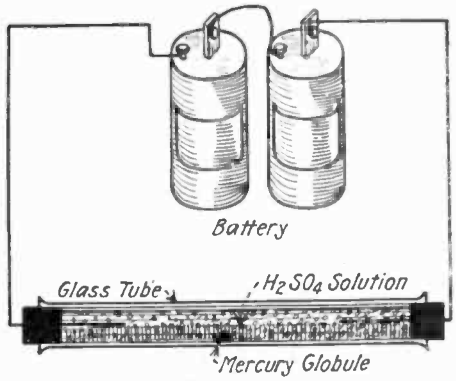


Fig. 1. Experiment Which Demonstrates That Metrls Can be Carried Along by an Electrolytic Effect. The Current Passing Thru the Acid Sclution Will Cause the Globule of Mercury to Work Toward the Negative Pole.

Metals themselves can be carried along by an electrolytic effect, as Fig. 1 shows. Here a glass tube is filled with a dilute solution of sulphuric acid and corked at both ends, clean wires being inserted thru the corks to make connection with the electrolyte within. The electrodes should also be connected with a storage battery as shown. By taking out a cork at one end, a globule of mercury can readily be introduced. Under the influence of the current which flows thru the tube of electrolyte from the battery, the globule of mercury will move, altho slowly, to the cathode or negative pole, for it, the Hg, has positive polarity.

An ordinary boiler gauge glass can be used in the apparatus set up. Rubber stoppers should be used where possible. The drop of mercury, if not too large, will move along the tube, when as little as 0.1 ampere is flowing thru the circuit.

The above experiment readily demonstrates that metals themselves can obey the laws of electrolysis.

Most metals yield cations when ionized, or when their salts are dissolved in water. Copper, for instance, in copper sulphate, yields copper cations. Copper can, as in the case of complex salts, yield copper anions; copper ions which travel to the positive pole, despite their acquiring a positive charge in most cases.

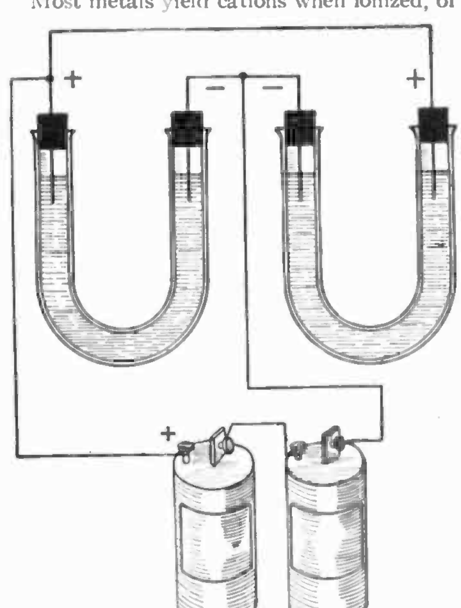


Fig. 2. Experiment to Show the Simultaneous Movement of Copper Ions to Both the Anode and Cathode. Metals Proceed Toward the Negative Pole When Electrolyzed, Generally Speaking.

In the complex copper salt, cupric sodium ditartrate, having the formula $Na_2CuC_4H_2O_5$, copper is contained in the anion radicle, or the group of ions which travel toward the positive pole or electrode.

By using two U-tubes connected with a battery as shown in Fig. 2, the simultaneous movement of copper ions to both the anode and cathode can be shown. U-tube 1 should contain a rather strong solution of copper sulphate, while the liquid in tube 2 should be a solution of the above compound in water. It can be made by dissolving 3.5 grams of copper sulphate, 20 grams of Rochelle salt and 12.5 grams of sodium hydroxide in 100 cc. of water. Use the solution direct. It is best to make it up fresh each time it is desired. A solution of sodium sulphate (L) should now be poured cautiously on top of the solutions in each arm of the U-tubes. Be careful not to mix the two layers. A pipette will assist in making sharply defined boundaries. The wire electrodes are thrust thru stoppers.

On passing a current thru the tubes, they being connected as shown, the blue colored solutions in the tubes will be found to move up or down the arms of the tubes. The liquid in both right-hand arms will move upward, after several minutes of electrolysis, as shown by the arrows. It should be noted, however, that these arms are of different polarity, one positive and the other negative. Since it is the copper ions which color the solutions, and the colored solution moves toward the electrode, it can be said that the copper ions move toward the electrodes. The electrodes being of different polarity, the copper ions are of different ionic charges; one set of copper ions are cations (in the copper sulphate tube), while the copper ions in the complex copper salt tube are anions, being negatively charged. So it can be seen that metals, when ionized, can either acquire positive or negative charges. The general rule which can be laid down, however, is that metals proceed toward the negative pole when electrolyzed.

Measuring the Speed of Ions

By measuring the rate of speed of an effect produced by ions in motion, we may determine the rate of motion of the ions themselves.

In Fig. 3 a glass tube is shown, bent slightly at each end and immersed in beakers containing dilute sulphuric acid or other electrolyte. The glass tube is filled with a colored gelatin solution, the coloring being obtained by the addition of phenolphthalein, which is decolorized by one of the products of the electrolysis.

An ordinary glass tube ten to fifteen inches long can be used. It should be bent as shown. One end of the tube is inserted into a warm, or fluid, solution of the following: 10 grams gelatin dissolved in 140 cc. water. Filter while hot and add 7 grams salt and several drops of phenolphthalein solution to which a few drops of sodium hydroxide solution have been added to cause it to become red. Mix well, while hot. When the glass tube has been filled and allowed to cool, a jelly will be found in the tube.

On passing a current thru the tube, connecting it with the battery by means of wire electrodes WW, a gradual decolorization of the red jelly will be produced. By using a centimeter rule, it will be found that the decolorization proceeds at the rate of 1.5 to 2.0 centimeters an hour. This is the rate of travel of the chlorine ion, since it is these ions which decolorize the red jelly as they proceed toward the anode or positive pole. Different ions move with different speeds.

Isolation of Ions

Ions can, apparently, be made to travel at will, as the following experiment, which requires the use of the nearly obsolete static or Wimshurst machine, shows.

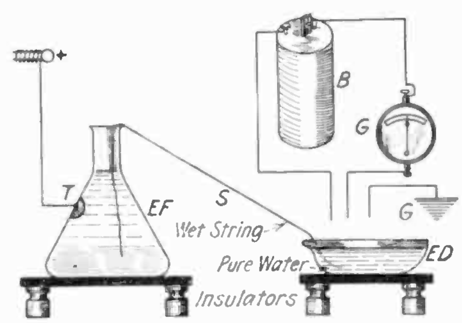


Fig. 4. A Static Machine is Used in This Experiment to Cause Ions to Pass Along a Wet String from One Vessel to Another.

The positive pole of the static machine is connected by means of a wire to a spot of tin-foil T, coated on the outside of an Erlenmeyer or other flask EF. A soft cotton string S dips into EF and also, at its other end, into the evaporating dish ED. EF should contain a solution of potassium chloride. ED should contain a solution of pure water. The string S should be wet with water and care should be taken that the solution of EF does not become introduced into ED.

Upon revolving the plates of the static machine and generating an electromotive force, the positive pole connected with the tin-foil of the flask EF becomes positively charged. The potassium chloride solution has become ionized and positively charged potassium ions and negatively charged chlorine ions have been formed. Anions, or negatively charged ions, proceed toward the positive pole upon electrolysis, so the chlorine anions will be attracted to and held by the tin-foil coating upon the inside of the flask EF. The potassium ions will be repelled by the positive pole of the static machine and will proceed, seemingly, over and across the wet string and thence into the evaporating dish ED. Upon removing the string from ED by means of an insulated rod, and then grounding the liquid in the dish ED by means

(Continued on page 299)

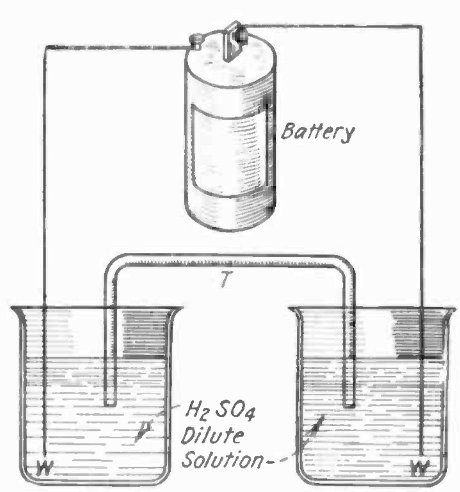


Fig. 3. With This Apparatus It Becomes Possible to Measure the Speed of Ions. The Glass Tube T is Filled With a Colored Gelatin Solution; the Rate of Decolorization Along the Tube is Measured and the Ionic Velocity Thus Determined.

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.

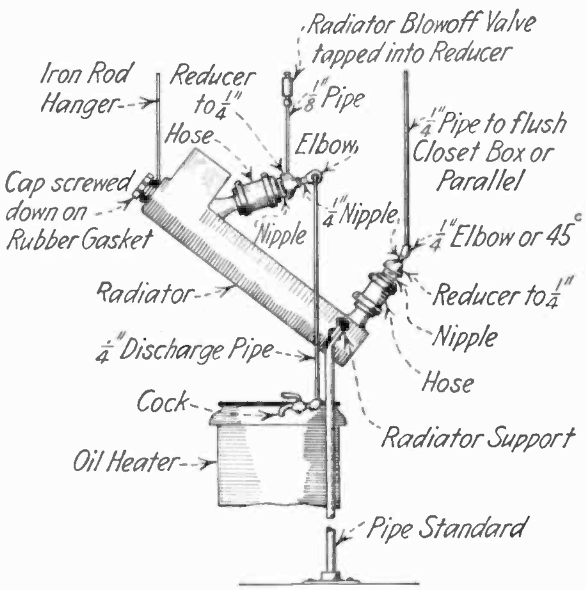
FIRST PRIZE, $15.00

AUTO RADIATOR AS HOT WATER HEATER

A barber ran a shop in a country town and suffered for want of hot running water. The building was equipped with a cistern which was usually well filled with rainwater. The barber took advantage of that fact and made use of it in combination with a used Ford radiator in the following manner:

The radiator was first thoroly cleaned of all rust accumulation by giving it several doses of scalding hot water and baking soda. Then it was suspended over the floor at about the angle indicated in the sketch. This was for the purpose of exposing the radiating surface to heat applied from below and also to allow the warmed water to rise to the top.

The supports were made of two 3-ft. lengths of ¾-inch pipe threaded into floor flanges placed 21½ inches apart—center to center. The top ends of the pipe had been previously flattened and bent at the proper angle to support the radiator as shown and drilled so they could be bolted to the support wings of the radiator. Then a piece of small round iron suspended from the ceiling served to steady the top of the radiator by being looped about the filling neck under the cap. Leaking is prevented at the cap by inserting a rubber gasket similar to a fruit jar rubber and then screwing the cap down tightly.



Full Details are Here Given for Connecting Up An Old Automobile Radiator, so as to Serve as a Hot Water Heater.

The piping was the unique part of this affair.

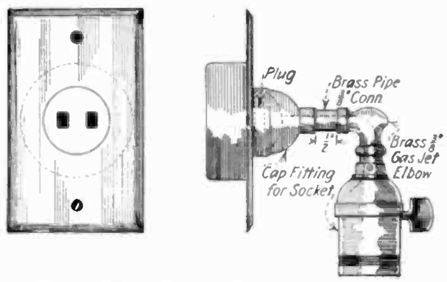
Both inlet and outlet openings were supplied with rubber hose exactly the same as when the radiator was in use on the car. The size of this opening was then reduced to ¼ inch by inserting a pipe nipple to fit the open end of the hose and supplementing this with a reducing coupling and

(Continued on page 277)

SECOND PRIZE, $10.00

WALL BRACKET

No doubt the average experimenter has often desired to make his own electric lighting fixtures, especially for his private room. In the majority of cases, however, the result is that the finished product turns out to be exceptionally crude.



A Simple Home-Made Electric Light Fixture, Which Can be Plugged into or Removed from Any Wall Outlet.

Here is a wall bracket that is novel and will suit the purpose to a "T," being easy to construct. The first thing that is necessary is to secure a brass baseboard receptacle, a standard Edison brass socket and a brass cap, the same as is used on the back of the Edison socket. Both should have a ⅜" thread, so that a ⅜" elbow such as is used on gas jets and a short piece of threaded brass pipe will connect the socket with the socket cap. The job is now practically finished.

When these parts are assembled, the fixture has to be wired. A short piece of fixture cord is procured, and connected to the two-pronged plug that fits into the receptacle. The wire is then passed thru the socket cap, pipe and elbow, connecting with the socket. The wire, after being connected, should have very little play so that the plug will fit snugly into the cap. In order to more rigidly secure the plug, sealing wax may be poured into the cap. When all is in readiness, the fixture is fitted into the receptacle and the bracket is made.

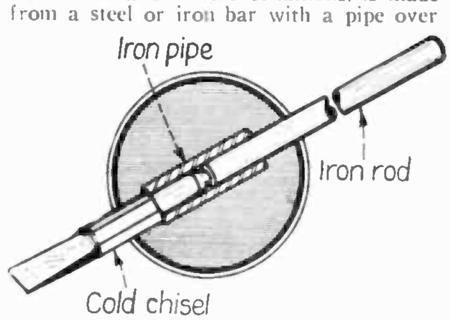
The fixture can at any time be removed, and it may also be plugged in, in an inverted or upright position, making a very serviceable light, especially for a bedroom without changing the lamp itself.

Contributed by GEORGE A. BOOKAW.

EXTENSION FOR COLD CHISEL

When it is necessary to cut a loose rivet from the frame of an automobile, the ordinary short chisel is of little use, inasmuch as it is not possible to wield the hammer and chisel on rivets which are partly hidden and in inaccessible positions under the frame hangers or springs.

An extension for the chisel which is serviceable under these conditions, is made from a steel or iron bar with a pipe over



Frequently, It is Necessary to Use a Long Cold Chisel and Here is a Simple Way to Lengthen the Handle of An Ordinary Chisel With a Piece of Pipe and An Iron Rod.

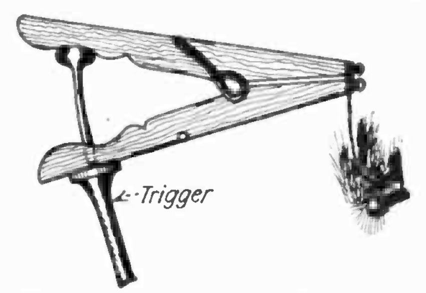
the end. This serves as a socket into which the chisel is inserted. A piece of pipe sometimes serves.

Contributed by G. A. LUERS.

THIRD PRIZE, $5.00

TIME CAMERA SHUTTER RELEASE

Shutter releases which operate after a short time interval are rather expensive, but an apparatus which will perform the



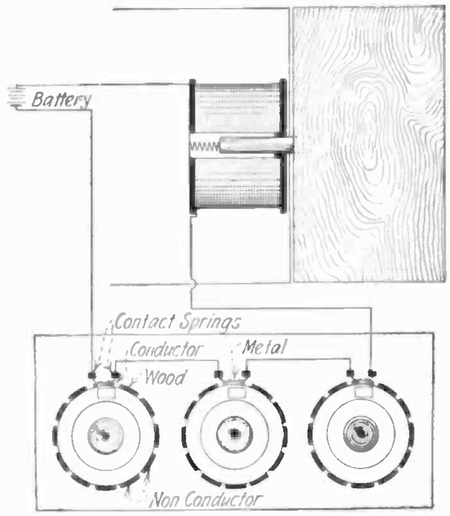
A Piece of Thread Tied Around Two Screws or Brads in the Two Ends of a Wooden Clothes-Pin Arranged as Shown, Makes An Admirable Camera Shutter Release, When You Want to Take Your Own Picture. Light the Depending Thread or String, and When It Burns Up to the Screws, the Spring Clothes-Pin Trips the Shutter.

same work may be made in a few minutes. Secure an ordinary spring clothes pin or wooden test tube clamp. Cut one of the jaws, as shown in the illustration. Now drive a screw in each of the two ends, and the apparatus is finished. To set it in operation, it is merely necessary to place the slot over the flexible wire of a plunger release and tie the screws together with a thread. A thin ribbon is now tied to the thread and hung loosely. After the group has been focused and set, place a plate in the camera. Choose the position you are to occupy and then light the bottom of the ribbon with a match. The flame rises and burns the knot, the prongs of the clothes pin are suddenly freed, causing the pressure release of the shutter to operate, thus taking the picture.

Contributed by CHARLES MOHR.

COMBINATION SWITCH AND LOCK

This combination switch can be used for any kind of a door where a secret combination is needed. The box is made of



A Simple Electric Combination Lock Which Requires No Key. The Locking Member Comprises a Solenoid or Magnet Coil Wound on a Brass or Other Non-Magnetic Tube, Inside of Which Slides the Lock Bar Made of Soft Iron, This Bar Normally Being Pressed Outward by the Spiral Spring Shown.

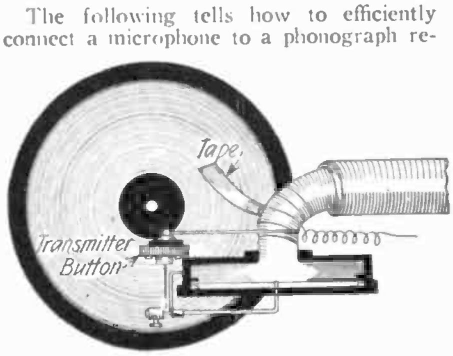
soft wood ¼" thick. The outside dimensions are 11" long 1½" wide. and 4½" high. In the cover of the box. holes are drilled for each disk so that the numbers of the dial mounted underneath may be seen. The three disks are ½" thick and 3" in diameter. made of hard wood. A piece of tin or thin brass is nailed on the rim of each disk and pieces of non-conductors corresponding to each of the numbers on the dial and of a thickness equal to that of the conductor are then mounted in place. so that the lock cannot be worked by the "feeling out" method. Numbers are then printed or painted on the face of the disks near the edge. The disks are mounted upon small axles and fixed to the shaft so that they will rotate with it. Holes are drilled in the rear board to serve as bearings for the axles. Two contacts for each disk fixed on the inside of the box press on the disks. There are six of these contacts. and it is best to cut them out of springy brass. They are designated by a different number on each disk.

The magnetic lock needs little explanation as its construction is very simple. A steel bolt is first made to fit loosely inside of a brass or copper tube (about 1/32" clearance). The tube 3" long is then wound with 12 layers of No. 18 D.C.C. wire. A spring is mounted in back of the bolt and the whole secured to the door jamb. as shown.

Contributed by JOHN BEATON.

A LOUD SPEAKING PHONOGRAPH

The following tells how to efficiently connect a microphone to a phonograph re-



Where a Telephonic Loud-Speaker is to be Connected to a Phonograph, One of the Best Methods of Arranging the Microphone is That Here Illustrated, the Stylus Operating the Microphone Button Directly.

producer. A heavy copper insulated wire is wrapped around the tone arm and held fast by a piece of adhesive tape. It is then extended to connect to one terminal of the microphone. The other terminal is connected by a light stiff wire to the stylus or needle holder of the phonograph. The volume of sound given by the phonograph is somewhat reduced when operating the phonograph with this connection. but the microphone gives much better reproduction when connected to a loud speaking horn than when connected in the customary manner.

Contributed by ARCH A. DUNCAN.

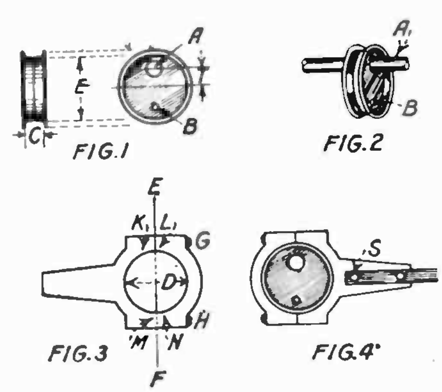
HOW TO MAKE AN ECCENTRIC WITH TWO CAN COVERS

Holding two can covers together coinciding face to face. a hole is bored at A (Fig. 1), this hole being the same size in diameter as that of the shaft to be used. The shaft is soldered at the edge of the hole. and a rivet B used to hold the two covers close together.

From a piece of hardwood having a thickness equal to the distance between the edges of the covers C. (Fig. 1) a square is cut out. The diameter D (Fig. 3) of the hole must be a trifle larger than diameter E. (Fig. 1). The square is divided into two pieces (line E. F). which are put together and held close together by means of screws G and N. Small pieces of cardboard are placed between the joints K-L and M-N to fill the gap left by the thickness of the saw. A rod of wood or metal is then fixed by means of screws S, (Fig. 4) to the wooden piece.

The stroke of this eccentric is twice the distance between the center of the shaft hole and that of the can covers (distance T. Fig. 1).

Contributed by X. S. SOUSE.

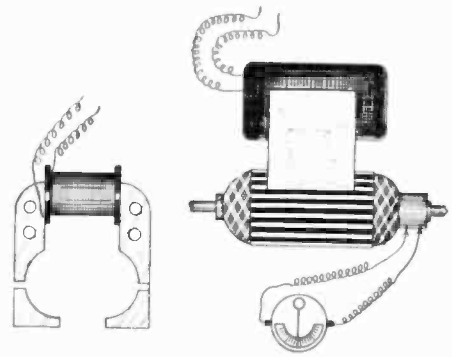


A Novel Way in Which to Make an Eccentric for Light Machinery from Two Can Covers.

ARMATURE TESTER

In order to make a growler for testing generator armatures. take a laminated core section of the old type light generator used on autos. and after cleaning it up. saw off that portion of the laminations indicated by the diagram herewith. Then all of the old field winding must be completely removed. Insulate the core thoroly. with paraffined paper and tape. Wind this core with approximately 420 turns of No. 19 copper magnet wire. the ends of which should be connected to a section of lamp cord equipped with a plug for screwing into the socket. Every layer of winding should be soaked with shellac and allowed to dry for 24 hours. In connection with this wound core. an ordinary combined volt and ammeter may be used. and while the growler may not be as efficient as those placed on the market by the manufacturers. it does the work and is a reliable test set for small generator armatures, as it indicates shorts. grounds, open, or reversed windings. It is used on 110 volt lighting circuits. and draws from 2 to 5 amperes, according to the armature being tested. In experiments. a buzzer connected in series with the winding found on the original field gave very good results. using. of course, sensitive meters as the indicators.

Contributed by J. R. GLISSON.



A Quick and Efficient Way of Testing Motor and Dynamo Armatures is by Means of the So-Called "Growler," Comprising a U-Shaped Iron-Core Which Will Fit Over the Armature and on Which Core a Magnetizing Coil is Wound. The Growler Can Frequently be Made from a Discarded Small Motor Frame, Together With Its Field Coil.

TESTING SPARK COIL WITH 110 VOLTS.

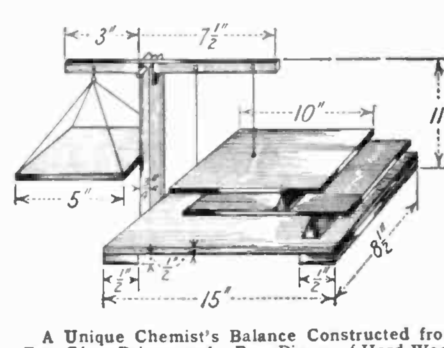
While several methods of testing spark or induction coils such as are used for jump spark ignition of a gasoline engine are available. one which differed considerably from the usual was recently demonstrated by a local mechanic. This test consisted in connecting up the secondary winding of the coil with the standard 110 volt A. C. lighting circuit and placing in circuit with the primary winding a small candle-power, low voltage bulb. When the current was turned on the small bulb was made to glow, thus indicating that the wires in these windings were intact. A break in either wire or its connections would prevent the lamp glowing.

Contributed by G. A. LUERS.

CHEMIST'S BALANCE

Often it becomes necessary to weigh small objects, but the cost of a balance for this purpose sensitive enough to weigh correctly is generally prohibitive. With two glass prisms and several pieces of hardwood, I have constructed a balance, as shown in the diagram herewith, which has served my purpose for a great many months. There is very little to say regarding the construction of the device. A hole is drilled in the top plate for the thread which passes thru this and is attached to the plate underneath. Inasmuch as all dimensions are given in the diagram. which is self-explanatory, we will not fill up otherwise valuable space with useless specifications.

Contributed by F. TRESTON RING.

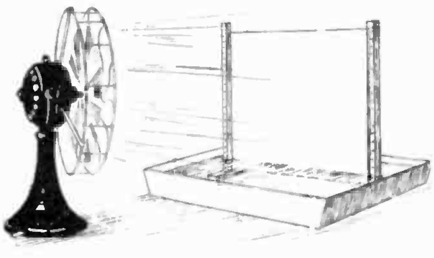


A Unique Chemist's Balance Constructed from Two Glass Prisms and a Few Pieces of Hard Wood Which Scheme the Contributor States He Has Used Successfully for Many Months. A Hole is Drilled in the Top Plate at the Right, Thru Which a Thread Passes to the Plate Beneath, to Which it is Attached.

EDITED BY S. GERNSBACK

THIS MONTH'S $5.00 PRIZE

COOLING THE STUFFY OFFICE



Helping to Cool a Room by Arranging an Electric Fan to Blow Against a Moist Cloth Screen.

Conditions can be helped to a wonderful extent if the simple but effective means shown in the drawing are used. Stretch a square of cheese cloth or muslin between two upright sticks set in holes in the ends of a wood strip one half inch thick and four inches wide. The screen is then placed in a pan of water and set in front of the fan with the sheet at a slight angle to deflect the breeze to any particular portion of the room desired.

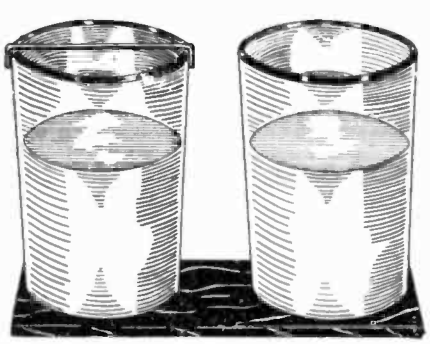
It may be necessary to weight the wood strip down, but this can be easily done with a paper weight. At least one inch of the lower edge of the sail should be under water. If the cloth is of loose weave, capillary attraction soon moistens the whole surface and the air, being driven across this surface, is moistened and cooled at the same time.

Contributed by
DALE R. VAN HORN.

THE DANCING WIRE

A curious little experiment may be carried out with two drinking glasses. Half fill these with water. Now rub a moistened finger round the rim of each and see if they are of similar tone. There will probably be some slight difference, but this can be adjusted by adding more water to one of them. Then secure a piece of thin wire and bend this at the ends so that it can rest across one of the tumblers. Now start to rub the other glass and almost at once the wire commences to jump about altho it is not actually touched at all. This is due to the fact that sympathetic vibrations arise in one tumbler when the other is touched. A still more vigorous movement on the part of the wire may be induced by striking one of the tumblers rather sharply with a piece of wood.

Contributed by S. LEONARD BASTIN.



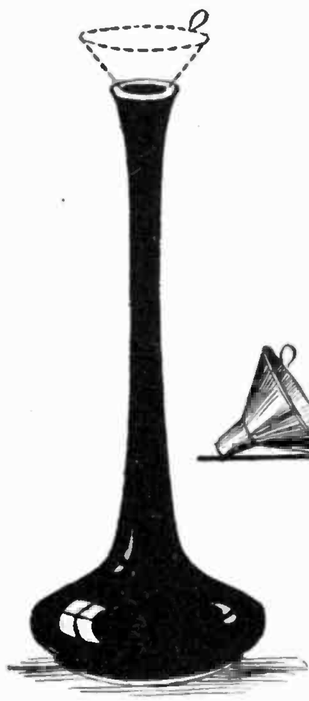
When the Glass at the Right is Rubbed, the Wire on the Glass at the Left Will Start to Dance, Due to Sympathetic Vibrations Set Up in the Second Tumbler.

A CIGARETTE ASH TRAY

A long necked flower vase will serve nicely as an ash tray and cigarette receptacle and is superior to others in that the moment a smouldering cigarette is dropped in it, it is extinguished due to the lack of oxygen.

This is especially handy for one who smokes while working at figures or drawing. It may be further helped by cutting off most of the neck of a small funnel and inserting this in the top as shown.

Contributed by
DALE R. VAN HORN.



A "Safety First" Cigarette Ash Receptacle, Which Snuffs Out the Cigarette when Received, Owing to the Lack of Oxygen.

CEMENT AND NEW-SKIN

A good celluloid cement may be made by mixing equal parts of ether and banana oil together. The parts to be stuck are coated with the solvent and pressed together till dry. This takes just a few minutes. The liquid acts by softening the surfaces of the pieces to be connected.

To make a more general cement that may be used to stick other things, a few celluloid shavings may be added. This makes a good skin covering for cuts, etc., as it keeps out the dirt. If movie film is used, clean off the gelatine with warm water.

Contributed by RUSH BRILL.

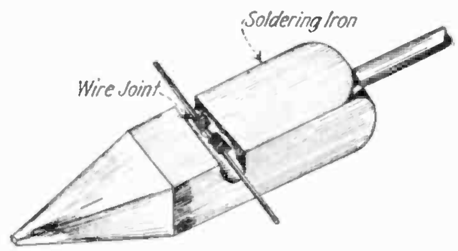
A KNIFE HINT

When cutting anything of a leathery nature such as raw meat, candied peel, etc., the housewife should bear the following point in mind. The knife will work much better if it is hot when used. Have at hand a bowl of very hot water into which the knife is dipped again and again.

Contributed by
S. LEONARD BASTIN.

SOLDERING IRON KINK

A groove made in a soldering iron, as shown in the illustration, is much better for soldering wire connections than using



Did You Ever Cuss a Wire Joint as it Skidded About Over the Hot Soldering Iron? File a Groove or Two in Your Iron, Tin It Thoroly with Sal-ammoniac or Resin, and You Will be Tickled Pink With the Results.

the tip of the iron, as the solder is given a chance to sweat into the connection. This groove may be filed or ground into the iron. Several different sized grooves located on the different faces permit the soldering of different sized wires more easily.

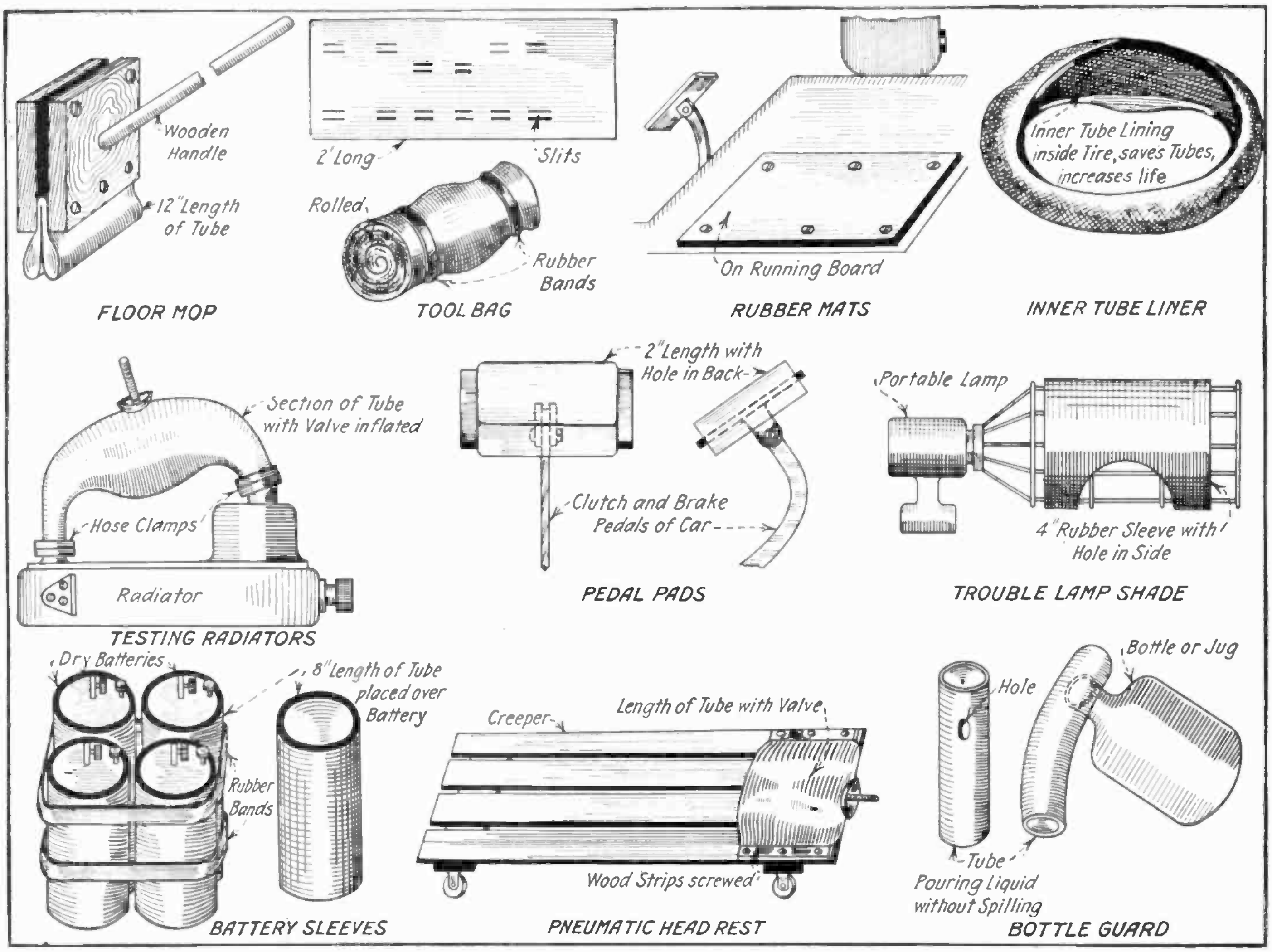
Contributed by FRANK HARAZIM.

EXPERIMENT WITH LIGHT RAYS AND HEAT RAYS

A very interesting experiment by means of which light and heat rays may be separated is on the following lines. Procure a flat sided bottle or a trough with glass sides, and fill this with a solution of iodine dissolved in carbon disulphide. Place this in line with direct light, or the rays of a bright electric arc, and it will be found that the light does not penetrate the liquid. All the visible light is held back by the solution but the heat rays pass thru unaffected. This may be proved by holding a lens on the other side of the bottle opposite to where the sunlight is seen to enter. After experimenting with various positions of the lens, a scrap of paper or any dry substance may be set on fire by the concentrated rays. The effect is very curious, for at no time is any ray of light visible.

Contributed by S. LEONARD BASTIN.

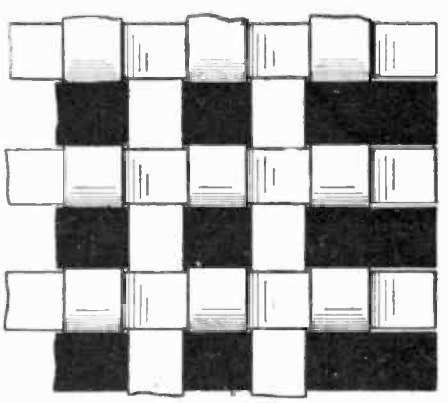
Separating Light and Heat Rays by Means of a Filter Formed of a Solution of Iodine Dissolved in Carbon Disulphide. The Light Rays are Cut Off, While the Heat Rays Pass Thru the Solution.



The Pneumatic Head Rest Shown in the Lower Central Portion of the Above Illustration, is the Prize Winning Idea in the "Old Inner Tube Contest." The Other Suggestions Submitted by the Same Author are Likewise in Evidence. In These, Inner Tubes Slit, Cut and Inflated are Used. The Writer Explains the Method of Applying These Suggestions Very Concisely Below.

Old Inner Tube Contest Winners

WE were very much pleased with the results of the *Old Inner Tube Contest* announced in the May number of this magazine. The prize of $10.00 as announced was won by G. A. Luers, of 3104 Mt. Pleasant Street, Washington, D. C., for his suggestion of a pneumatic head rest, shown in the accompanying illustration.



A Method of Making a Very Serviceable Rubber Mat from Red and White Inner Tubes, Cut into Bands and Woven. This Mat May be Washed and in General Handled Quite Roughly.

Mr. Luers forwarded quite a few uses for inner tubes, the entire list being likewise shown. He writes: "There is in all probability an old tube in the corner of the garage, and the present illustrations show how it may be employed for some useful purpose, saving time and material."

Floor mop. This is made from a 12-inch length, folded and screwed between two similar pieces of wood, with a broom handle inserted into a bored hole.

Tool bag. Two feet of rubber, slit lengthwise, and a series of short slits for insertion of tools, is secured when rolled with rubber band cut from tube.

Rubber mats cut from inner tubes are a protection against wear and slipping. Placed under car pedals, on running boards, door sills, in either double or single layers, they are secured with brass head tacks.

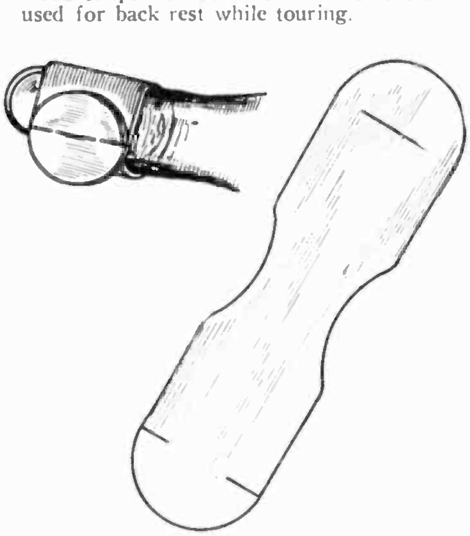
Testing radiators. Connect top and bottom pipes of radiator with section of tube containing valve. Use tire pump to inflate the tube and locate the place where the air escapes. It may be necessary to immerse the radiator in a tub of water.

Pedal pads. Two-inch length of small tube with hole for pedal support drawn over the pedal provides cushioning and prevents foot slipping.

Trouble lamp shade. Four-inch length with wide circular hole in side, drawn over trouble lamp wire guard; stops glare and is added protection against breakage.

Battery sleeves. Eight-inch lengths of tube, one for each dry cell, offers a protection from short-circuits, moisture and abrasion and adds to life of batteries. Several rubber bands about batteries hold them together.

Pneumatic head rest. Length of tubing containing valve; have ends cemented or vulcanized together and affixed to creeper with wood strips. If made detachable it can be used for back rest while touring.



Cutting a Piece of Rubber from an Old Inner Tube, as Shown, Enables Pages and Papers to be Handled More Expeditiously. The Tab is Passed Thru the Slit, Locking the Strip of Rubber into a Band to Fit Tightly on the Finger.

Bottle guard. Tube with hole for neck prevents the spilling of liquid.

Inner tire liner. Saves tubes. If used inside the tire it will increase the life of the tube.

(*Continued on page* 298)

Freaks of Railroad Radiophony

By A. P. PECK

THE Delaware, Lackawanna & Western Railroad Company have discontinued broadcasting from trains and are concentrating their efforts on producing more satisfactory receiving results. They, however, expect to start broadcasting from the terminal station at Hoboken in the very near future. They have at the present time two trains equipped with receiving apparatus and antennae, the styles of which are constantly being changed in an endeavor to obtain better results. The antennae consist at the present time of a single wire on each side of the cars and 18 inches above the roof. This type has been found as efficient as the cage-type antenna that was formerly used.

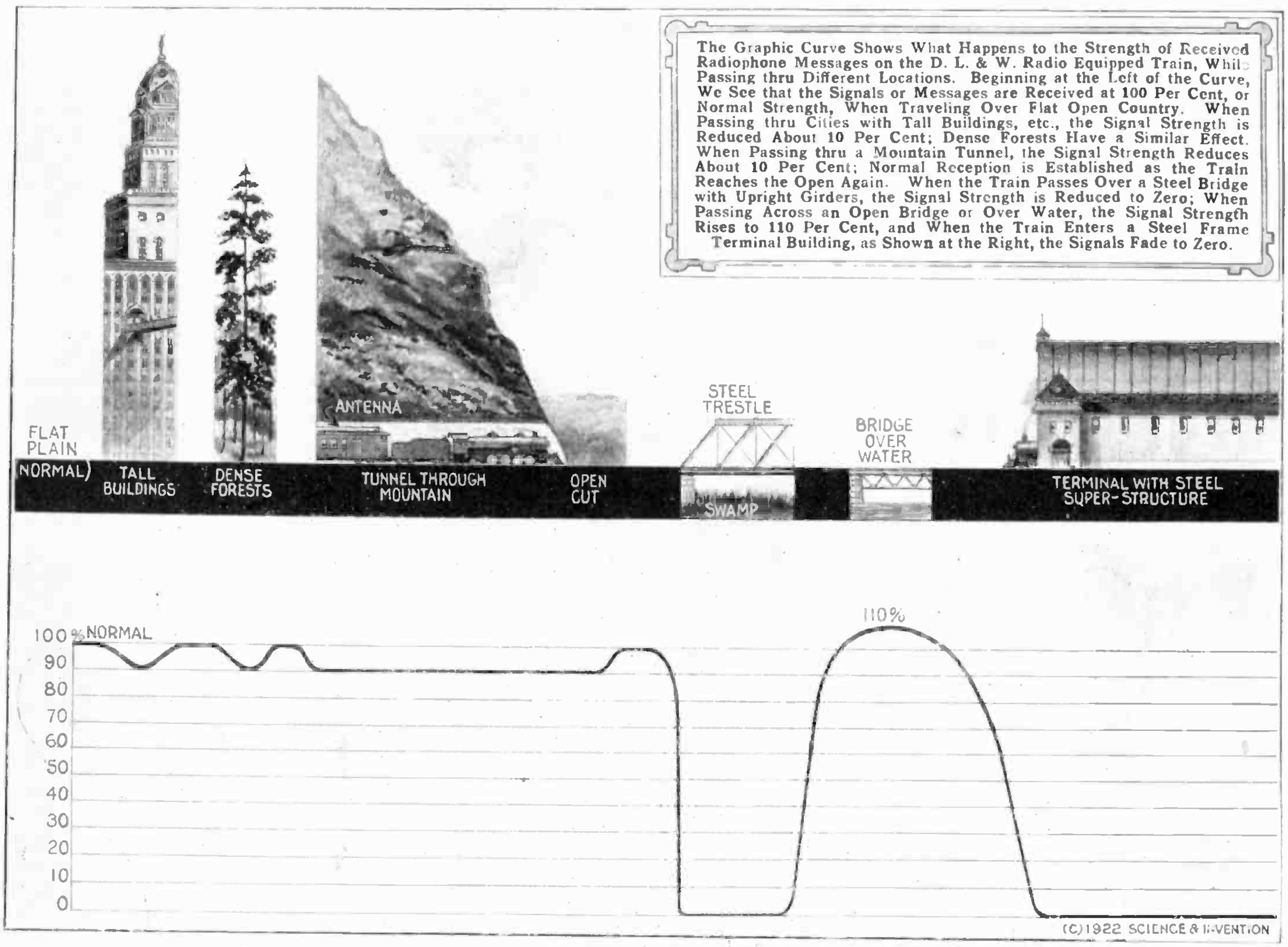
The train that leaves Hoboken at 8:50 in the evening, Eastern standard time, receives the broadcast from Newark, N. J., and Wanamaker's store, N. Y. City, until 9:50 Eastern standard or 10:50 daylight saving time, at which time these stations stop broadcasting. The train leaving Buffalo at 8 P. M. receives the broadcast from Detroit Daily News and General Electric Co. in Schenectady up to 11 P. M.

Just outside of Hoboken the radio equipment is troubled considerably from the terrific hum caused by the proximity of parallel high tension lines. This, however, soon stops, and near Boonton, New Jersey, Detroit, Michigan, is picked up while traveling 50 miles an hour. This, however, is lost while traveling thru a deep cut, but Newark, N. J., is still heard. Further on KDKA has been tuned in, and the signals are perfect, fading only slightly when mountains intervened.

About 200 amateur stations have been heard along the line.

On steel bridges where the steel truss-work and girders over-top the train's antennae, the signals are lost entirely, but come in again as loud as ever the minute the trestle is left behind. The speed at which the train travels does not seem to affect the signal strength in the least. Thick forests and tall buildings—reduce the signal strength somewhat. A reduction of about 10 per cent in the signal strength is experienced while passing thru the mile long tunnel just outside of Hoboken. Tests have also shown that signal strength is increased near bodies of water such as rivers and lakes.

The engineers conducting the tests are finding out new developments on almost every trip, and improving their apparatus accordingly. The apparatus is at the present time installed in a buffet car, but by opening the door between that and the diner, and turning the loud speaker in that direction, those in the dining car are enabled to hear radio with their meals.



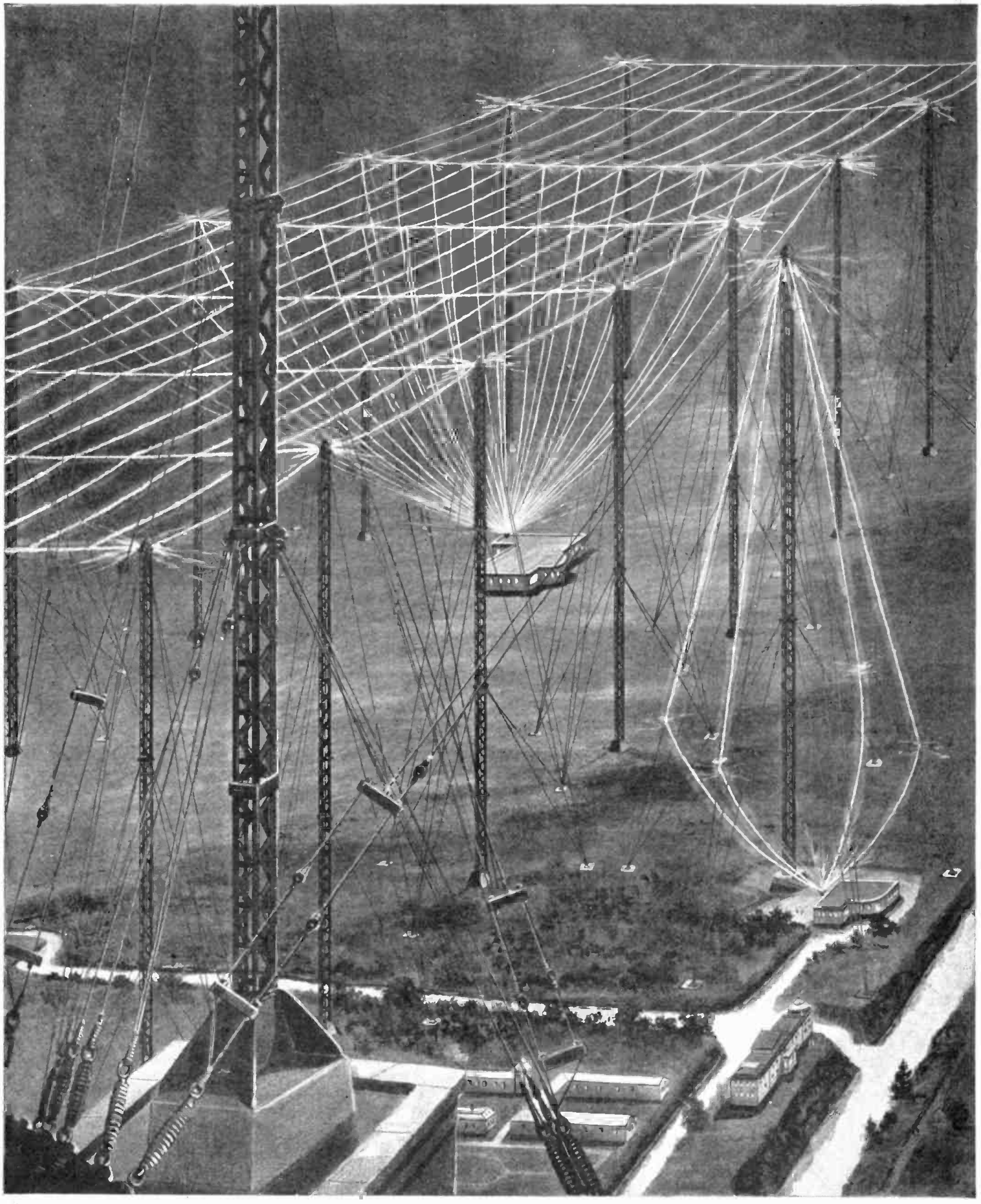
The Graphic Curve Shows What Happens to the Strength of Received Radiophone Messages on the D. L. & W. Radio Equipped Train, While Passing thru Different Locations. Beginning at the Left of the Curve, We See that the Signals or Messages are Received at 100 Per Cent, or Normal Strength, When Traveling Over Flat Open Country. When Passing thru Cities with Tall Buildings, etc., the Signal Strength is Reduced About 10 Per Cent; Dense Forests Have a Similar Effect. When Passing thru a Mountain Tunnel, the Signal Strength Reduces About 10 Per Cent; Normal Reception is Established as the Train Reaches the Open Again. When the Train Passes Over a Steel Bridge with Upright Girders, the Signal Strength is Reduced to Zero; When Passing Across an Open Bridge or Over Water, the Signal Strength Rises to 110 Per Cent, and When the Train Enters a Steel Frame Terminal Building, as Shown at the Right, the Signals Fade to Zero.

Results Obtained in Transmission

When the Delaware, Lackawanna & Western Railroad started their recent experiments with radiophony on their trains, they carried, in addition to the receiving set, a transmitting set consisting of three 5-watt power tubes, with an output of .6 of an ampere. The power for these tubes was tapped from the 12-volt storage batteries ordinarily used for lighting the cars of the train. The high voltage for the tubes was obtained from a motor-generator run on these same storage batteries, and delivering 350 volts. The transmitting apparatus was very compactly constructed and was located in one end of the baggage compartment. It was controlled from the desk on which the receiving appar-

(*Continued on page 297*)

French Radio Station at Night



In France, at Sainte-Assise, Near Melun, What is Claimed to be the Most Powerful Radio Station in the World Has Been Erected. In Its Transatlantic Antennae it Can Develop One Thousand Kilowatts of Electric Power, Which is About 1,500 Horse-Power. This is Over Three Times the Power of the Famous Nauen Station. It Can Communicate With South America and Asia. The Masts Are 250 Meters High, a Little Over 800 Feet. When in Shape and Complete the Station Will be Able to Transmit Nearly Two Million Words in 24 Hours. To Obtain an Idea of This Figure the Reader Must Know That the Maximum Output of the France-South America Cable is 5,000 Words a Day and That All the Cables Between France and North America Can Only Transmit 18,000 Words a Day. The Effect of the Limited Capacity of the Cables is to Interfere With and to Delay Messages. This Great New Installation it is Hoped Will Remedy These Troubles When it Has Attained Its Full Capacity and When the Last Details of Construction Have Been Attended to. Our Illustration Gives a Good Idea of This Triumph of French Engineering, and in Seeing it and Knowing What it Can do, it Makes One Feel as if the Days of the Submarine Cable Were Indeed Numbered. When Hertz Astonished the World With His Minute Spark, Produced by Electric Excitation at a Distance of a Few Yards and Which Excitation Had Penetrated a Stone Wall, and When Branley Developed His Sluggish Coherer, Which Was Decohered by Mechanical Tapping, and When the Directors of One of the Cable Companies Objected to Marconi's Experiments in Transatlantic Cable Work Being Carried Out on One of the Islands of the Canadian Provinces, Because They Thought it Interfered With Their Cable Monopoly, No One Could Have Foreseen That the Hertz Experiments Would Have Been Forgotten, and That Soon Radio People Would Hardly Remember What a Coherer is, and That Such a Giant Station as the One We Describe Would Bid Fair to Relegate the Transatlantic Cables to a Position of Threatened Insignificance. This View Shows the Antenna at Night All Aglow With Its Brush-Like Discharges.

Radio for the Beginner

By ARMSTRONG PERRY

NO. 5—HOW A RADIO RECEIVER MAKES YOU HEAR SOUNDS FROM AFAR

"HOW far can you hear music with this radio receiver?" is a question frequently asked by a prospective purchaser. The salesman replies with stories of folks who hear the grand opera sung in Chicago, the orchestra concert played in Pittsburgh, the educational lecture delivered at Medford Hillside, the Senator's address spoken in Washington, at distances of from one hundred to three thousand miles. If he were speaking literally, instead of in practical terms, he would be just as much mistaken as tho he told the customer that he could see his mother across such spaces. The sound that we hear at the radio receiver travels about half an inch if we wear the phones. With an amplifier a receiver may deliver sounds that can be heard twenty feet or more from the phones. A loud-speaker may project the sound waves considerably farther but the best radio outfit yet built will not under ordinary conditions throw the sound for a distance of more than three miles.

Even extremely loud sounds such as thunder, the firing of cannon and the shrieks of powerful whistles seldom are heard at distances greater than twenty to thirty miles. No electrical or mechanical device has as yet been invented that will carry sound farther than that.

The sound we hear at the radio receiver is not the sound that was produced at the transmitting station. It is all produced right where we are. The little disc of metal inside the telephone receiver, or the loud-speaker, makes it. All the traveling it does is from that disc to our ears and to the point where it grows weak and disappears from human consciousness. This fact brings a sense of disappointment to those of us who have imagined that we were actually hearing the voices of distant celebrities, but there is also a bit of consolation in it. We really would not want the voice of a grand opera star to sound as it sometimes does at the present stage of radio development when her aria is passed out to us by a loud-speaker. We would not pay to hear anything like that from the stage.

Sound consists of a series of concentric air bubbles. Starting at a common source, for example the head of a drum, the vocal organs of a human being or the diafram of a telephone receiver, they expand rapidly, one inside the other. The surface of each is a thin stratum of compressed air. Between the surface of one and the surface of the next is a stratum of air less compressed than it normally is. These bubbles are called sound waves, sound oscillations, or sound vibrations. Hit the head of a bass drum with its padded stick and you drive it inward, compressing the air before it. The stick rebounds, the drum head flies back and compresses the air on the outer side of it. Its elasticity or spring causes it to make many vibrations before coming to rest and at each vibration it blows a new bubble of compressed air. The air itself does not move very much, but the wave of compression goes on and on. As on a river, when the wind blows up stream, the wave may even go contrary to the general movement of the current.

This wave motion, or succession of bubbles as it may be called to indicate that it is not a wave traveling in one direction but a sphere of motion expanding in all directions, is common to heat, light and radio also. Sound waves are slower and shorter than the others. They need air to carry them, apparently, while the others travel as well or better thru space where there is no atmosphere. We gave these waves different names because we discovered them in different ways and did not recognize at first how similar they were. The sound waves we discovered with our ears, the heat waves with our skins and the light waves with our eyes. It was only when we began to hunt with specially designed apparatus for the waves we could not hear, feel or see that we discovered how much they all resembled each other.

Just as common folks began to be a little bit familiar with wave-lengths the scientists began to speak of "frequencies" instead of wave-lengths, and got us all mixed up again. But the principal difference is that in using the new term they refer to the number of times per second that the drum-head wiggles instead of the length of the sound wave it starts. The more wiggles per second the more waves per second, and the more waves per second the shorter the waves. Sound waves, and all the other waves, have rather definite speeds. Instead of sending out the same length waves and making them travel faster, a smaller drum head, which of course vibrates faster, sends out shorter waves and makes them travel at the same rate of speed as the longer ones. One drum might send out 100 waves per second and another 200 waves per second, but at the end of that second both drums would be heard simultaneously at a point about a thousand feet away.

Now, having in mind that sound waves and radio waves are of the same general nature, it is easy to understand that we can build apparatus to change waves of one length into waves of another length. The radio transmitter changes sound waves, which are short, into radio waves, which are long. The radio receiver changes the radio waves back into sound waves. If we could really sit in Washington and hear what was going on in Chicago we would not have to use radio. But sound waves are slow, awkward and weak compared with radio waves. At the best they will travel only a few miles before breaking up and getting lost, whereas there are good reasons for believing that radio waves roll for millions of miles, coming all the way from the sun to the earth the same as heat and light waves do.

When it was discovered that a sound produced by a human voice or a musical instrument would vibrate a diafram, wiggle a needle and punch holes in a wax cylinder or disc, and that the process could be reversed so that the holes would wiggle the needle, vibrate the diafram and make it produce similar sounds, it became possible to enjoy a concert in Oshkosh, altho the artists had warbled somewhere a thousand miles from there, years before, and died afterward. We refer, of course, to the phonograph. Radio merely provided a means by which the voices of the artists would vibrate a distant diafram while they were making their music, instead of punching holes in wax to be carried to the distant point and used later. There is nothing to hinder the voices from doing both things at the same time, and *canned* music can be radioed as well as that which is newly made.

The process has been developed by slow and painful labor, but thanks to the consummate genius of modern scientists, it is now so simple that even without scientific training the average man can see the whole thing clearly in his mind's eye.

First, there is a diafram at the transmitting station like the one in the ordinary telephone receiver. It is placed where the sound waves beat upon it and it vibrates in time with them. Even tho there may be a score of different and distinct sound wave trains striking it at the same time, as when a large orchestra plays, the diafram vibrates to all of them.

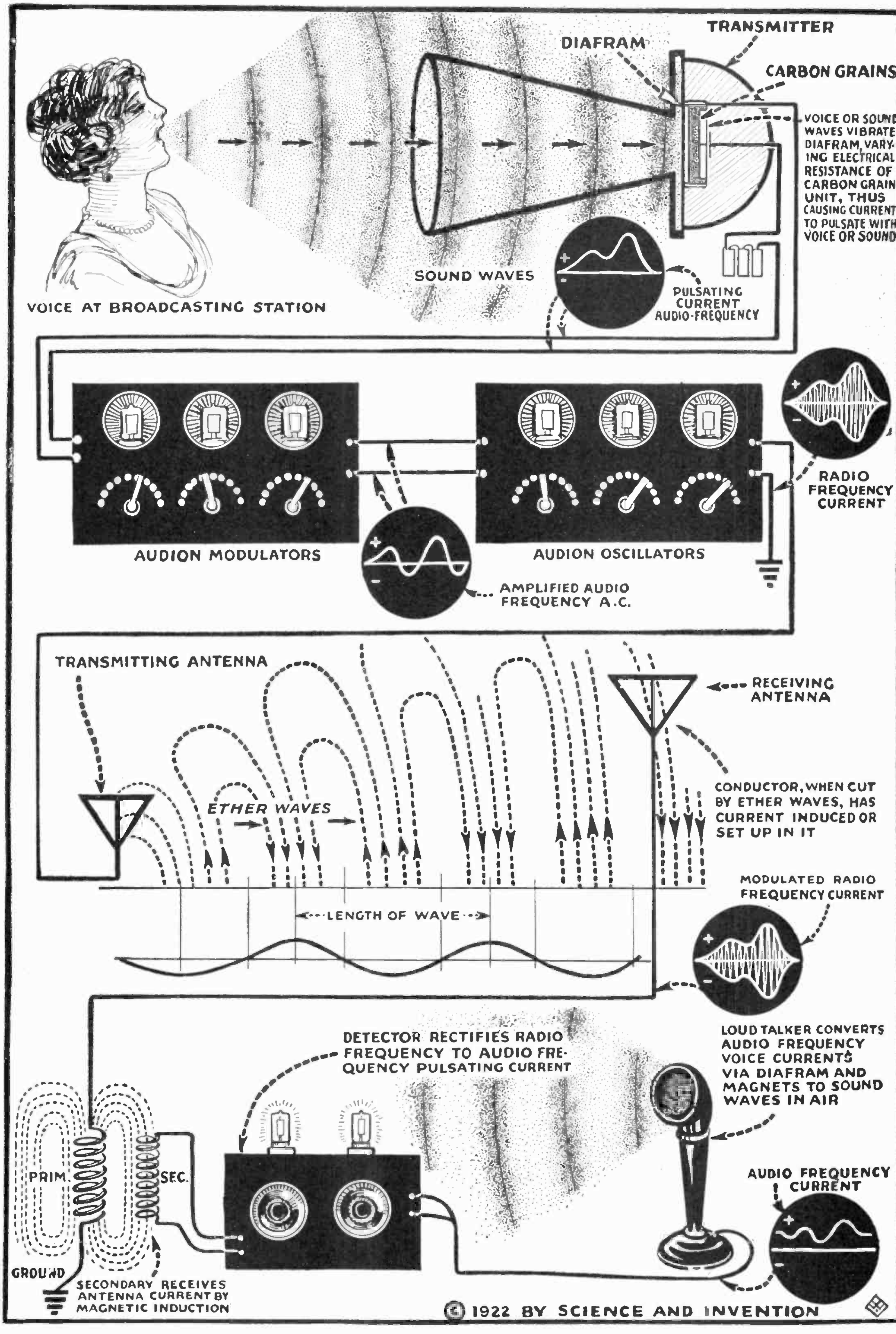
The diafram, at each vibration, compresses some carbon granules that are behind it in the transmitter as the drum head compresses air. These granules, fine and dry as dust, loosen up again each time the diafram flies back and relaxes its pressure. The diafram, the carbon and their accessories make what is called a *microphone*. (See cut opposite.)

The carbon granules are connected into an electrical circuit around which flows a current supplied by a battery. With the carbon at rest this current flows smoothly, but the slightest variation of pressure on the carbon varies its resistance to the current, and an increase of resistance causes a change in the current. When the sound waves strike the diafram and it gives the carbon a series of taps, the electric current instead of flowing smoothly becomes wavy, like a smooth pond when a breeze sweeps across it. The action is similar in some ways to what would happen if you had a thin rubber tube thru which water was being pumped and you would alternately squeeze and release it, changing the even flow of water to a pulsating flow. The rise and fall of the current causes a corresponding rise and fall of magnetism around the wires of the circuit, for whenever electricity flows a magnetic field surrounds whatever it is flowing thru, and any change in the current causes a corresponding change in the magnetic field.

Next to this microphone circuit is another circuit, whose wires come within the influence of the magnetism. This circuit connects with the transmitting antenna. In it flows a much stronger current than that in the microphone circuit, but this stronger current is affected by every impulse that reaches it thru the sound waves, the diafram, the carbon, the microphone circuit, and the magnetism. The current in the antenna is oscillatory, which means that it reverses its direction many times per second, often as many as 3,000,000 times per second. Such a current flowing in a radio antenna starts radio waves from that antenna. To reverse its direction the current must first stop an instant like a man who turns to retrace his footsteps. When the current stops the magnetic field collapses like the inner tube of an auto tire when the air escapes. The current

(*Continued on page 288*)

Feature Articles in July "Radio News"



How the Voice Is Transmitted from a Radio Broadcasting Station—Told in Pictures.

Radio Amplification--Best Methods

By ROBERT E. LACAULT

SINCE the broadcasting of music, news and other information has become so popular, a great number of persons have installed in their homes receiving sets of various types, which quite often have failed to give the expected results, for different reasons. In some cases the installation cannot be made under the best conditions on account of lack of space for the erection of a good aerial, or the distance between the broadcasting stations and the receiver is such that the power picked up by the aerial is not sufficient to operate efficiently the receiving apparatus. In any case, this may be remedied by means of a suitable amplifier which makes for poor efficiency, as we will explain later. Another thing which is becoming more and more popular is the loud talker. Very often it fails to talk loud enough "to enable an audience to listen to the concerts," as the advertisements say, for the proper amplifier is not used in conjunction with it to boost up the signals before they are applied to it. We shall describe some type of apparatus for the operation at maximum efficiency of loud speakers.

Radio- and Audio-Frequency Amplification

There are two kinds of amplifiers, the radio- and the audio-frequency types. The former is for the purpose of increasing the sensitiveness of a receiver, while the latter is for boosting up the rectified signals to produce a greater volume of sound in the telephones or loud speaker. The radio-frequency amplifiers are necessary when it is desired to receive very weak signals, which cannot operate the detector, which is itself very inefficient, unless sufficiently strong oscillations are applied to it. In a radio-frequency amplifier for short wave reception special transformers, or tuned circuits, only may be used; as the resistance coupled amplifier is not sensitive on short-wave lengths. The resonance type, in which tuned circuits are used, is best, as it may be adjusted for one particular wave length and gives, with maximum amplification, a sharpness of tuning which is desirable and useful when receiving thru heavy interference. Its only drawback is that owing to the necessity of tuning each step separately, it becomes impracticable if more than one or two stages are used, unless it is permanently adjusted on a certain wave length

Photo Above Shows a Tuned Radio-Frequency Amplifier With Four Vacuum Tubes, Comprising Two Stages of Radio-Frequency Amplification, Detector, and One Stage of Audio-Frequency Amplification. The Two Large Variable Condensers Shown, Correspond to Those Indicated at K1 in Diagram Fig. 2, or the VC's Across the Primaries of the Transformers T1 and T2. This Set Gives Excellent Results.

for the reception of a particular station. It is necessary also to adjust the potential of the grids of the vacuum tubes so as to prevent self-oscillation occurring on account of the feed-back effect between the circuits, the resistance of which is so reduced as to permit the signals to build up to a great extent when they start local oscillations. This may be remedied by making the grids positive by means of a potentiometer connected across the filament battery.

The transformer coupled amplifier is somewhat more practicable for the amateur, as it requires no tuning, and gives good results over a certain band of wave lengths, if well-designed transformers are used. In the impedance capacity coupled amplifier, which is a simplification of the resonance type, only one coil connected in the plate circuit of each tube and shunted by a condenser is used; the variations of voltage across this circuit being impressed upon the grid of the next tube thru a small condenser, as shown in Fig. 1, which is the hookup of a two-stage amplifier of this type with a detector tube. The inductances which are connected in the plate circuit may be some honeycomb or duo-lateral coils, which can be plugged in for the reception of different wave lengths, while the transformers of the resonance amplifiers shown in Fig. 2 may either consist of the same coils closely coupled, or may be wound especially on an insulating tube with a ratio of about 2 to 1.

Some means of plugging should be provided so that a transformer may easily be substituted by another when it is desired to receive on another band of wave lengths than that covered by the transformer in use. For this purpose, vacuum tube sockets may be used, if the transformers are wound on a rod of the same diameter as the base of a tube, with pins fitted at one end and corresponding to the blades in the socket. For short-wave reception, three transformers are sufficient to cover a range of 200-600 meters. They should be wound with No. 30 to 40 enameled or silk-covered wire, and have the following number of turns on the primary and secondary:

Primary	Secondary
50	100
75	120
110	200

Fig. 5 shows the details of construction of such a transformer.

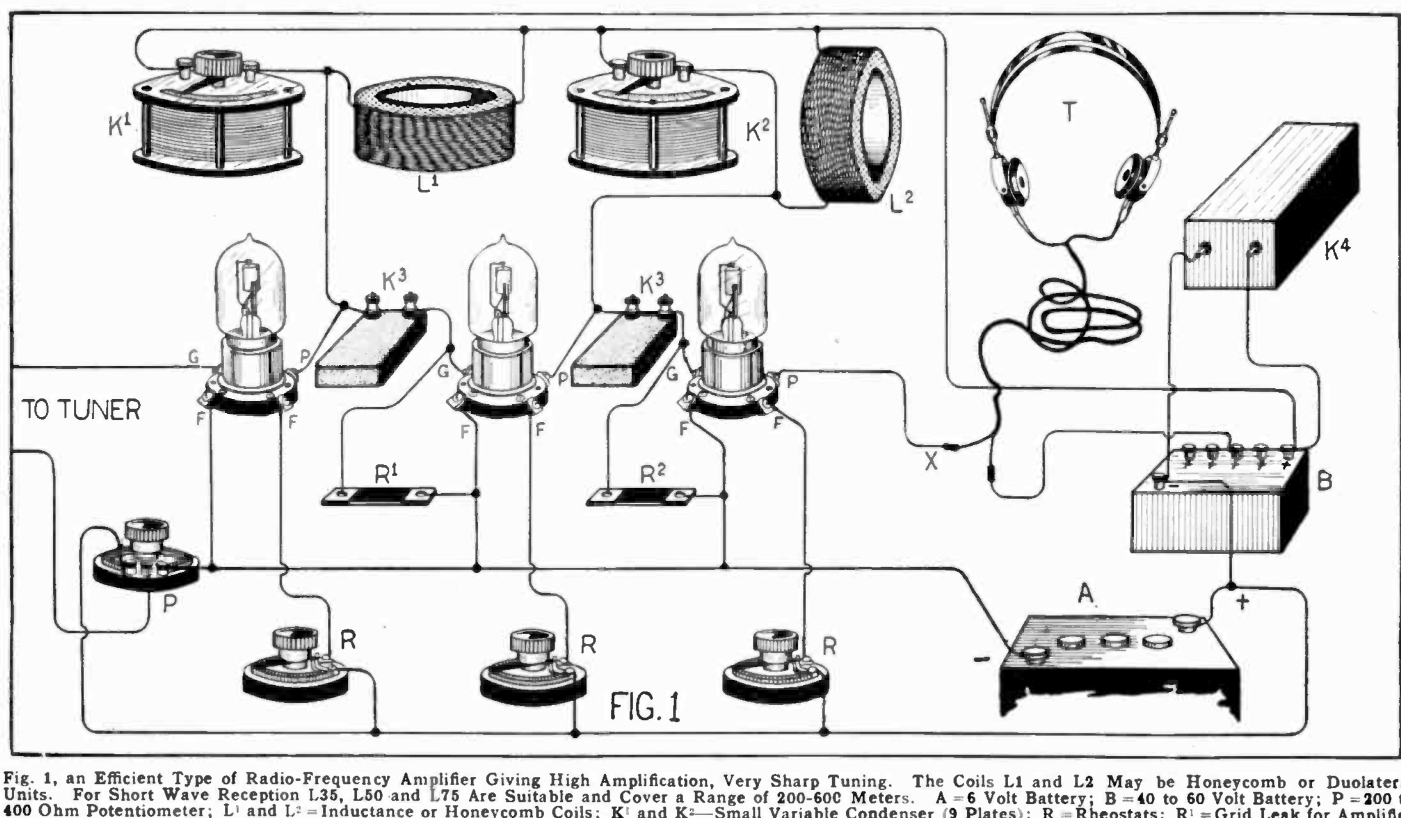


Fig. 1, an Efficient Type of Radio-Frequency Amplifier Giving High Amplification, Very Sharp Tuning. The Coils L1 and L2 May be Honeycomb or Duolateral Units. For Short Wave Reception L35, L50 and L75 Are Suitable and Cover a Range of 200-600 Meters. A = 6 Volt Battery; B = 40 to 60 Volt Battery; P = 200 to 400 Ohm Potentiometer; L^1 and L^2 = Inductance or Honeycomb Coils; K^1 and K^2—Small Variable Condenser (9 Plates); R = Rheostats; R^1 = Grid Leak for Amplifier Tube; R^2 = Grid Leak for Detector Tube; K^3 = .00025 M.F. Fixed Condenser, and K^4 = 2 M.F. Condenser.

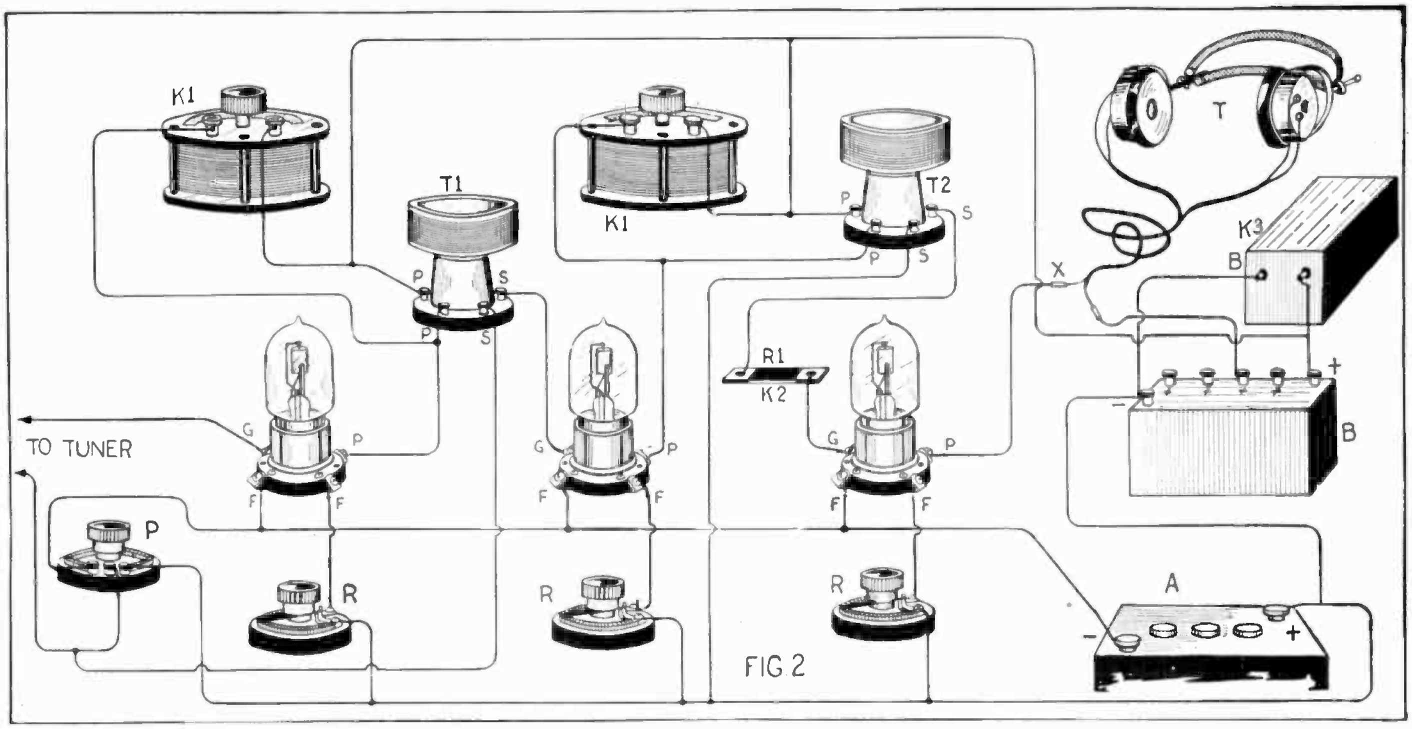


Fig. 2, Hook-up of a Two Stage Resonance Type, Radio Frequency Amplifier and Detector. The Transformers May be Honeycomb Coils Closely Coupled or Specially Wound. A = 6 Volt Battery; B = 40 to 60 Volt "B" Battery; P = 200 to 400 Ohm Potentiometer; R = Rheostat; K[1] = Small Variable Condenser (9 Plates); PS = Primary and Secondary Windings; K[2] = Grid Condenser .00025 M.F.; R[1] = Grid Leak, and K[3] = 2 M. F. Fixed Condenser.

Such amplifiers may be used with any type of tuner or with a loop aerial. If a regenerative set is already installed, the secondary of the variocoupler should be connected to the potentiometer slider, the grid variometer to the grid, and the plate variometer or tickler coil cut in between the plate of the detector tube and telephones at point X in the diagram. A great sensitiveness is obtainable with such an amplifier, provided it is carefully built.

In the construction, care should be taken to make the wiring so that one wire will not run parallel to another at a distance of less than 3", and to mount the transformers or inductances at right angles to each other, and at a distance of about a foot, to prevent as much as possible reaction between the circuits, which would result in the production of continuous oscillations, very difficult to control. These recommendations also apply to an amplifier using radio-frequency transformers, the hook-up for which is similar to that of Fig. 2 minus the variable condensers.

When weak signals are to be received, a two-stage radio frequency amplifier will prove most useful and will be found sufficient for the average work in an amateur station. When a loop or an outdoor aerial must be used, such an amplifier is necessary to make the signals readable. If further magnification of the signals is desired, an audio frequency amplifier may be added after the detector.

Detector

The soft tube, that is, the type containing a small quantity of gases, is the most sensitive, but requires a careful adjustment of the filament and plate voltage. The value of the grid leak is also of importance, and is generally to be found thru experiment. The easiest way to determine the proper resistance of the leak is to coat a small piece of bristolboard with India ink, insert it between two clips when dry, and vary the distance between the clips until the signals received are loudest. A buzzer may be used as a standard, and allows the operator to judge of the difference between various values of leak, if the signals are made very weak by placing the buzzer far from the set. Once the resistance giving best results is found, the piece of cardboard should be permanently clamped on an insulating base and the whole unit made weatherproof by inserting it in a glass tube sealed at each end with sealing wax or paraffine, or in some other way. To adjust the plate voltage, if a variable "B" battery is not at hand, a potentiometer should be connected across the filament battery and the negative of the "B" battery connected to the slider.

Audio Frequency Amplifiers

In order to obtain good results with an amplifier, it must be carefully built, and all the connections soldered. The transformers should be placed far enough from each other to prevent induction effect which produces in the telephones a characteristic roar.

As it is desirable to obtain maximum amplification without distortion, transformers having different ratios should be used in the different stages, otherwise distortion is most likely to occur when a high plate voltage is applied on the tubes to operate a loud talker at full volume. This effect is more marked in a three-step amplifier and it is best to experiment with various makes of transformers to obtain maximum amplification with the tubes in use. The grid potential must also be adjusted when high voltages are used. For voltages below 100, a potentiometer connected across the filament battery and having its slider connected to the secondary of the transformers provides sufficient variation; but above this voltage a grid battery is often necessary. Its voltage may vary from two to 45, according to the plate voltage used. To supply a loud talker which is designed for great volume, the last stage of the amplifier should consist of a 5-watt power tube with 200 to 400 volts on the plate. It is not necessary to use transmitting tubes in all of the stages.

To minimize the possibilities of distortion, if more than one stage of power amplification is used, it is best not to connect the transformers between the high tension source and the plate, but to use a choke-coil, as shown in the last stage of the diagram, Fig. 3. Similarly, the secondary of the transformers should be shunted by a grid leak, the value of which depends upon the make of the transformer. If the amplifier has a tendency to howl, it may be stabilized by connecting fixed condensers between the grid and filaments of the tubes. Another good precaution to prevent noises is to connect the

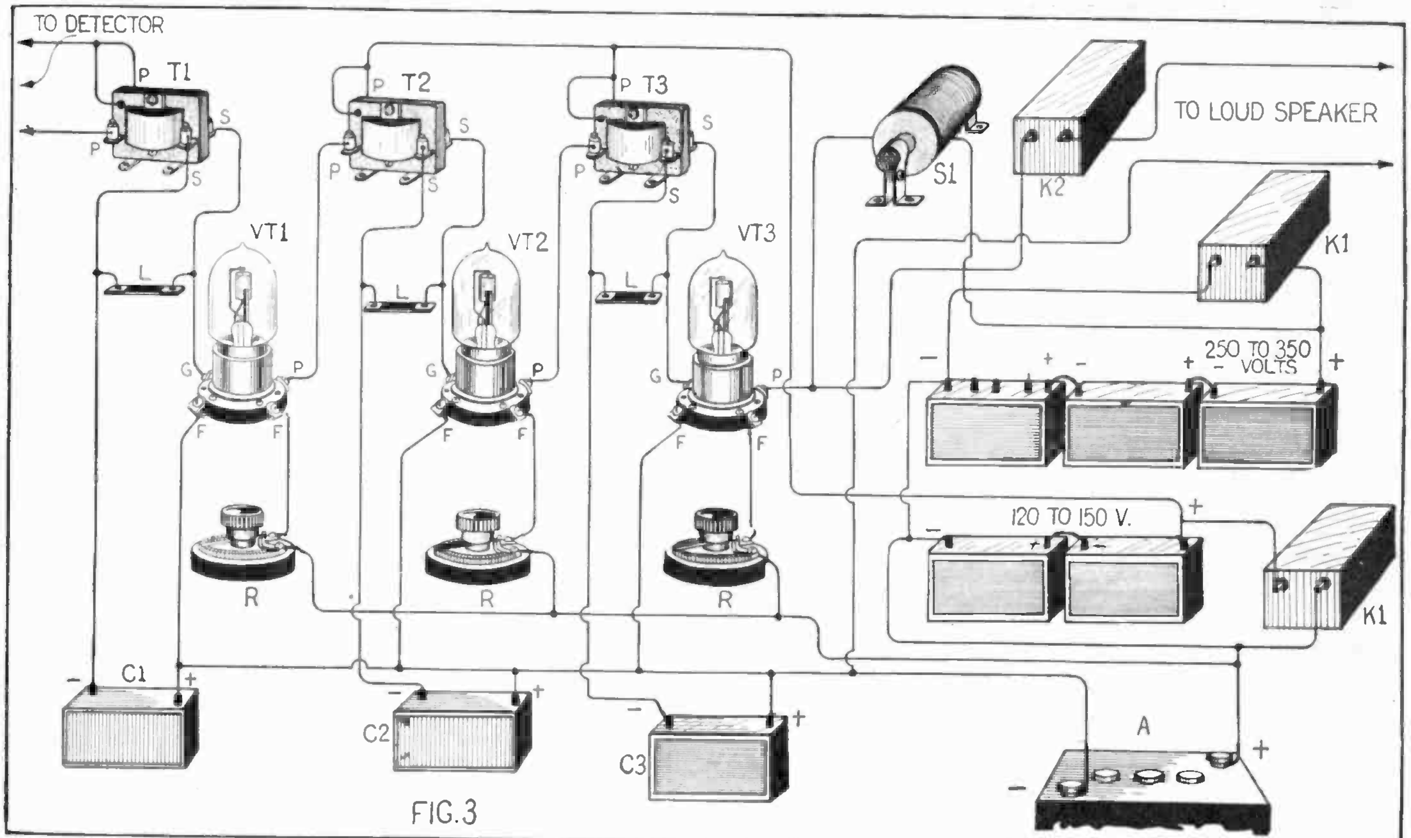


Fig. 3 Shows the Connection of a Three Step Amplifier, the Last Stage of Which Acts as a Power Amplifier. This Apparatus is Especially Suitable to Operate a Loud-Speaker at Full Volume. R = Rheostat; VT1 and VT2 = Amplifying Tubes; VT3 = 5 Watt Power Tube; T1, T2, T3 = Amplifying Transformers; C[1], C[2] = Grid Batteries 3 to 5 Volts; C[3] = 35 to 45 Volts; L = Grid Leak; S[1] = Choke Coil of About 30 Henries; K[1] = 2 M.F. Condenser; K[2] = 4 M.F. Condenser.

iron cores of the transformers, and other metallic parts to the positive of the plate battery, so that no difference of potential exists between these parts. It should be noted that a high capacity condenser connected across the plate batteries of the amplifier is shown in the diagrams; this is for the purpose of providing a path of low resistance for the oscillations, which are considerably damped, when the resistance of the plate battery increases with age, if this condenser is not used.

Noises on the Amplifying Sets

The noises which are heard on an amplifier, especially of the audio frequency type, are of various kinds. When intermittent cracking, which sounds like a discharge, is heard the trouble should be sought in the batteries, especially the filament battery. There may be a bad contact in one of the sockets or the rheostat or in the leads from the amplifier to the battery. Frying noises and intermittent faint whistling sounds are generally caused by bad or run-down cells of the "B" battery. Poor amplification is generally caused by an interruption in one of the grid circuits, either in the connection from the transformer secondary to the filament or in the secondary of the transformer; if a grid is entirely insulated, howling is heard which shows an interruption in one of these circuits. When no signals at all are heard, the trouble generally lies in one of the plate circuits, and the transformers should be verified for continuity, either with a milliammeter and

(Continued on page 286)

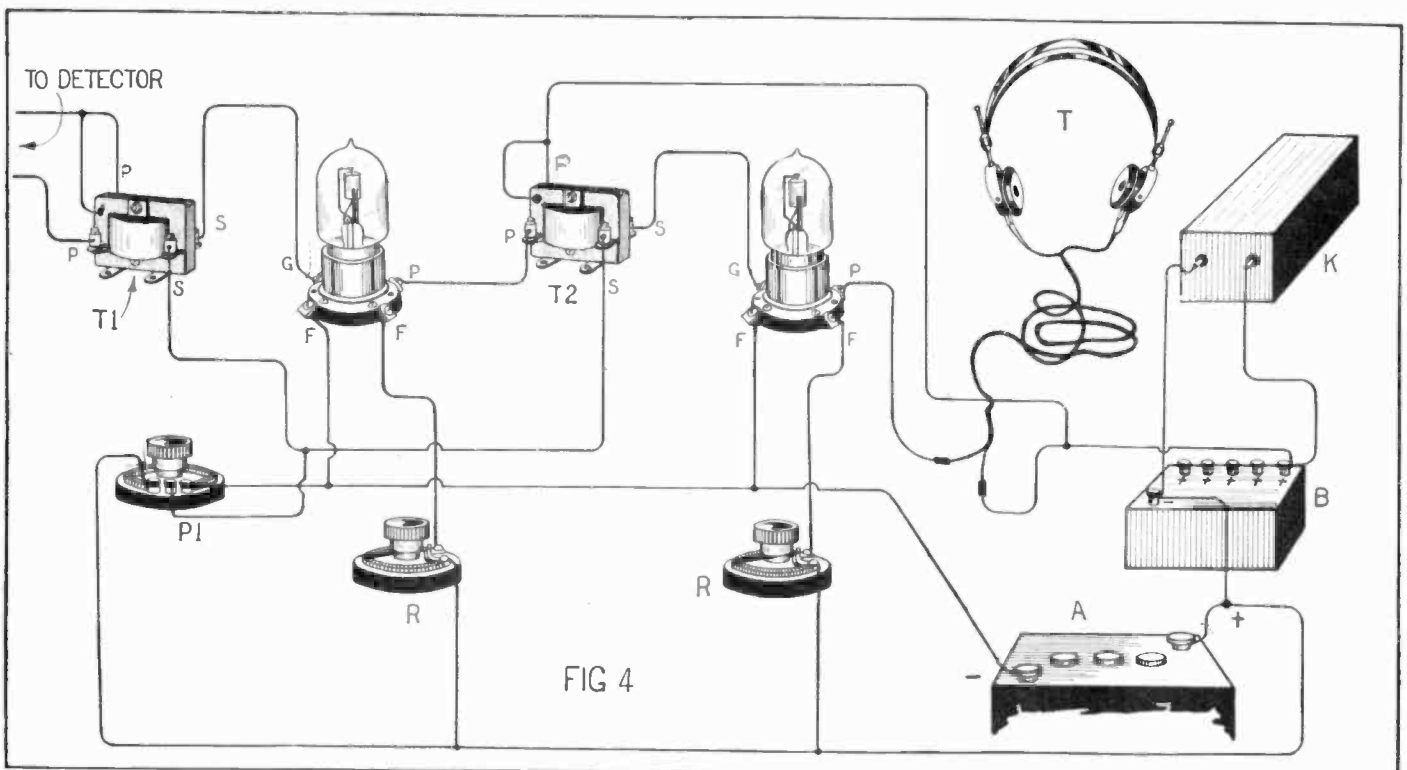


Fig. 4, Hook-up of a Two Stage Audio-Frequency Amplifier Which May be Used With Telephones to Obtain Maximum Amplification, so That a Horn May be Adapted to the Phones for Loud Speaking Purposes. T1 = High Ratio Transformer (About 10—1); T2 = Lower Ratio Transformer (About 6—1); P1 = Potentiometer of 200 to 400 Ohms; R = Rheostats; K = 2 M.F. Condenser.

Simplest Radiophone Receiver

By LEON WEBSTER

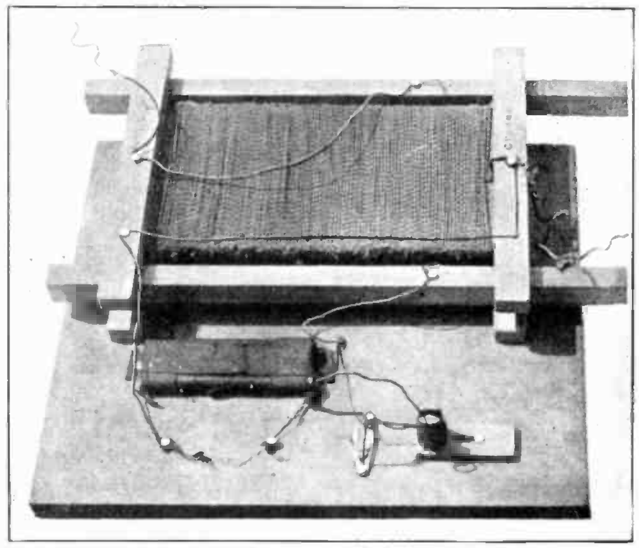
(WINNER OF $50.00 THIRD PRIZE)

BELOW is given a description of a simple and inexpensive radiophone receiving set, which can be constructed by a twelve year old boy, and from which a lot of pleasure may be obtained. The material can be "picked up" in almost any place. An aerial or outside receiving wire, a ground wire, a wooden base or small table, a tuning coil, a condenser, and a detector will be required.

In order to build the aerial, about 100 ft. of No. 14 galvanized fence or telephone wire, which is to be strung up outside the house to a garage or other out building, or to a convenient tree as high as possible, will be needed. The figure gives an idea of how this should be done. Two or more insulators as shown, will be required. These may consist of porcelain cleats, such as electricians use in house wiring. For the lead-in wire use regular No. 14 insulated copper wire, sufficient to reach from the aerial to the receiving set. A piece of board 10" wide by 12" or 14" long, ¾" to 1" thick, will answer the purpose of a base.

The tuning coil may consist of a piece of pine, ¾"x4"x10" long, around which about one-half pound of No. 20 or No. 22 enameled or covered wire is wound in a single layer with the turns touching. If you are unable to secure this wire, one-half pound of No. 18 bell wire, which can be obtained at any hardware store, can be used. To secure the end of the wire while you are winding the coil, place a carpet tack 1" from the end of the core. When you have completed the winding, secure the wire to a tack placed at the other end of the coil. With a knife or other instrument, carefully scrape the insulation from the wire on each edge of the coil, as shown. This is done so that the slider springs may make contact. Four pieces of pine, ½"x¾"x7" long, and two pieces, ½"x¾"x17" long are obtained. The long pieces are used as the sliders. With No. 3 lath nails or one inch brads, fasten the short pieces to the ends of the coil, as shown. Bend two safety pins about 1½" long, as shown, and place them in each slider piece, as shown in cut. Place a nail 1½" long thru pieces nailed to the ends of the coil, about 1" from the coil core piece. (Do not drive all the way in until wire connectors have been placed, as described below.) These nails are to hold the slider spring contacts against the bare wire of the tuning coil, but still allow the sliders to move freely. The tuning coil is now complete.

Next comes the condenser which is obtained from the family flivver. Hunt around for a burned out or "dead" spark coil; if you haven't one, perhaps your neighbor or the local garage man has. Dissect it and carefully remove the condenser which will be found at one side of the coil, and is about 1¼"x4"x½" thick. Secure this to your base board or table by some strips of tape and a couple of carpet tacks, as shown in the diagram.

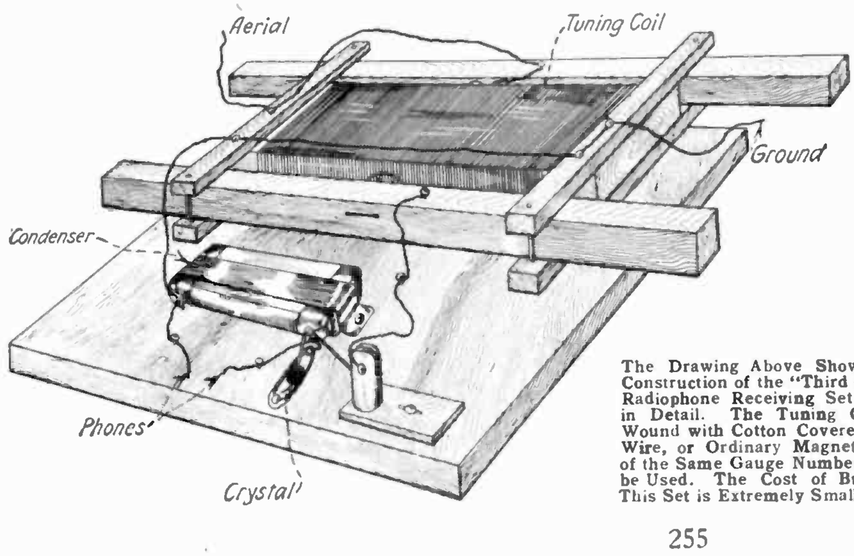


It is Not Always the Most Elaborate Radio Set Which Receives With the Greatest Efficiency. The Picture Herewith Shows the Simple Radiophone Receiving Outfit Constructed By Mr. Leon Webster, Winner of the $50.00 Third Prize in Our "Simplest Radiophone Receiver" Contest Conducted Some Months Ago. The Tuning Coil as Well as the Sliders and Guides for Them are All Constructed of Wood, Including the Base. The Detector Post, Which Holds the Cat-Whisker, is Constructed Likewise of Wood, and is Adjustable by Means of a Slot, as Shown. The Mineral is Held to the Base by Means of a Safety Pin, Fastened in Position by a Screw.

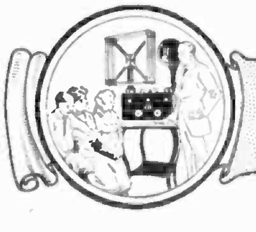
The detector consists of a piece of galena or silicon crystal, which can be purchased at any radio supplies dealer for about 25c, and is held to the base board by a safety pin and a couple of tacks, as shown. Take a piece of a common wooden clothes pin, and cut out a section as shown. Bore a hole thru it using an awl or small drill. Glue to a thin wood base ¾" wide by 2" long (a piece of a cigar box will do), and cut a small slot in the center, as shown. Now bend a safety pin as illustrated and place the pin in the slot in the clothes pin, and secure it there with a carpet tack or nail. Place a small rubber band around the post and pin, to secure a slight tension and hold the point of the pin in contact with the detector crystal. Mount on base board, as shown, using carpet tacks, but leave the crystal loose enough so that it may be moved about with one hand. The outfit is now ready to hook up.

Three or four feet of flexible wire cable which may be made from the secondary coil wire in your Ford coil, will now be required. Take 12 or 14 strands of this fine wire and twist them together, which will make a very neat and serviceable cable. Scrape the enamel from the ends of a piece of cable about 12" long, and fasten one end securely in the eye of No. 1 slider safety pin contact, as shown in Fig. 2, and connect the other end of the cable to the tack on the end of the tuning coil, as also shown, leaving the cable long enough, so that the slider may be moved the entire length of the coil. Take another piece of cable about 18" long, and clean its ends as before; connect one end to the wire of the coil, and the other end to the condenser, as shown in the diagram. Clean the ends of another piece of cable 12" long, and connect from the safety pin slider No. 2 to tack in the base, and thence to the eye of the safety pin on the detector movable stand. From the eye of the safety pin, which holds the detector crystal, run a short piece of cable to the other connection of the condenser. Now fasten your ground wire, which may be a piece of bare galvanized wire, No. 14 or larger, to the tuning coil, as shown in the wiring diagram, and run to a water or gas pipe where a good ground connection must be made. An iron rod placed in the ground and connected with the wire will do, if there is no gas or water pipe accessible.

The next step in construction will be to obtain a 'phone. Secure an old telephone receiver or better yet a 1,000 ohm radio receiver, and connect to the two condenser terminals. You are now ready to "listen in." See that all connections are secure, and that both slider contacts touch the coil wires. Place the sliders about half way along the coil, then with the 'phone receiver to your ear, bring the detector point in contact with the crystal and very gently "feel" for a sensitive spot, by moving it from place to place on the crystal. When a "spot" is touched, a slight grating sound will be heard in the receiver, or possibly the dots and dashes of some distant radio transmitting station. Now move the sliders a little each way until a spot is reached where the message is the loudest; then try to adjust the detector and perhaps the receiving will be still clearer. Experience will quickly enable you to tune the instruments to the wave lengths of the broadcasting stations.



The Drawing Above Shows the Construction of the "Third Prize" Radiophone Receiving Set More in Detail. The Tuning Coil is Wound with Cotton Covered Bell Wire, or Ordinary Magnet Wire of the Same Gauge Number May be Used. The Cost of Building This Set is Extremely Small.



RADIO BROADCAST

WE are publishing in this issue the complete list of radiophone broadcasting stations in the United States and possessions. This list will not be repeated in future issues of this magazine in its complete form. Information regarding the nature of the broadcast of some of these stations will appear in the next issue. We would suggest to the reader or the radio enthusiast that he form a card index of all of these stations, cross indexing them by states, cities, call letters and names of the stations. Next month we will publish the details of the broadcast, the time of the broadcast, the consistent range, and the maximum distance stations have been heard, of as many of the stations as we can find space for. This broadcasting information will be continued thru the list with additional stations appearing from time to time. We desire to thank our many readers who have assisted us in the location of various stations and ask them for their continued support to make this page the most successful broadcasting page to be found anywhere. In addition to the list, we intend to publish photographs of every one of the broadcasting stations found thereon. The reader can then either cut out the photo and paste it to the card in his index, assigning it to the proper station, or make a photostat of the station and paste that upon the card, or write the words "photo appears in the —— issue."

Thus the broadcasting list is practically up to date, being corrected to June 1st, 1922, but our list of the amateur telephone transmitting stations is not yet so completed. We, therefore, request our readers to continue to send their information to Broadcast, % SCIENCE AND INVENTION MAGAZINE, and those who desire further information on any of the stations found on this list or any station not so listed, should write to the same department, enclosing stamped self-addressed envelope for such information.

Of course, some of the stations here recorded are not broadcasting at present; in others the broadcast is very limited, but here are the calls; if you hear them, you will know the name of the concern and its exact location.

Don't forget—further information regarding each of the stations will appear. Don't forget the photos which are also going to be featured regularly in this same department, and don't forget to send us any information of new stations not already listed. Attention—Broadcast Stations—Send us photos of your outfit for publication. We thank you.

We are signing off—Broadcast, SCIENCE AND INVENTION MAGAZINE.

City State	Station Name	Call Letters	Wave Length	Location
Aberdeen, Wash	North Coast Products Co	KNT	360	C-5
Akron, Ohio	Buckeye Radio Service Co	WOE	360	M-41
Albany, N. Y	Shotton Radio Mfg. Co	WNJ	360	J-48
Altadena, Calif	Altadena Radio Laboratory	KGO	360	T-6
Ames, Iowa	Iowa State College	WOI	360, 485	L-30
Anderson, Ind	Arrow Radio Laboratories	WMA	360	N-37
Anthony, Kan	T. & H. Radio Co	WBL	360	R-26
Athens, Ohio	Athens Radio Co	WAAV	360	O-41
Atlanta, Ga	Atlanta Journal	WSB	360, 485	V-40
Atlanta, Ga	Ga. Railway and Power Co. (Atlanta Constitution)	WGM	360, 485	V-40
Auburn, Maine	Auburn Electrical Co	WMB	360	G-50
Austin, Texas	University of Texas	WCM	360	Z-29
Baltimore, Md	Joseph M. Zamoiski	WKC	360	N-46
Bay City, Mich	George M. McBride	WTP	360	J-38
Berkeley, Calif	Maxwell Electric Co	KRE	360	O-3
Birmingham, Ala	Alabama Power Co	WSY	360	V-37
Boston, Mass	Eastern Radio Institute	WAAJ	360	J-50
Bridgeport, Conn	Diamond State Fibre Co	WBAG	360, 485	L-48
Buffalo, N. Y	Federal Tel. and Tel. Co	WGR	360, 485	K-43
Buffalo, N. Y	McCarthy Brothers and Ford	WWT	360	K-43
Camden, N. J	Federal Institute of Radio Telegraphy	WRP	360	N-47
Canton, Ohio	Daily News Printing Company	WWB	360	M-41
Charleston, W. Va	Radio Service Co	WAAO	360	P-41
Charlotte, N. C.	Southern Radio Corporation	WBT	360	T-42
Chicago, Ill	City of Chicago	WBU	360	M-35
Chicago, Ill	The Fair	WGU	360	M-35
Chicago, Ill	Union Stock Yards & Transit Co	WAAF	360,485	M-35
Chicago, Ill	Westinghouse Electric & Mfg. Co	KYW	360	M-35
Cincinnati, Ohio	Cino Radio Manufacturing Co.	WIZ	360.485	P-38
Cincinnati, Ohio	Crosley Manufacturing Co.	WLW	360	P-38
Cincinnati, Ohio	Precision Equipment Co	WMH	360, 485	P-38
Clearfield, Pa	Electric Supply Co	WPI	360	M-44
Cleveland, Ohio	Warren R. Cox	WHK	360	L-41
Colorado Spgs., Colo.	C. F. Aldrich Marble & Granite Co	KHD	485	P-20
Columbia, Mo	University of Missouri	WAAN	360	P-31
Columbus, Ohio	Erner and Hopkins Co	WBAV	360	O-40
Crafton, Pa	Radio Service Corporation	WAAX	360	M-43
Dallas, Texas	City of Dallas (Police & Fire Signal Dept.)	WRR	360	X-26
Dayton, Ohio	Rike Kumler Co	WFO	360, 485	O-39
Dearborn, Mich	Ford Motor Co	WWI	360	L-39
Decatur, Ga	Georgia Radio Co	WAAS	360	V-40
Decatur, Ill	James Millikin University	WBAO	360	O-34
Denver, Colo	Reynolds Radio Co	KLZ	360	O-20
Denver, Colo	Young Men's Christian Association	KOA	485	O-20
Des Moines, Iowa	Iowa Radio Corporation	WHX	360	M-30
Des Moines, Iowa	The Register and Tribune	WGF	360	M-30
Detroit, Mich	Detroit News	WWJ	360	L-39
Detroit, Mich	Detroit Police Department	KOP	360	L-39
East Lansing, Mich	Stuart W. Seeley	WHW	485	K-38
East Pittsburgh, Pa.	Westinghouse Elec. & Mfg. Co.	KDKA	360	N-42
El Dorado, Kan	Midland Refining Co	WAH	360, 485	R-27
El Monte, Calif	Coast Radio Co	KUY	360	S-6
Emporia, Kan	Hollister Miller Motor Co.	WAAZ	360	Q-27
Erie, Pa	Electric Equipment Co.	WJT	360	L-42
Erie, Pa	Erie Radio Company	WSX	360	L-42
Eureka, Calif	T. W. Smith	KNI	360	K-3
Fort Worth, Texas	Fort Worth Record	WPA	360	X-26
Fort Worth, Texas	Worthan Carter Publishing Co.	WBAP	360, 485	X-26
Fresno, Calif	San Joaquin Light & Power Corp	KMJ	360	P-5
Granville, Ohio	Richard H. Howe	WJD	360	N-40
Greenwich, Conn	New England Motor Sales Co.	WAAQ	360	L-48
Gridley, Calif	The Precision Shop	KFU	360	M-4
Hamilton, Ohio	Doron Brothers Electric Co	WRK	360	O-38
Hamilton, Ohio	Republican Publishing Co.	WBAU	360	O-38
Hollywood, Calif	Electric Lighting Supply Co	KGC	360	S-5
Honolulu, Hawaii	Marion A. Mulroney	KGU	360	
Hood River, Ore	Blue Diamond Electric Co	KQP	360	E-6
Houston, Texas	Hurlburt-Still Electrical Co	WEV	360	AA-28
Huntington, W. Va.	Groves Thornton Hardware Co.	WAAR	360	P-41
Indianapolis, Ind	Hamilton Manufacturing Co	WLK	360, 485	N-37
Indianapolis, Ind	Hatfield Electric Co.	WOH	360	N-37
Jefferson City, Mo	Missouri State Marketing Bureau	WOS	485	Q-31
Jersey City, N. J.	Wireless Tel. Co. of Hudson Co., N. J.	WNO	360	L-48
Kansas City, Mo	Central Radio Co	WPE	360	P-29
Kansas City, Mo	Western Radio Co	WOQ	360, 485	P-29
Lacey, Wash	St. Martins College	KGY	360	C-6
Little Rock, Ark	L. M. Hunter and G. L. Carrington	WSV	360	U-31
Long Beach, Calif	Prest and Dean Radio Research Laboratory	KSS	360	U-6
Los Altos, Calif	Colin B. Kennedy Co	KLP	360	O-3
Los Angeles, Calif	Earl C. Anthony	KFI	360	T-6
Los Angeles, Calif	Beacon Light Co	KNR	360	T-6
Los Angeles, Calif	Bible Institute of Los Angeles	KJS	360	T-6
Los Angeles, Calif	Braun Corporation	KXS	360	T-6
Los Angeles, Calif	Bullock's	KNN	360	T-6
Los Angeles, Calif	City Dye Works and Laundry Co	KUS	360	T-6
Los Angeles, Calif	Irving S. Cooper	KZI	360	T-6
Los Angeles, Calif	Los Angeles Examiner	KWH	360	T-6
Los Angeles, Calif	C. R. Kierulff and Co	KHJ	360	T-6
Los Angeles, Calif	Arno A. Kluge	KQL	360	T-6
Los Angeles, Calif	Leo J. Meyberg Co	KYJ	360	T-6
Los Angeles, Calif	Radio Supply Co	KNV	360	T-6
Los Angeles, Calif	Standard Radio Co	KJC	360	T-6
Los Angeles, Calif	Western Radio Electric Co	KOG	360	T-6
Madison, Wisc	University of Wisconsin	WHA	360	K-33
Manhattan, Kan	Kansas State Agricultural College	WTG	485	P-27
Marietta, Ohio	Marietta College	WBAW	360	O-41
McKeesport, Pa	K. & L. Electric Co	WIK	360	M-43
Medford Hillside, Mass	American Radio and Research Corp	WGI	360	J-50
Memphis, Tenn	Riechman-Crosby Co	WKN	360	U-34
Memphis, Tenn	United Equipment Co	WPO	360	U-34
Milwaukee, Wisc	Gimbel Brothers	WAAK	360	K-35
Minneapolis, Minn	Minnesota Tribune Co. and Anderson Beamish Co	WAAL	360	H-30
Minneapolis, Minn	The Dayton Co	WBAH	360	H-30
Minneapolis, Minn	Findley Electric Co	WCE	360	H-30
Minneapolis, Minn	Sterling Electric Co. and Journal Printing Co	WBAD	360	H-30
Minneapolis, Minn	University of Minnesota	WLB	360, 485	H-30
Modesto, Calif	Herald Publishing Co	KXD	360	O-3
Modesto, Calif	Modesto Evening News	KOQ	360	O-3
Monterey, Calif	Noggle Electric Work	KLN	360	P-3
Montgomery, Ala	Montgomery Light and Power Co	WGH	360, 485	W-37
Morgantown, W. Va.	West Virginia University	WHD	360	N-43
Moorestown, N. J.	Fred M. Middletown	WBAF	360	M-47
Newark, N. J	L. Bamberger & Co.	WOR	360	M-48
Newark, N. J	D. W. May, Inc	WBS	360	M-48
Newark, N. J	I. R. Nelson Co	WAAM	360	M-48
Newark, N. J	Westinghouse Electric & Mfg. Co	WJZ	360	M-48
New Haven, Conn	A. C. Gilbert Co	WCJ	360	K-49
New Lebanon, Ohio	Nushawg Poultry Farm	WPG	360	O-39
New Orleans, La	Interstate Electric Co	WGV	360	AA-34
New Orleans, La	Loyola University	WWL	360	AA-34
New Orleans, La	I. B. Rennyson	WBAM	360	AA-34
New Orleans, La	Times Picayune	WAAB	360	AA-34
New Orleans, La	Tulane University	WAAC	360	AA-34
New York, N. Y	American Tel. and Tel. Co	WBAY	360	L-48
New York, N. Y	DeForest Radio Tel. & Tel. Co.	WJX	360	L-48
New York, N. Y	Ship Owners Radio Service	WDT	360	L-48
New York, N. Y	John Wanamaker	WWZ	360	L-48
Norfolk, Va	Ship Owners Radio Service	WSN	360	Q-46
Oakland, Calif	Preston D. Allen	KZM	360	O-3
Oakland, Calif	Atlantic Pacific Radio Supplies Co	KZY	360	O-3
Oakland, Calif	Warner Brothers	KLS	360	O-3
Oklahoma City, Okla.	Oklahoma Radio Shop	WKY	360, 485	T-27
Omaha, Neb	Metropolitan Utilities District	WOU	360, 485	M-28
Omaha, Neb	Omaha Grain Exchange	WAAW	360	M-28
Omaha, Neb	John O. Yeiser, Jr	WDV	360	M-28
Paris, Texas	Paris Radio and Electric Co.	WTK	360	W-28
Pasadena, Calif	J. J. Dunn and Co	KLB	360	S-6

City State	Station Name	Call Letters	Wave Length	Location
Paterson, N. J.	Wireless Phone Corporation	WBAN	360	L-47
Peoria, Ill.	Bradley Polytechnic Institute	WBAE	360, 485	N-34
Philadelphia, Pa.	Gimbel Brothers	WIP	360	M-47
Philadelphia, Pa.	Thomas F. J. Howlett	WGL	360	M-47
Philadelphia, Pa.	St. Joseph's College	WPJ	360	M-47
Philadelphia, Pa.	Strawbridge and Clothier	WFI	360	M-47
Philadelphia, Pa.	John Wanamaker	WOO	360	M-47
Pine Bluff, Ark.	Pine Bluff Co.	WOK	360	V-32
Pittsburgh, Pa.	Doubleday Hill Electric Co.	KQV	360	N-42
Pittsburgh, Pa.	Newspaper Printing Co.	WPB	360	N-42
Pomona, Calif.	Pomona Fixture & Wiring Co.	KGF	360	T-7
Portland, Ore.	Hallock and Watson Radio Service	KGG	360	E-5
Portland, Ore.	Willard P. Hawley, Jr.	KYG	360	E-5
Portland, Ore.	Northwestern Radio Mfg. Co.	KGN	360	E-5
Portland, Ore.	Oregonian Publishing Co.	KGW	360	E-5
Portland, Ore.	Stubbs Electric Co.	KQY	360	E-5
Reedley, Calif.	Lindsay-Weatherill and Co.	KMC	360	T-6
Reno, Nev.	University of Nevada	KOJ	360	N-6
Richmond, Ind.	Palladium Printing Co.	WOZ	360	O-38
Richmond, Va.	Times Dispatch Publishing Co.	WBAZ	360	Q-46
Ridgewood, N. Y.	Ridgewood Times Printing & Pub. Co.	WHN	360	L-48
Rochester, N. Y.	Rochester Times Union	WHQ	360	J-44
Rock Island, Ill.	Karlowa Radio Co.	WOC	360, 485	M-33
Roselle Park, N. J.	Radio Corp. of America	WDY	360	M-47
Roswell, N. Mex.	Roswell Public Service Co.	KNJ	360	V-19
Sacramento, Calif.	J. C. Hobrecht	KVQ	360	N-4
Salt Lake City, Utah	Deseret News	KZN	360	M-13
San Diego, Calif.	Holzwasser, Inc.	KON	360	V-7
San Diego, Calif.	Southern Electrical Co.	KDPT	360	V-7
San Diego, Calif.	Thearle Music Co.	KYF	360	V-7
San Francisco, Calif.	The Emporium	KSL	360	O-3
San Francisco, Calif.	Examiner Printing Co.	KUO	360	O-3
San Francisco, Calif.	Hale Brothers	KPO	360	O-3
San Francisco, Calif.	Leo J. Meyberg Co.	KDN	360	O-3
San Francisco, Calif.	Radio Telephone Shop	KYY	360	O-3
San Jose, Calif.	O. A. Hale and Co.	KSC	360	P-4
San Jose, Calif.	Charles D. Herrold	KQW	360	P-4
Schenectady, N. Y.	General Electric Co.	WGY	360	J-47
Schenectady, N. Y.	Interstate Electric Co.	WGV	360	J-47
Schenectady, N. Y.	Union College	WRL	360	J-47
Seattle, Wash.	First Presbyterian Church	KTW	360	C-6
Seattle, Wash.	Vincent I. Kraft	KJR	360, 485	C-6
Seattle, Wash.	Public Market and Market Stores Co.	KZC	360	C-6
Seattle, Wash.	Northern Radio and Electric Co.	KFC	360	C-6
Seattle, Wash.	Louis Wasmer	KHQ	360	C-6
Shreveport, La.	Elliott Electric Co.	WAAG	360	X-30
South Bend, Ind.	Myron L. Harmon	WBAQ	360	M-37
Spokane, Wash.	Doerr Mitchell Electric Co.	KFZ	360	C-10
Spokane, Wash.	Spokane Chronicle	KOE	360	C-10
Springfield, Mass.	Westinghouse Elec. and Mfg. Co.	WBZ	360	J-49
State College, N. Mex.	New Mexico College of Agriculture & Mechanic Arts	KOB	360, 485	
St. Louis, Mo.	Benwood Co.	WEB	360	P-33
St. Louis, Mo.	St. Louis Chamber of Commerce	WAAE	360	P-33
St. Louis, Mo.	Post Dispatch	KSD	360	P-33
St. Louis, Mo.	Stix-Baer-Fuller	WCK	360	P-33
St. Louis, Mo.	St. Louis University	WEW	360	P-33
Stockton, Calif.	C. O. Gould	KJQ	360	O-4
Stockton, Calif.	Portable Wireless Tel. Co.	KWG	360	O-4
St. Paul, Minn.	Commonwealth Electric Co.	WAAH	360	H-30
Sunnyvale, Calif.	Radio Shop	KJJ	360	O-3
Syracuse, N. Y.	Andrew J. Potter	WBAB	360	J-45
Tacoma, Wash.	Love Electric Co.	KMO	360	C-6
Tacoma, Wash.	Wm. A. Mullins Electric Co.	KGB	360	C-6
Tarrytown, N. Y.	Tarrytown Radio Research Laboratory	WRW	360	L-48
Tuscola, Ill.	James L. Bush	WDZ	360	O-34
Toledo, Ohio	Wm. B. Duck Co.	WHU	360	M-39
Toledo, Ohio	Marshall Gerken Co.	WBAJ	360	M-39
Toledo, Ohio	Service Radio Equip. Co.	WJK	360	M-39
Tulsa, Okla.	Midland Refining Co.	WEH	485	T-27
Urbana, Ill.	University of Illinois	WRM	360	O-34
Utica, N. Y.	J. & M. Electric Co.	WSL	360	J-46
Washington, D. C.	Church of the Covenant	WDM	360	O-45
Washington, D. C.	Continental Electrical Supply Co.	WIL	360	O-45
Washington, D. C.	Doubleday Hill Electric Co.	WMU	360	O-45
Washington, D. C.	Radio Construction & Elec. Co.	WDW	360	O-45
Washington, D. C.	White and Boyer Co.	WJH	360	O-45
Washington, D. C.	Thomas J. Williams	WPM	360	O-45
West Lafayette, Ind.	Purdue University	WBAA	360	O-36
Wichita, Kan.	Cosradio Co.	WEY	360	R-26
Wichita, Kan.	Otto W. Taylor	WAAP	360	R-26
Wilkes-Barre, Pa.	John H. Stenger, Jr.	WBAX	360	L-46
Worcester, Mass.	Clark University	WCN	360, 485	J-49
Yakima, Wash.	Electric Power and Appliance Co.	KQT	360	D-7
Yakima, Wash.	Foster-Bradbury Radio Store	KFV	360	D-7
Youngstown, Ohio	Columbia Radio Co.	WMC	360	M-42
Youngstown, Ohio	Yahrling Rayner Piano Co.	WAAY	360	M-42
Zanesville, Ohio	Fergus Electric Co.	WPL	360	N-40

LIST OF WIRELESS TELEPHONE STATIONS (TRANSMITTING) USED FOR OTHER PURPOSES THAN FOR BROADCASTING

Location	Owners' Names	Call Signal	
Camp 61, Calif.	Southern California Edison Co.	KDPW	
Camp 60, Calif.	Southern California Edison Co.	KDPV	
Camp 61-C, Calif.	Southern California Edison Co.	KFM	
Cascada, Calif.	Southern California Edison Co.	KDPU	
Cleveland, Ohio	Westinghouse Electric & Mfg. Co.	KDPM	L-41
Dearborn, Mich.	Henry Ford	KDEN	L-39
Detroit, Mich.	Detroit-Edison Co.	KDPH	L-39
Everett, Wash.	Puget Sound Telephone Co.	KJB	B-6
Flagship Div. 1, Camp Eustis, Va.	U. S. Shipping Board	WPF	
Flat Rock, Mich.	Ford Motor Co.	WFD	L-39
Fort Worth, Texas	Midland Refining Co.	WCV	X-26
Galveston, Texas	Sugarland Industries	KDLZ	AB-29
Harrisburg, Pa.	Pennsylvania State Police	WBAK	M-45
Hartford, Conn.	C. D. Tuska Co.	WQB	K-49
Honolulu, Hawaii	The Radio Shop	KYQ	
Laramie, Wyo.	Illinois Pipe Line Co.	KDC	M-19
Lima, Ohio	Illinois Pipe Line Co.	WBY	N-39
Long Beach, Calif.	Pacific Telephone & Telegraph Co.	KUXT	U-6
Los Angeles, Calif.	Southern California Edison Co.	KHI	T-6
Los Angeles, Calif.	Boulevard Express	KVT	T-6
Martinsville, Ill.	Illinois Pipe Line Co.	WHY	P-35
Minneapolis, Minn.	Northern States Power Co.	WLP	H-30
Negley, Ohio	Illinois Pipe Line Co.	WCQ	M-42
Norfolk, Neb.	Midland Refining Co.	WKH	M-26
Northville, Mich.	Henry Ford	KDEP	L-39
Orange, Texas	Hamilton Oil Corp.	WBAR	Y-30
Orange Field, Texas	Hamilton Oil Corp.	WBAS	V-30
Pedrocitas, Calif. (Santa Catalina Id.)	Pacific Telephone & Telegraph Co.	KUXV	U-5
Pike, Ky.	Sullivan Pond Creek Co.	WAAI	S-40
Port Huron, Mich.	Detroit-Edison Co.	KDPJ	K-40
San Diego, Calif.	Boulevard Express	KVU	V-7
Seattle, Wash.	Garrison Babcock	KFL	C-6
Seattle, Wash.	City of Seattle, Light Dept.	KVW	C-6
Skagit Power Site, Wash.	City of Seattle, Light Dept.	WJE	
Springfield, Ohio	Ford Motor Co.	WNA	O-39
Springwells, Mich.	Ford Motor Co.	WPZ	L-39
Sugarland, Texas	Sugarland Industries	KDLY	
Superior, Mich.	Detroit-Edison Co.	KDPI	
Tulsa, Okla.	Hamilton Oil Corp.	WBAT	S-28

Safety for Naval Aviators

Utmost precautions for the safety of naval aviators and aircraft and provisions insuring prompt assistance in case of disaster, as well as minimizing the danger of losing a plane and its crew at sea, are emphasized in an explanation of naval practices just made public by Secretary Denby.

It is pointed out by the Secretary that every plane is to keep constantly in touch by radio with ships or shore stations along routes traveled. No naval plane is dispatched over a route where it will be at any time completely out of communication with the radio stations at one end or the other of the route, the explanation said. To insure this at all times, the regulations provide that a power span a little more than half the total distance of the flight ordered must be maintained.

Where there is any possibility of a forced landing between the start and the end of the flight, two planes must be sent together. In case one is forced down, it is assumed that the other will be able to report by radio the situation and position and summon relief, or, in case of urgent need, report and then make a landing itself to aid the disabled machine.

Position reports at regular intervals, usually every half hour, must also be made while en route. These reports will be of great value to shore stations or ships, for should some extraordinary accident force down both planes simultaneously and silence their radio calls, rescue parties can be rushed to the place of the last position report and from there begin the search with reasonable hope of picking up the aviators in a comparatively short distance from that spot.

As a final precaution, all naval planes are equipped with rocket pistols to fire color signals at night to guide rescuers to their aid.

Secret Radio Messages

SECRECY OF RADIO MESSAGES PROMISED.

John Hays Hammond, Jr., apparently has revolutionized radio communication by a new invention. He has perfected a comparatively simple apparatus to prevent any station from taking messages except those for which it is intended.

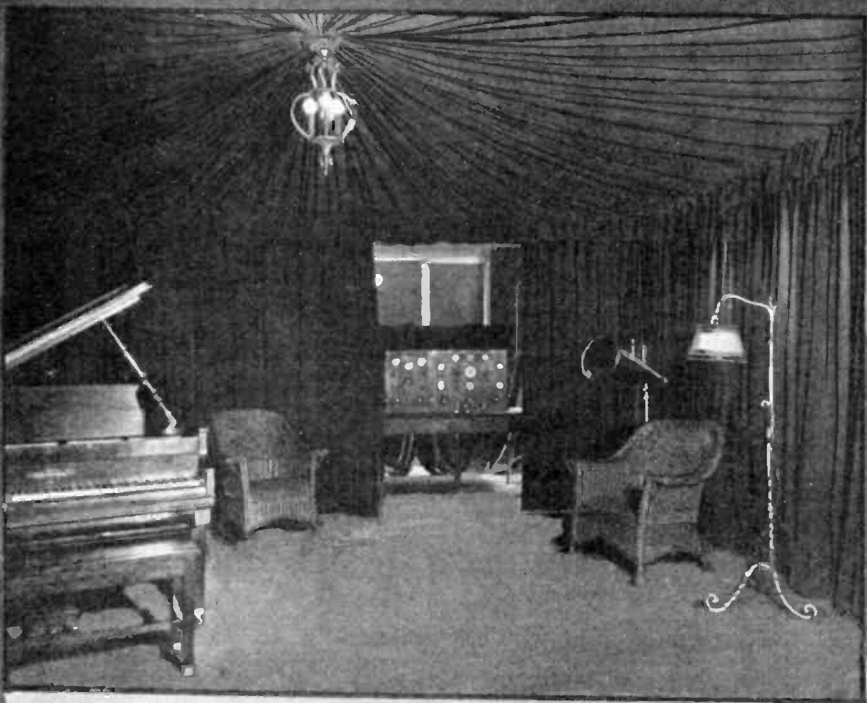
The same wave can be made to carry several messages at the same time, and further, it is stated, both voice and code may be transmitted.

The new apparatus will allow a far greater number of stations to communicate over a limited number of wave lengths. Accidental interference from other stations is greatly reduced. Efficiency is increased. Atmospheric electricity, or static, is diminished in its effect upon the new system to such extent that the system may be operated under conditions when the standard radio apparatus cannot successfully receive.

Mr. Hammond's statement declares that he has been at work upon these problems for the past fourteen years. A demonstration was recently given before officials and experts of one of the leading American radio companies, and Mr. Hammond says the United States Navy and War Departments have given his latest discoveries exhaustive tests with success.

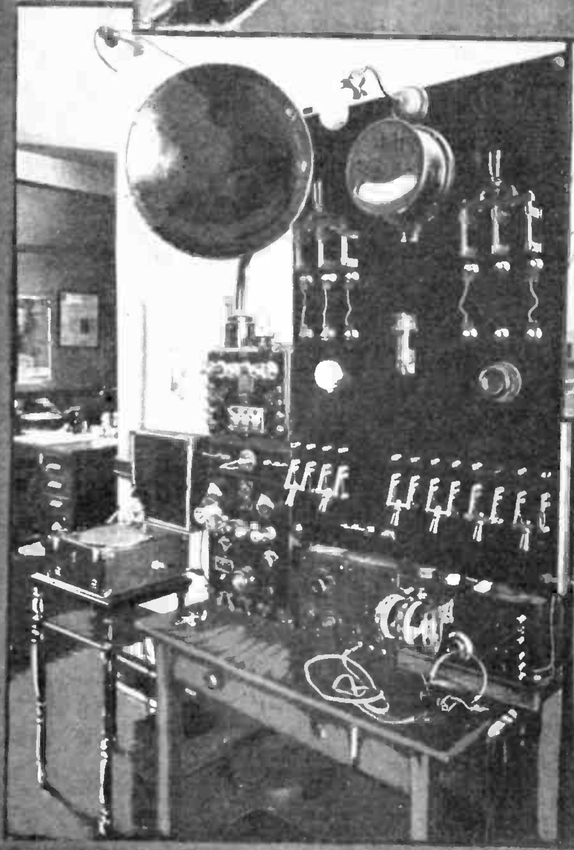
The system, it is declared, embodies a direct and simple means of insuring privacy, and it will be practically impossible under ordinary conditions for any other than the proper receiving station to hear anything but a jumble.

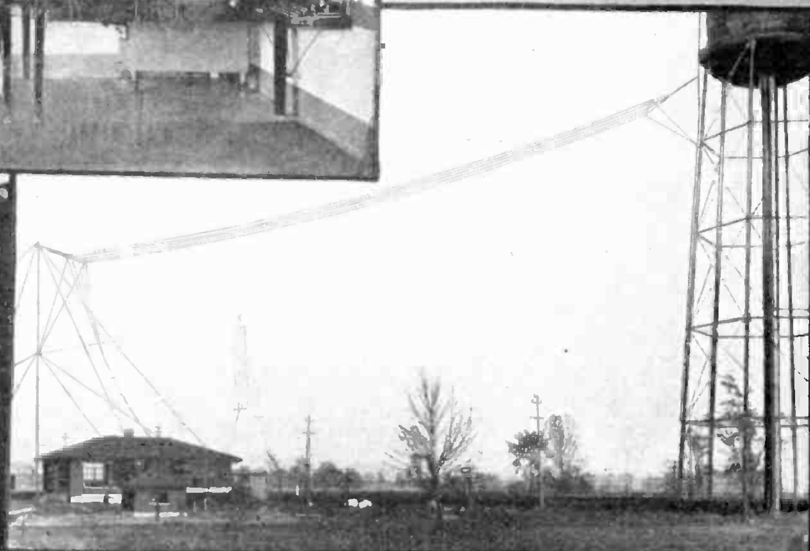
It is stated that, because of the new device, the navy has asked the Senate Subcommittee considering the army appropriation bill to strike out the requirement that the $750,000 appropriation made in 1916 to acquire the special rights of John Hays Hammond, Jr., be returned to the Treasury.



Broadcasting Station of the Hatfield Electric Company Located at Indianapolis, Ind. Call Letters WOH. Who Would Not Be Comfortable in This Palatial Studio? The Ceilings and Walls Are Draped in Velvet, and a Heavy Carpeted Floor Together with Easy Arm Chairs Would Make Any Musical Artist Want to Linger and Play Some More. The Draperies are Parted at the Rear to Show Part of the Transmitting Set. Studios Such at This Are Self-Inviting, and a Musician or Lecturer Should Not Have to Be Asked Twice to Talk or Sing.

Broadcasting Station of the Ford Motor Company, Located at Dearborn, Michigan; Call Letters WWI The Talent Which Broadcasts from This Large Station Is Obtained from the Personnel of the Ford Motor Company and Its Subsidiary Concerns such as the Henry Ford Hospital, the Dearborn Publishing Company, the D. T. & I. R. R., etc.





Admirably Located, the Ford Aerial Stretches from a Specially Constructed Mast to a Water Tank Tower. The Station Has Been Heard Rather Consistently over Ranges of 800 Miles, and Broadcasts Every Wednesday Evening, Beginning at 10 00 P. M. We Do Not Doubt But That This Station Will Eventually Broadcast Every Night.

Broadcasting Station of the Roswell Public Service Company, Located at Roswell, New Mexico; Call Letters KNJ. Weather and Stock Reports are Broadcasted at 5:00 and 7:00 P M. on 485 Meters, Both in Code and Voice; and at 8:00 P. M. on 360 Meters, Music as well as Baseball Scores and News.

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.

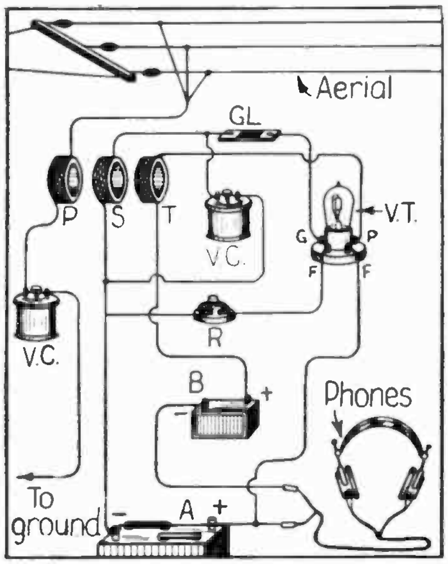
Long Wave Receiving Set

(24) W. A. Baber, Wichita Falls, Texas, requests:

Q. 1. A list of instruments necessary for constructing a long wave set.

A. 1. In order to construct a long wave receiving set, we would advise you to use three honeycomb coils for tuning. These may be purchased in different sizes from any radio supply house. The sizes necessary for various wave lengths are given herewith:

Wave-length range (meters)	Primary coil No.	Secondary coil No.	Tickler coil No.
145–350	DL–35	DL–25	DL–35
305–710	DL–75	DL–50	DL–35
635–1660	DL–150	DL–100	DL–75
845–1970	DL–200	DL–150	DL–100
1420–2850	DL–300	DL–250	DL–150
2550–4250	DL–500	DL–300	DL–200
4200–6300	DL–500	DL–400	DL–200
6250–14500	DL–1250	DL–1000	DL–400
13600–21000	DL–1500	DL–1250	DL–500



An Excellent Form of Long Wave Regenerative Receiving Set Is Shown Above, Using the Three Honeycomb Coils, P, S, and T, and the Variable Condensers, VC, for Tuning, in Connection with an Audion Detector. GL Represents the Grid Leak and Condenser; VT the Vacuum Tube, R Rheostat, B "B" Battery, and A "A" Battery. The Letters, G, P, F and F, Around the Vacuum Tube Socket, Designate the Grid, Plate and Filament Connections Found on All Audion Sockets.

In connection with the three coils used in the circuit at one time, you would have to purchase an audion bulb, a grid leak and condenser, an audion socket, a rheostat, a six volt storage battery, two variable condensers with a capacity of .001 M.F., a high voltage "B" battery, and a pair of phones.

Q. 2. Give hook-up of these instruments.

A. 2. The hook-up for this apparatus is given herewith.

Experimental Audion Tubes

(25) H. Edwards, Belmar, N. J., wants to know:

Q. 1. Where he can obtain double filament automobile electric light bulbs, to use in making experimental audion tubes with external grids.

A. 1. We believe that you will be able to purchase two filament automobile head-light bulbs thru any large automobile dealer. These bulbs are at the present time being used as standard equipment on Ford cars.

Aerials

(26) Leo C. Greenburg, S. Boston, Mass., requests:

Q. 1. Data on aerial construction.

A. 1. An aerial should be erected as high above the ground as possible, and approximately 100 feet long. At no place in its length should the aerial touch any objects which might possibly form a circuit to the ground. The two ends of the aerial wire should be suspended by insulators, either from a building, a mast, or a tree. The lead-in is taken from the end nearest the instruments. It is soldered securely to the wire, and run as nearly direct as possible to the receiving set, avoiding any sharp bends.

Farm Lighting Plant for Audions

(27) Harry Maison, Seattle, Wash., asks:

Q. 1. How can I use the current from a 32-volt farm lighting outfit to light the filament of my audion tubes?

A. 1. We would advise you to tap three of the cells of your lighting system to obtain the six volts necessary for the filament of your audion bulbs. If you think that this would be too much of a drain on any particular three cells you could arrange them with a switch so that any three cells could be selected for use at different times.

Amplifying Transformers

(28) Millian Schneider, Detroit, Mich., wants to know:

Q. 1. If an indoor or outdoor aerial would be best for receiving broadcasts from New York City?

A. 1. For receiving the New York stations in Detroit, an outdoor aerial would be by far the best. This, however, need not be cumbersome. A single wire 100 feet long would be as efficient as one with many wires for receiving.

Q. 2. What apparatus he should use for the work?

A. 2. A short wave regenerative set with one step of radio frequency amplification, a detector and two steps of audio frequency amplification, would do this work very well.

Q. 3. Advice on making amplifying transformers.

A. 3. We would advise you to purchase a copy of the book entitled "Design and Construction of Audion Amplifying Transformers" from our Book Department.

Range of Crystal Set

(29) John G. Amdahl, Ossian, Iowa, inquires:

Q. 1. About what is the range of a crystal receiving set for radiophone reception?

A. 1. The approximate range of a crystal receiving set is 25 miles.

Q. 2. What apparatus should I use to receive broadcasts from about 300 miles away?

A. 2. In order to hear broadcast stations within a radius of 300 miles, you would need an audion detector, with two steps of amplification.

Indoor Aerial with Crystal Receiver

(30) Russel Wheeler, Jr., Utica, N. Y.

Q. 1. Can an indoor aerial be used with a crystal detector for receiving a half mile?

A. 1. The indoor aerial could be used for this work.

Q. 2. How should it be erected?

A. 2. This form of aerial should be suspended from the corners of the room, by insulators, and should not at any place touch the woodwork or the walls of the room. A loop aerial could probably be used, and should be as large as could be conveniently handled.

Q. 3. Can a loud talker be used with a crystal detector?

A. 3. Crystal receiving sets do not have a large enough output to operate a loud speaker.

Cunningham Versus UV-200 Audions

(31) Ernest J. Hanson, Lake Worth, Fla., asks:

Q. 1. How does the Cunningham tube compare with a UV-200 vacuum tube?

A. 1. It is impossible to give you the comparison between the tubes about which you ask. We have heard of excellent results obtained with nearly every tube on the market.

Q. 2. Has this tube two filaments?

A. 2. The tubes which you mention are not made with two filaments.

Q. 3. The prongs at the base of my tube are corroded. Does this matter?

A. 3. It would be best to clean the corroded brass parts, as they may form imperfect contacts.

Q. 4. Are Western Electric Company radio phones all right?

A. 4. The phones which you mention are very good.

Q. 5. What kind of "B" battery should I use?

A. 5. A tapped "B" battery is always best, because it enables the operator to adjust the voltage to the requirements of the particular tube he is using.

Q. 6. Will moisture affect the batteries?

A. 6. "B" batteries and storage batteries are both affected to a small extent by moisture. It is best to keep them as dry as possible, on the outside.

Audions on A. C.

(32) John White, Jr., Monticello, Arkansas, asks:

Q. 1. Can a Tesla coil be used for radio transmission?

A. 1. No.

Q. 2. Can I use A. C. for operating my audion tube?

A. 2. We would advise that the July, 1919, issue of the *Electrical Experimenter* contained an article on operating audions on A. C.

Winding a Vario-Coupler

(33) H. V. Truitt & Sons, Huntington, W. Va., asks:

Q. 1. In what direction should a vario coupler be wound?

A. 1. It does not make any difference which way the coils of a vario coupler are wound in relation to each other, because when the rotor is turned one half revolution, the direction of the secondary winding on it will be reversed in relation to that on the primary.

Q. 2. Will the condenser from a high tension coil serve as a grid condenser?

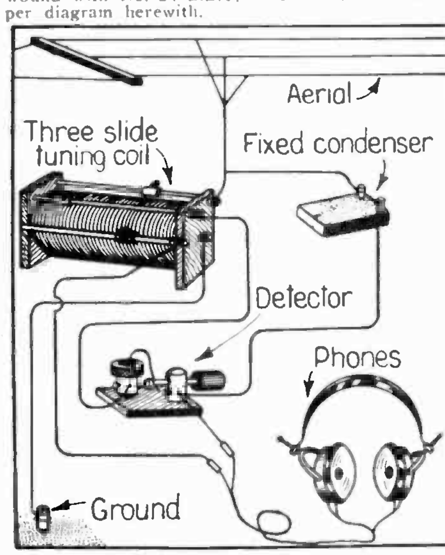
A. 2. The condenser from a high tension coil has too great a capacity and cannot be used as a grid condenser. You had better buy one having a .0005 M.F. to .00025 capacity.

Simple Receiving Set

(34) F. K. Baker, Detroit, Mich., wants:

Q. 1. The data on a simple tuner to use with a crystal detector to tune to 360 meters, the same to be quite selective.

A. 1. Construct a three slide turner approximately 3 inches long by 3 inches in diameter, wound with No. 24 S.S.C. wire and connect it as per diagram herewith.



A Unique Three Slide Tuner Circuit Is Shown Above. This Circuit Has Been Found Very Selective, and Is An Efficient Set for Radiophone Broadcast Reception Within a Radius of 25 to 30 Miles.

Radio Queries

(35) V. F. Holland, Spartansburg, So. Carolina, asks:

Q. 1. What instruments comprise a short wave regenerative tuner and is such a tuner better than one using honeycomb coils?

A. 1. Two variometers and a vario-coupler form a short wave regenerative tuner. We would refer you to the December, 1921 issue of SCIENCE AND INVENTION in which appeared an article on a short wave regenerative tuner by Wm. H. Grace, Jr. This type of tuner is considered to be the best for short wave reception, while the honeycomb coils take the lead for long wave work, and rapid changing of wave lengths.

Q. 2. When using honeycombs is a condenser used across the tickler?

A. 2. Ordinarily there is no condenser used in connection with the tickler coil.

Q. 3. Which combination is best for long distance work, a detector with four steps of audio-frequency amplification, or two steps of radio-frequency amplification, or a detector and two steps of audio-frequency amplification?

A. 3. The latter will be the best combination.

Q. 4. Will amplifiers distort music or speech?

A. 4. There will be no distortion of music or speech with the second of the above mentioned amplifier circuits, providing your circuits are properly tuned and balanced.

Q. 5. Can amplifying transformers be used next to each other without resulting induction?

A. 5. We would advise you to place your audion-amplifying transformers in such a way that their windings are at right angles to each other, and a fair distance apart. Try metal shields over them.

Q. 6. Should a bridging condenser be of fixed or variable capacity?

A. 6. Bridging condensers are usually of the fixed variable type, that is, there are several fixed condensers, any one or more of which may be placed in the circuit by means of a switch.

Q. 7. What is the correct capacity in microfarads of the following condensers: primary, secondary, grid and bridging condensers?

A. 7. The capacity of the primary condenser should be .001 M. F., of the secondary .001 M.F. of the grid .0005 to .00025 M.F., and of the bridging condenser, variable to .015 M.F.

Q. 8. What is the resistance of phones for radio reception?

A. 8. Phones for radio reception are generally made in different resistances from 2,000 to 3,000 ohms. Exceptionally, phones having a resistance of 10,000 ohms have been employed. Not much is gained by windings of this high resistance.

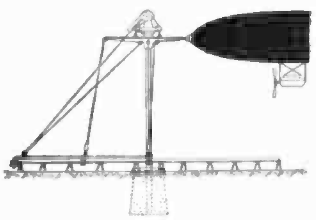
LATEST PATENTS

PATENT OFFICE WASHINGTON

Mooring Means for Dirigibles

(No. 1,413,948 issued to Emanuel Salomon Ullman)

This is a mooring device for privately owned dirigibles, the old

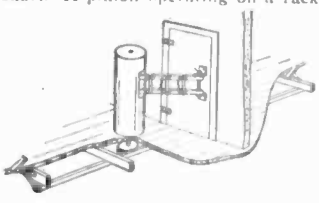


style masts being impractical as the guy cables may injure the craft. The mast itself is of any suitable height or diameter, rigidly mounted in a concrete base, and fitted at the top with a Y arm, a thrust collar, and a ball race. Around the mast and raised several inches above the ground is a track. Rollers are secured to a frame, which moves freely upon the track and is held down by the track against the pull of guys. The guys in question are connected to the Y arm; consequently regardless of the shifting winds, the stays are always in a position to take up the greatest strain.

Door Opening Device

(No. 1,413,642 issued to William P. White)

This rather unique appliance is installed a short distance from the door opposite to the hinged side. On the floor a stationary cylindrical casting fitted with a side opening is mounted upon a vertical shaft. A pinion operating on a rack

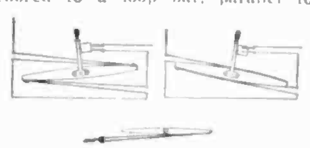


bar, which rack bar is actuated by two foot pedals extending downwardly thru the floor is supported from the floor joists. The device is likewise fitted with springs so that very heavy doors will have most of their weight taken up by the spring action. After this appliance is set up one can press the pedal and open the door, and after having gone on thru the doorway by again pressing the other pedal, the movement of the rack in the opposite direction closes the door.

Rheostat

(No. 1,411,901 issued to Edward M. Bentley)

A rather characteristic rheostat is shown herewith. In one form of the device, the resistance takes on the form of a ribbon, the top of each loop is connected to the upper or lower edge of a presser plate, which is carried by trunnions and has its side curved or arched. The opposite ends of the loops are anchored to a loop bar, parallel to

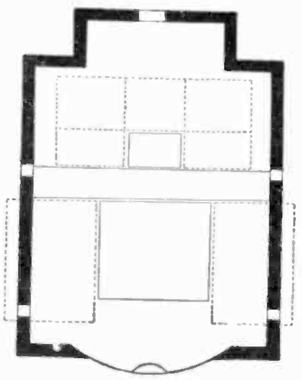


the axis of the plate. This loop bar is connected by springs to any suitable holder, and these springs tend to draw the loops taut. By shifting the rheostat, the two flat ribbons are brought face to face in contact with each other, being progressively opened or closed as the loop bar is shifted. The conductance of the loops is further increased at their divergent ends by increasing the thickness of the material of which they are composed.

Dropping Scene

(No. 1,404,919 issued to Dragutin Zabaratz)

The stage proper is shown in the illustration. The square solid-line block in the center indicates where the action takes place during the play. This space as well as the smaller one back of it may be moved freely up and down, being constructed in the form of an elevator. In the cellar, on either side of the large elevator shaft large chambers are located. In these, subsequent scenes are laid out upon movable platforms so that they may be shifted to the elevator, and

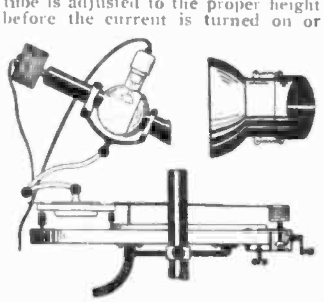


raised to the proper position on the stage. The small stage is also arranged in a similar manner, and smaller settings are lifted on that stage and lowered again when desired; being likewise mounted on rollers they may be pushed to the front of the platform while another large scene is being prepared.

Panoramic X-Ray Apparatus for Dental Radiographs

(No. 1,408,559 issued to Alvin Frank Zulauf)

An X-ray tube is mounted upon a U shaped track and its movement around this track is controlled by two wheels operated by a crank. The patient sits in a chair and the tube is adjusted to the proper height before the current is turned on or

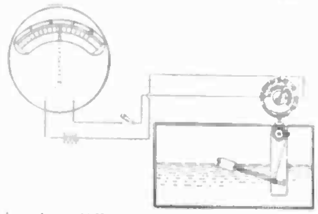


the tube shifted. Two films of a peculiar cut shape are then placed in the patient's mouth. These films are backed by lead so that there will be no danger of fogging the film on the side of the mouth opposite to the tube. The entire film pack is also covered with a moisture proof protector to prevent action of the saliva upon the film. When all is in readiness, the current is turned on, and the tube slowly shifted around the track to produce a panoramic view of the teeth on one film. The tube itself permits the passage only of a thin ray inasmuch as it is covered on the outside by a lead covering thru which a vertical slit has been made.

Indicator for Gasoline

(No. 1,406,312 issued to Shelden M. Wessoleck)

There are many draw-backs to gasoline indicators of the nature described herewith. One of these

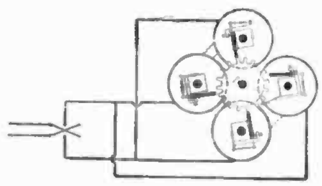


is the difficulty of maintaining a constant voltage in the battery, necessitated in this system; another is the fact that wires may become loose, due to the vibration of the automobile, and if but slightly loosened will increase the resistance of the circuit giving an erroneous record. The inventor proposes to insert an arm into the gasoline tank which has a float member attached to it. A lever connects to this float member, at one end, rotating a gear; with which it is connected at the other end. This gear in turn transmits its movement to a second gear, connected directly to the sliding contact arm of a rheostat. A suitable current meter graduated in this system to show the amount of gasoline in the tank is placed upon the dashboard of the automobile, and wires connected thereto thru a switch and battery enable the amount of gas in the tank to be read at the dash.

Electric Motor

(No. 1,405,502 issued to Lee L. Dodds)

This motor possesses the advan-

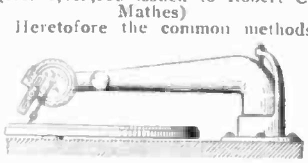


tage of having but a very short air-gap, and is susceptible of a step by step operation. Its particular use is for driving secondary clocks or stock tickers. In this device the inventor employs a bolt-shaped permanent magnet for maintaining a constant magnetic field. The armature has a longitudinal slotted periphery. To each pole-piece a secondary armature is pivoted. This is maintained at a definite space relation with the pole-piece by a spring. The secondary armature is likewise limited in movement by an adjustable stop-screw. Electromagnets surround the pole-pieces. If any source of alternating current is now passed thru the coils at one moment the current will amplify the magnetic properties of the pole, and since the polarity of the upper ends of these cores is then different from the polarity of the armature, an attraction will be set up.

Phonograph Tone Control

(No. 1,409,388 issued to Robert C. Mathes)

Heretofore the common methods

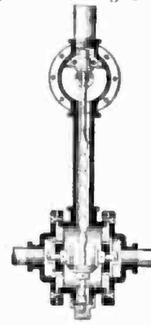


for changing the volume of tone in a phonograph consisted in constricting the cross-sectional area of the horn or interposing shutters at some point in the horn. The inevitable result of such methods was an alteration of the tone. In this invention, however, a sound modifier is attached to the sound-box of the phonograph. This consists of a support-arm and a slide-way in which slide-way an adjustable slide is mounted. This slide is retained in any position desired by means of a thumb-screw. The stylus-lever passes thru an extension of the slide, thus permitting the slide to act as the fulcrum. Thus, by changing the position of the fulcrum, the sound is modified.

Thermostatic Device

(No. 1,408,122 issued to Paul Mirk)

The illustration of this thermostatic device shows at the foot two tubes supplying hot and cold water. These tubes communicate with a casing perforated by a number of holes, which holes may be closed by the turning of a disc on

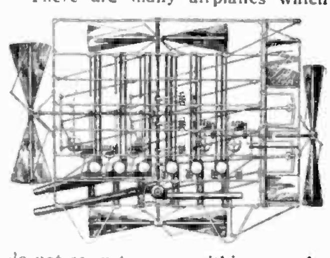


either side. This casing connects with another casing above, and with the outlet pipe at the very top of the apparatus. The water, in its course of flow, passes thru this communicating tube and is thoroly mixed. At the same time its temperature affects the spiral tube-like member in the center, which is merely a flattened pipe filled with kerosene or other similar liquid. By turning a thumb-nut located outside of the upper casing, the valves are shifted, permitting the passage of water. The flattened pipe, due to its contraction and expansion, maintains a constant temperature by its shifting valve effect, closing one of the valves and opening the other, and vice versa.

Flying Machine

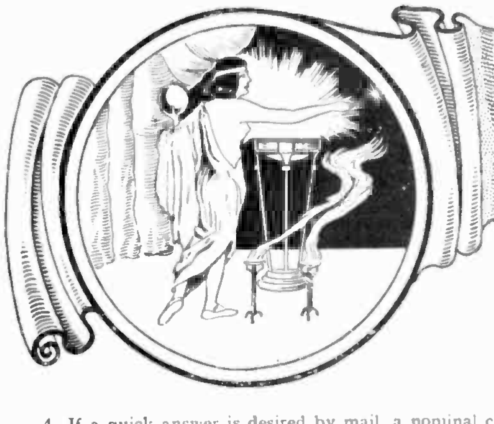
(No. 1,408,918 issued to Israel Williams)

There are many airplanes which



do not seem to come within even the limits of plausibility, whose construction would be so costly and whose rising possibilities so slight that it is doubtful if they would ever be built. This statement, we fear, holds true for the invention here disclosed. Aside from the helicopter designs, the inventor employs a number of fans or blowers supported on a swinging frame. Intake tubes extend upward thru the deck and discharge pipes terminating at the rear end of the machine, permit air to be taken in from the upper part of the machine and discharged with sufficient force to assist in propelling the machine forward by the reaction of the air. This causes a counter-acting effort which may be transmitted to the forward end of the machine. Other blowers discharge air downward so as to assist the machine in rising.

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 publisht. Rules under which questions will be answered:

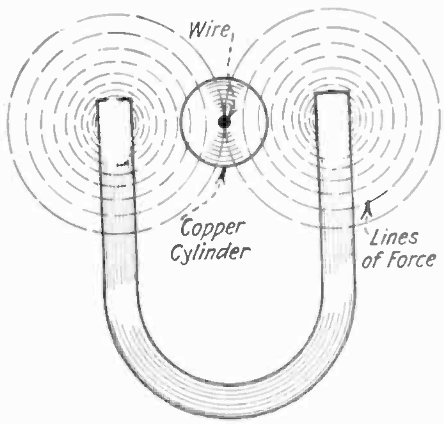
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail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

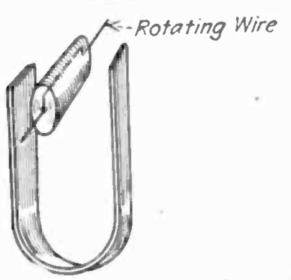
Magnetic Lines of Force

(1242) H. T. Borrabaux, Calexico, Cal., wants to know:

Q. 1. If a copper cylinder is introduced into the magnetic field between the poles of a magnet, will the lines of force penetrate therein?

A. 1. When a copper cylinder is moved between





To Prove That the Lines of Force About a Magnet Penetrate a Copper Cylinder, Pass a Wire Thru the Latter, and Connect the Ends to a Galvanometer. By Moving the Wire at Right Angles to the Lines of Force, a Slight Electromotive Force Will Be Induced Therein, Due to the Cutting of the Magnetic Lines.

the two poles of a magnet in such a way as to cut the magnetic lines of force, these lines of force will penetrate thru the interior of the cylinder. This may be shown as follows: An insulated wire is passed thru the cylinder, and the cylinder is rotated in the field of force. An electro-motive-force will be induced in that wire just as if the copper cylinder were not present. The resulting current will be so small, of course, that it will be necessary to use a galvanometer to detect it.

Bleaching Straw

(1243) Harry Fekas, Roanoke, Va., requests:

Q. 1. Several Formulae for the bleaching of straw.

A. 1. We are giving you herewith two formulae for the bleaching of straw.

No. 1. Dip the straw in a solution of oxygenated muriatic acid, saturated with potash. The straw is thus rendered very white, and its flexibility is increased.

No. 2. Wash the straw thoroughly in pure water and place in a closed chamber in which sulphur is being burned. The sulphur fumes acting upon the water forms sulphurous acid, which bleaches the straw.

Making Matches

(1244) Wilbert Ruck, Wahoo, Nebraska, writes the Oracle for:

Q. 1. Information on the making of both *safety* and *ordinary* matches, together with the formulæ of the chemicals used.

A. 1. We are giving you herewith the formulæ you requested. The splints used are first dipped in a solution of ammonium phosphate, (2% of this salt with 1% to 1½% of phosphoric acid, or ammonium sulphate, 2½%), then drained and dried. This is to prevent an after-glow. The splints are next dipped into a paraffin or stearin bath, and after that into the match bath proper. A formula for *ordinary* matches is as follows:

The mixture into which the splints are first dipped.

Potassium Chlorate	6 parts
Antimony Sulphide	2 "
Gum Arabic	1½ "
Powdered clay	1½ "

The very tips of the matches are then dipped into the following compound:

Potassium Chlorate	2 to 3 parts
Amorphous phosphorus	6 "
Gum Arabic	1½ "
Aniline	1½ "

This is the mixture which ignites by friction and is set on fire by friction on a rough surface.

Safety Matches

Dip the ends of the splints into a mixture of:

Potassium Chlorate	6 parts
Antimony Sulphide	2 to 3 "
Glue	1 "

On the side of the box which has been made rough by a coating of glue and sand, spread a mixture of:

Amorphous phosphorus	10 parts
Antimony Sulphide or Manganese dioxide	8 "
Glue	3 to 6 "

The reason for dividing the ingredients is to prevent combustion by accidental friction, as neither the mixture on the splint nor that on the box could be ignited separately by rubbing on an unprepared surface. Again, by using the amorphous phosphorus, the danger of poisoning is entirely prevented.

In mixing these compounds, great care must be taken to prevent accidental ignition.

Can Water Be Used to Polish Lenses?

(1245) H. E. Erickson, Grandy, Minn., asks:

Q. 1. Since water, flowing over Niagara Falls, polishes the rocks, could not this same force be used to polish telescope lenses?

A. 1. Water, to the best of our knowledge, has never been used for polishing telescopic lenses and frankly, we do not believe that it could be so employed. You must remember that the water which flows over Niagara Falls has taken thousands of years to wear out the bed rock, and a lens maker could not wait a thousand years to polish his product, which even then might be defective, due to the fact that the stream of water would hardly wear evenly over the entire surface of the lens.

Q. 2. Will bed-rock be found all over the world, even in sandy deserts?

A. 2. It is quite probable that bed rock may be found all over the world, as borings in the various deserts indicate rock at great depths. This would seem to be a natural finding in view of the tons of earth material which are constantly compressing the lower layers of the earth strata.

Composition for Constructing an Electric Heater

(1246) J. H. Hilmer, Grand Rapids, Mich., writes:

Q. 1. Give formula for mixing the compound used in making the body of an electric furnace.

A. 1. A quantity of clay is placed upon a table or smooth slab, and to this about one half its bulk of asbestos is added. The two dry substances are then mixed, and water glass added sufficient to make the consistency that of a paste. Asbestos is used to hold the clay together.

The Gyroscopic Compass

(1247) Chas. F. Strobel, Ridgewood, N. J., wishes to know:

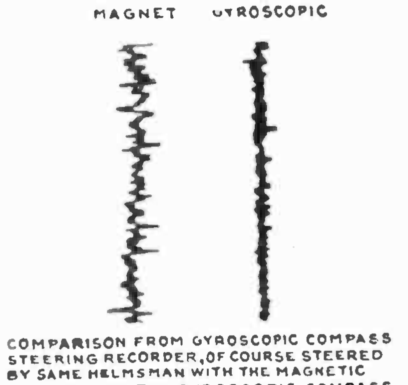
Q. 1. What is the principle of the gyroscopic compass?

A. 1. It was discovered by prominent scientists that when a small rotating wheel, properly supported, is placed upon a larger one, also in a state of rotation, the rotation of the larger wheel would so influence the smaller that the axis of the latter would point in the same direction as the axis of the larger wheel. This principle was applied to the gyroscopic compass, assuming that the earth rotating upon its axis is the larger wheel, and the compass as the smaller wheel, the result will be that the axis of the latter will fall in the same plane as the earth's axis, (larger wheel) which will, of course, be due north and south.

Q. 2. How does the efficiency of the gyroscopic compass compare with that of the magnetic compass?

A. 2. The efficiency of the gyroscopic compass is much greater than that of the magnetic compass. There are many factors which influence the magnetic compass, but which will have no effect on the gyroscopic type. For instance, the magnetic needle will be affected by steel and iron which is used in the construction of the ship, but these will have no effect on the gyroscopic compass. Also, steering is much more accurate when the latter is used, and it has been found that a steamer, when using the gyroscopic compass, made a trip from New York to Mata Redonda seven miles shorter than ever previously attained, which as may be seen, affected a certain saving in fuel consumed.

We give, herewith, a chart showing the comparison between a course steered by a magnetic compass, and one steered by the gyroscopic compass for a two hour period in each instance.



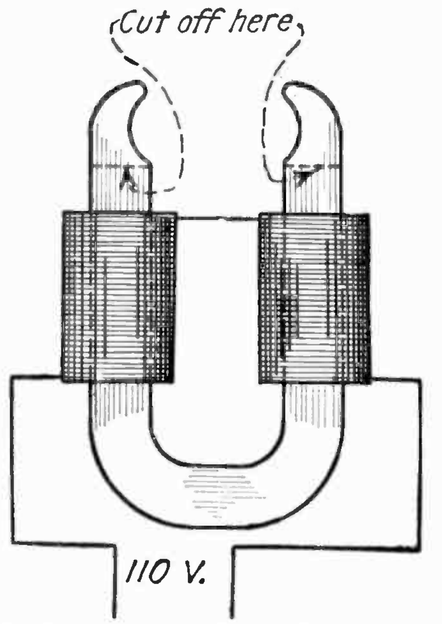
These Graphs Show How Much More Accurate a Gyroscopic Compass Is Than a Magnetic Compass.

How to Make a "Growler"

(1248) J. J. DeMurier, Houston, Texas, wants to know:

Q. 1. How to make an armature "growler", or tester.

A. 1. The easiest and simplest way to construct an armature growler is as follows: Obtain a small 110 volt fan motor, cut off the pole pieces just above the windings, as shown in the accom-



This Illustration Shows How to Make an Armature Testing Growler from the Field Coils of an Old 110 Volt Fan Motor. The Ends of the Poles Are Cut Off on the Dotted Lines.

panying cut, and connect the field winding to the 110 volt A.C. line. By placing the faces of the field magnets from which the ends were cut off, against the armature to be tested, you will be able to test the winding on each pole by connecting a 75 ohm receiver from pole to pole of the commutator, or using a lamp instead of the receiver, dependent upon the size of the coil.

Bluing a Gun Barrel

(1249) R. C. Hager, Watsonville, Cal., requests:

Q. 1. A formula for bluing a gun barrel.

A. 1. Mix together:

25 parts of trichloride of antimony
25 parts of fuming nitric acid
50 parts of hydrochloric acid

Very great care should be exercised in mixing the acids to prevent spattering.

Tie a rag to a stick, and apply the mixture freely. After rubbing with a flannel, it may be polished with a green oak wheel on a polishing head until a clear, even blue is obtained.

Polarized Light

(1250) Benjamin Landis, Newark, N. J., asks:

Q. 1. If a plane polarized beam of light is passed thru a converging or diverging lens, will the light, after passing thru the lens, still be plane polarized, or will it be changed to elliptically polarized light; also, if the light is originally white, will its color change?

A. 1. The polarized beam of light will not be affected to any great extent by either converging or diverging lenses. If the lenses are of good quality, the light passing thru should retain its original plane of polarity and tho the brilliancy may be affected, in one case being increased and concentrated, and in the other decreased and dispersed, its polarity should not be changed.

A Question of Velocity

(1251) Arthur Meyers, Rochester, N. Y., asks:

Q. 1. If a ball is dropped from a balloon traveling upward at a rate of 16 feet per second, where will the ball be one second after it is dropped.

A. 1. If a ball is dropped from a balloon which is traveling upward at a rate of sixteen feet per second, at the end of the first second after it is released, the ball will be practically in the same position as where it was when released, in relation to the earth. The reason for this is that the ball after being released will have to overcome the momentum derived from the speed of the balloon, before it can start traveling down. Since the balloon is traveling upward at the rate of sixteen feet per second, and the velocity of falling objects is sixteen feet per second in the first second, the ball will travel upward for a period of one half second, at the end of which time it will start falling, and in one half second more will be in the same position as it was when released from the balloon.

Silver Plating Without Electricity

(1252) Jas. A. Butler, Wheeling, W. Va., asks:

Q. 1. Give me the formulas for silver plating steel and copper without the use of electricity.

A. 1. Herewith is the formula you request.

SILVER PLATING STEEL

Lunar caustic (fused silver nitrate in stick)	11 parts
Sodium hyposulphite	24 "
Sal Ammoniac	12 "
Whiting	20 "
Distilled water	200 "

Mix well together, and apply by rubbing. Be sure the article to be plated is free from all grease and dirt.

SILVER PLATING COPPER

Add to a solution of silver nitrate ($AgNO_3$) enough ammonium chloride NH_4Cl to bring about precipitation, cream to a light paste by adding cream of tartar ($HKC_4H_4O_6$). A little of this paste rubbed on clean metal with a soft cloth will give the desired effect, a thin coat of silver.

Re-charging Dry Cells

(1253) C. Lloyde Ramsey, Cincinnati, Ohio, requests:

Q. 1. A method of re-charging dry cells.

A. 1. At various times in the past there have been described in SCIENCE AND INVENTION methods of re-charging dry batteries. Of course it must be understood that these methods will practically never bring a dry battery up to its former standard. One of the simplest methods is to drill holes thru the zinc cup on the outside of the battery, and soak the whole battery in a strong solution of ordinary table salt, or sal-ammoniac. Another method is to drill holes thru the sealing compound on the top of the battery, and pour in a strong solution of salt or sal-ammoniac, until the entire interior of the battery becomes saturated, and will hold no more of the solution. The batteries will then be found to have recovered some of their strength.

Electrotyping and Buoyancy

(1254) D. Adams, Brooklyn, N. Y., states:

Q. 1. Please give the directions for preparing articles for electrotyping and the formula for mixing the electrotyping bath.

A. 1. The article to be used in electrotyping is first given two coats of commercial electrotyper's varnish. When this has dried, dust the surface carefully with finely ground graphite or plumbago, smoothing the surface with a soft-haired brush. This article is then hung in a regular copper-plating bath made as follows:

Water	1 gal.
Copper sulphate	5 ozs.
Sulphuric acid	1 oz.

A potential of one to one and half volts is used.

Q. 2. Will the buoyancy of a steel tank be increased by inflating it with air.

A. 2. The buoyancy of steel tanks if inflated with air will be decreased a minute fraction. This does not increase the buoyancy in any manner whatever, but decreases the same. This is due primarily to the fact that an increase in air pressure also increases the weight of the air in the tank.

If all the air is exhausted from the tank, then the buoyancy will increase very slightly. Such an increase is not even worth bothering about.

A Paper Hydrometer

(1255) James Fuller, Detroit, Mich., inquires:

Q. 1. What materials to use in making a paper hydrometer.

A. 1. Coat blotting paper with a very thin glue or gelatine solution. Sprinkle the surface with Cobalt chloride solution and roll the surface with an ordinary photographic print roller.

One Vacuum Tube on a Loud Talker?

(1256) Jack Glasser, Brooklyn, N. Y., inquires:

Q. 1. If he can use a loud talker on one vacuum tube?

A. 1. You will not be able to operate a loud talker from a single vacuum tube detector satisfactorily.

Q. 2. Can I receive KDKA with one audion?

A. 2. If you have a very selective receiving set, and tune the same very accurately, adjusting the filament and plate voltages carefully at the same time, you should be able to hear KDKA. (Pittsburg.)

Q. 3. How he should mount an audion set on a panel.

A. 3. We would advise you to look over the illustrations in catalogs put out by the various manufacturers of radio apparatus, and select a mounting to suit your taste. You can then purchase a panel and cabinet, and mount the instruments according to your choice.

Properties of an Expanding Spring

(1257) Max Blumberg, Philadelphia, Pa., wants to know:

Q. 1. How fast does a compressed spring expand when released suddenly.

A. 1. A compressed spring when permitted to expand by releasing the pressure suddenly does not extend itself at any definite speed. Its speed depends entirely upon circumstances, conditions, the structure of the spring, the nature of the material of the spring, the thickness of the spring, the temperature, etc., etc.

Q. 2. When does it have the greatest velocity of expansion?

A. 2. At no time could a definite speed for any given spring be calculated. The greatest velocity in its expansion is intermediate between the beginning and the end of its movement. Exactly where that position is, cannot be definitely determined either. In other words, its velocity starts at nothing, increases gradually to a maximum, and then decreases again to nothing.

Making Paper Fire and Water-Proof

(1258) C. S. Strauber, Wellsville, Missouri, asks:

Q. 1. For a way in which to water-proof paper so that writing may be washed from it and the paper written on again.

A. 1. The best method to water-proof paper, is to prime the paper with glue to which finely powdered chalk, zinc white, lime or heavy spar has been added, as well as the desired coloring matter for the paper. Next, the paper is coated with soluble glass (sodium or potassium silicate), or dipped into this solution which has had added to it a very small amount of magnesia. It is then dried for ten days at a temperature of 87 degrees F. This paper may be written upon in ink, washed twenty or more times, removing the ink each time, and yet leaving the paper in a condition in which it can be worked upon again.

Q. 2. Give a method of fire-proofing paper.

A. 2. Sodium silicate, two parts; Spanish white, 1 part; and glue two parts by weight makes a very good fire-proofing composition, as will the following: Two to four parts of solution of potassium carbonate is added to one to two parts of ammonium borate in twenty-five parts of water.

Producing Hydrogen and Oxygen Chemically

(1259) Jerome Suhre, Brooksville, Indiana, requests:

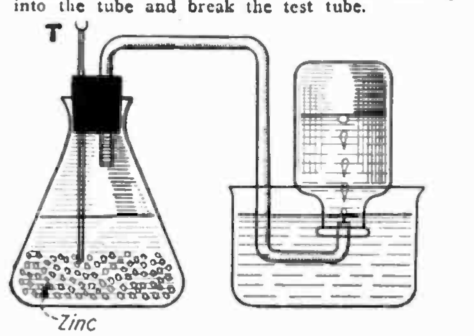
Q. 1. A way in which to produce oxygen and hydrogen without using electricity.

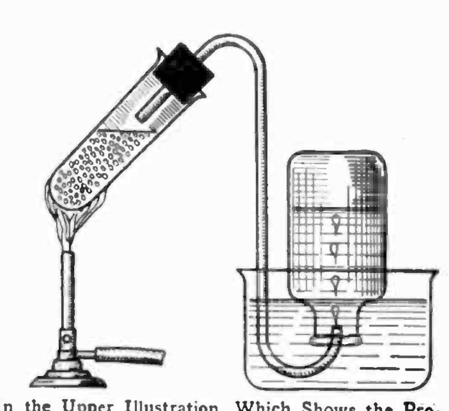
A. 1. Hydrogen may be produced as follows: In a Erlenmeyer flask or in a Florence flask, drop some lumps of zinc. Close the mouth of the flask with a double hole stopper, thru one hole of which, a delivery pipe passes, and into the other hole is inserted a thistle tube. Pour in enough water to bring the level in the flask above the lower end of the thistle tube. Add slowly, via the thistle tube, some dilute sulphuric acid.

Allow the gas to bubble out under water for about half a minute, and then collect by the water displacement method.

Oxygen may be produced as follows: In a test tube, or flask introduce equal parts of potassium chlorate crystallized, and manganese dioxide. Fit the flask with a one hole stopper and delivery tube. Heat with a Bunsen flame, and collect the gas given off by the water displacement method.

At no time in this operation remove the flame from under the flask, leaving the delivery tube under water; otherwise the water will back up into the tube and break the test tube.





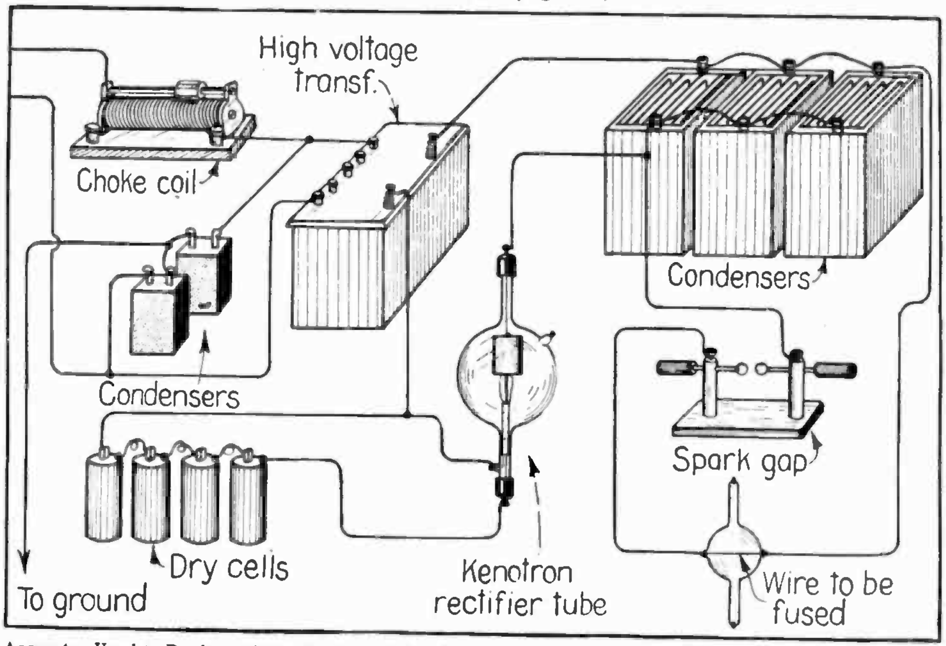
In the Upper Illustration, Which Shows the Production of Hydrogen Chemically, Sulphuric Acid Is Poured Thru a Thistle Tube "T" into an Erlenmeyer Flask, Which Contains Zinc Covered with Water.

In the Lower Illustration a Method Is Shown for Producing Oxygen by Heating a Mixture of Potassium Chlorate and Manganese Dioxide.

40,000 Degrees of Heat!

By GERALD L. WENDT

(Continued from page 226)



Apparatus Used to Produce 40,000 Degrees Fahrenheit, and Change Tungsten Into Helium. The Transformer Developed 100,000 Volts. One High Voltage Lead Passes Thru the Kenotron Rectifier and Both Then Pass Up To the Discharge Circuit Containing the Spark Gap and the Wire to Be Exploded Which is Within the Small Glass Bulb Shown at the Bottom. The Leads Enter the Latter at the Sides. The Small Tube Attached at the Top is the Spectroscope Tube, in Which the Spectrum of the Gases Produced is Observed. The Large Tube Protruding at the Bottom is Merely the Neck at Which the Bulb was Sealed Off From the Pump System After It Had Been Evacuated. This is the Apparatus as Now Set Up in the Chemical Laboratory of Iowa State College at Ames, Iowa, Where Mr. Clarence E. Irion and Prof. Anson Hayes are Continuing the Experiments Described in the Paper Herewith.

the secondary circuit and produce the explosion in the wire H. when the voltage has built up to the desired value in the condenser.

The explosions were studied by two methods. In one the bulb containing the tungsten wire was thoroly exhausted by the best available pumps with the help of cocoanut charcoal cooled by liquid air. Evacuation was pressed to a point where no current would pass between electrodes in a spectroscopic side tube. The wire was then exploded and the spectrum of the gases produced was examined in the side tube. The bright yellow line of helium was easily visible and there were fainter lines which seemed to be nitrogen and some evidence of the strongest line of mercury, probably from mercury vapor that had diffused back from the pumps. In the second method the explosion was produced in pure carbon dioxide gas at atmospheric pressure. After the explosion the gas was driven into a tube filled with concentrated potassium hydroxide solution in which the carbon dioxide was completely absorbed, leaving as a residue the gas produced by the explosion. This averages one cubic centimeter in volume, produced from a wire weighing 0.0005 gram. If the gas was all helium this corresponds to the conversion of about half the tungsten into helium. No complete analysis of the gas has yet been made, however. Special tests were made to prove that the gas was not a mixture of carbon monoxide and oxygen produced by the explosion from the carbon dioxide which filled the bulb.

Only a very preliminary report is possible on this work at the present time. The experiments are being continued at the Iowa State College at Ames, Iowa, by Mr. Irion and Professor Anson Hayes. Enough results have been obtained, however, to show that helium is at least one of the products obtainable from tungsten, that our elements are not as permanent and immutable as we once supposed, and that research at these extreme temperatures will teach us a good deal more about the atom. Transmutation, that is the voluntary synthesis of any atomic species from simpler units, is still a very long way off.

New Home Movie Projector

The family room becomes more and more interesting. Perhaps within a few years there'll not be a solitary excuse left for going out evenings. The player piano, phonograph and radio set being quite firmly established, now comes a portable cinematograph projector—one that weighs sixteen pounds and flashes on a screen five by eight feet in dimensions a photoplay about 300 feet in film length, lasting anywhere from five to fifteen minutes.

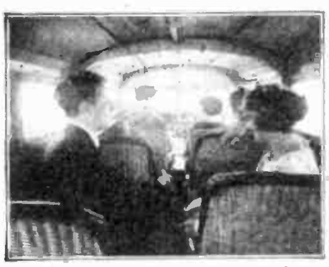
Herbert G. Ponting, an English photographer who was a member of the Scott Antarctic expedition, is telling the English all about his new machine. He declares it will bring motion pictures into the home, and that sooner or later plays made especially for his kind of apparatus will be filmed by reputable concerns and placed on the market after the fashion of music rolls and phonograph records.

The "Kinatome," which is the name Mr. Ponting has selected, is contained in a wooden case measuring 12x9x16 inches, which holds the projecting mechanism, optical and lighting systems, motor and ventilating fans.

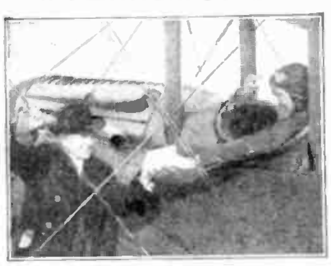
Go as High as You Like
No Limit to Salaries in Aviation

No other industry offers the wonderful chances for big money-making that the Airplane Industry offers to ambitious men. Many more trained men will be needed to fill big paying jobs. The airplane has come to stay—it will soon be a part of our everyday life. The men who get in now are the ones that will cash in big. Look at the "big fellows" in the automobile game today. They represent power and wealth because they got in early—you can do the same in Aviation and you have an advantage because you can be trained before you start.

Delivering Newspaper "Extras" by Airplane



A New Seven-Passenger Airplane



A New Job—The Aerial Postman

View in an Airplane Factory

Thousands of Airplane Mechanics Will Be Needed

The airplane industry is going forward by leaps and bounds. Transportation—passenger carrying and mail carrying lines are being opened up everywhere. This means men—men—men! Trained men only are wanted—men who know what's what. Get ready now to make big money. The industry is calling for real red-blooded fellows—heed the call—*now* is the time to get started—while the industry is still in its infancy.

Here Are a Few Jobs That Will Pay $50.00 to $250.00 a Week:

Aeronautical Instructor, Aeronautical Engineer, Aeronautical Contractor, Airplane Repairman, Airplane Mechanician, Airplane Inspector, Airplane Salesman, Airplane Assembler, Airplane Builder

Learn at Home In Your Spare Time

Keep right on with the work you are doing now. A little of your spare time is all you need. Our Special Course is simplified for home instruction and is endorsed by airplane manufacturers, aeronautical experts, aviators and the leading aero clubs. Any man who can read English can understand it. The Lessons are self-explanatory and are made plain as day with Blueprints, Diagrams, etc. Our Advisory Council and Instructors are behind you all the time giving you everything you must know. The entire field of Practical Aeronautics and Science of Aviation is laid right before your eyes. You are bound to succeed with this training. This means for you a man's size job with a man's size pay.

Big Book of Opportunities FREE!

Send for our big free book showing just what is going on in the Airplane Industry. It also shows what other men have done in this fascinating field and what you can do, too. It gives a list of some large manufacturers and dealers in airplanes and some of the jobs that are open to trained men. With the book we will send you a special offer that you will be glad to know about. This special offer may be withdrawn at any time without notice. *Send the coupon now and take advantage of this offer.*

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Address..

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

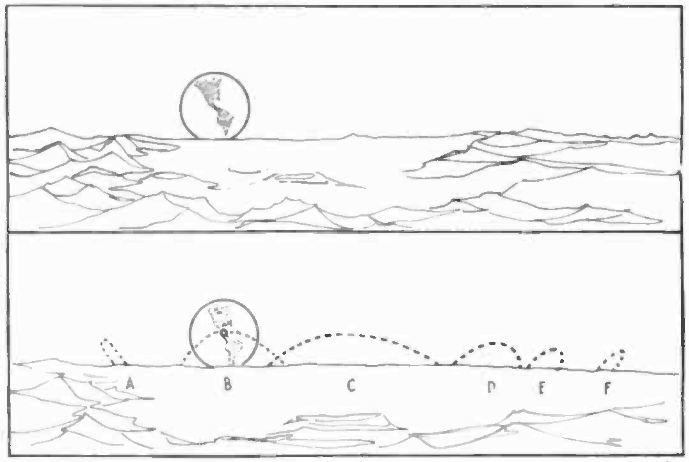
Popular Astronomy

By ISABEL M. LEWIS, M. A.

(Continued from page 231)

new earth—or as it appears to us from full moon to full moon.

In the course of a month the position of the moon with respect to the earth's equator changes very greatly. The earth's equator is, as we all know, inclined 23½° to the plane of the earth's orbit. The moon's orbit is also inclined about 5° to the plane of the earth's orbit. As a result the moon in its monthly circuit of the heavens may pass at a maximum from a point 28½° (23½° plus 5°) south of the earth's equator to a point 28½° north of the earth's equator. This has a very great effect upon the appearance of the earth-disk as viewed from the moon. When the moon is 28½° south of the equator it is in the zenith for an observer on the earth in that latitude. An observer on the moon would then see a point in 28½° south latitude in the center of the earth-disk. He would see 28½° beyond the south pole of the earth and his line of vision would fall 28½° short of the north pole of the earth. When the moon had passed in the course of two weeks to a point 28½° north of the celestial equator, the lunar observer would see a point in 28½° north latitude in the center of the earth-disk. He would then see 28½° beyond the north pole of the earth and the south polar regions would be invisible to him. When the moon is midway between these two positions the earth's equator would be in the center of the disk and the lunar observer would then see both poles of the earth equally well. In one month the lunar observer would view different portions of the earth's surface from widely different angles and have an excellent opportunity to study every part of the surface of our planet. He would be presented with a constantly changing panorama of continents and seas, lakes and islands, polar caps and tropical vegetation, such as is never granted to the terrestrial observer of the moon. Owing to the fact that the moon always keeps the same face turned toward the earth we always see the same lunar features stationary upon the lunar disk, except for the slight change in position with respect to the center of the lunar disk, due to the librations of which we have spoken.



Our First Illustration Shows the Earth on the Lunar Horizon Between Earthrise and Earthset.

The Second Illustration Shows Various Motions of the Earth on the Lunar Horizon. Naturally These Various Paths are not Exactly the Same for Any Lunar Horizon, but Change as to Locality.

If our lunar observer could have at his command one of our greatest telescopes, he might in effect bring our planet within a distance of sixty miles or so of the moon. He would then view our planet piecemeal, as it were, for only a portion of the earth's surface a few hundred miles in extent would be within the field of view of the telescope at one time. Our atmosphere would of course be as troublesome to the lunar observer as it is to our astronomers in observing the moon. Imagine how the earth would appear to an observer in an airplane at an elevation of sixty miles above the earth's surface and one has some idea of the appearance of the earth as viewed from the moon with one of our greatest telescopes.

Since we have no difficulty in detecting lunar markings a mile or so in diameter with such a telescope our observer on the moon would soon be in possession of a fund of knowledge regarding this planet of ours; in some respects he would know even more about our planet than we know ourselves. He would doubtless puzzle over our cities, those peculiar small markings that dot the earth's surface so plentifully in certain regions, and over the delicate lines that are visible in great numbers and that always lead to our seas—our large rivers. These are but one or two of the many problems with which the lunar observer of the earth's surface would be confronted.

With the exception of the splendor of Saturn and its rings as viewed from one of its satellites, or giant Jupiter in the sky of his historic moons, the solar system offers no more inspiring sight than would be afforded by a view of our planet earth from its lone satellite, the moon.

The Future of the Inventor

By H. GERNSBACK

(Continued from page 225)

whose object it is to give to the world worth-while inventions and put them in a position for protection for the benefit of the inventor. In the future, however, we must go one step further and the Patent Office must be supplemented by an *Inventions Office*, if I may use such a term. Broadly speaking, the Inventions Office should be a direct adjunct to the Patent Office. To-day when the inventor obtains his patent, the Patent Office is no longer interested in the invention. Once the patent is issued, the Patent Office stops right there.

Let us now see what happens. The inventor, who, as a rule, is poor or without means, tries to interest some one in his invention, but nine times out of ten he does not succeed. Often he does not have the money to develop the invention himself and frequently he dies of a broken heart, for the reason that he has not been able to realize the fruits of his labor. In that case the world has lost a man who might have enriched it by untold thousands. Can you imagine such a thing in the future?

The course of a patent, providing it is worthy, will be somewhat as follows. The future Inventions Office, who has a board of experts, picks out each week the latest patents that it thinks worthy of consideration. Design patents and those which are only slight improvements over existing devices will be disregarded by the Inventions Office. The board will probably select each week two or three hundred worth-while patents and will immediately begin making models of them. The inventor himself will be called in to confer and will be given a temporary place in the government workshop, if he cares to accept it, where he will see to it that his invention will be developed according to his own ideas. He will be given every opportunity to carry out his ideas and not only that, but experts will be at hand to correct faulty ideas, which every inventor has, as a rule. We all know that the inventor's first model is exceedingly crude. Sometimes six or seven or more models must be made before the correct design is evolved. That is because the average inventor is not trained sufficiently, and this is where the Inventions Office will prove its worth. The first model turned out will probably be perfect, because it will be worked all thru the blueprint stage before the actual structure is made.

The new Inventions Office will be a great source of income to the government. At the present time probably 999 patents out of 1,000 are never worked, for the reasons suggested above. Once the Inventions Office takes hold of the patent and invention situation, really worth-while inventions will be developed without any trouble. All will be conducted in a regular routine. Then it will be simple for the government to exact a moderate yearly tax from the working of such a patent, which could be enacted by law, and to which no manufacturer would have the slightest objection. This tax would more than defray the expenses of the Inventions Office. It would be a new source of revenue for the government, and would make every inventor happy.

It seems to me that our inventors and business men should get together and develop some plan where such an Inventions Office could be brought into being. It would enrich the country enormously. Suppose Edison or Westinghouse had not been able to put thru their early patents, and suppose that their ideas could not have been brought into life. Of how many billions in actual gold would this country be the loser today?

Dr. Hackensaw's Secrets

By CLEMENT FEZANDIÉ

(*Continued from page 229*)

but the protoplasm in the plant is surrounded by woody cells that make my work more difficult. From simple unicellular animals I was soon able to build up tissues and organs to suit me, and to make reptiles and animals of any pattern I desired, long before I discovered how to produce protoplasm or to give it life. Starch is the basis of both animal and vegetable life and must be converted into sugar before it can be utilized.

"I will not weary you with an account of my experiments. My failures would fill volumes. But at last I succeeded in producing chemically a protoplasm that was capable of receiving life.

"Meanwhile I was experimenting on the problem of giving life to inert protoplasm."

"How could you do that, when you had no inert protoplasm to work on?"

"Simply enough. I experimented with protoplasm taken from plants and animals. By various means I would stop life in this protoplasm, and then try to start it going again. In every way possible I tried to discover what was the basis of the irritability of the protoplasm and its power of contraction, and what would stop it or increase it. Success finally crowned my efforts. If you will step in to the next room, I will show you some samples."

"What! you really have some living specimens here?" cried the reporter eagerly.

Doctor Hackensaw smiled a peculiar smile. "Certainly," said he. "If you will look thru this microscope you will see some of my work."

Silas Rockett took a long look thru the instrument, and then turned to the doctor with a disappointed air.

"Is *that* all you have produced," he exclaimed contemptuously. "Why, that's nothing but slime such as you will find in any kitchen sink."

"You have struck the nail on the head, Silas," replied the doctor. "This, the life I have produced, is what is known as the *amoeba* or *slime-mould*. It may seem nothing to you to be able to produce this mould, but to me it meant victory. The power of manufacturing these little spots of slime gave me the key to creating life in any form I please.

"Of course, much patient work was needed, and many difficult problems had to be solved, constant experiments made and obstacles overcome. I met with numberless failures, but to-day I am triumphant. I can form, at will, out of my chemicals, practically any form of plant or animal that I wish."

Silas Rockett looked puzzled. "I understand you, doctor," said he, "but what I do not comprehend is how you can manage to produce, from the same substance animals as different as a fish, a chicken or a cow."

Doctor Hackensaw gave a snort of contempt. "I can do that," said he, "just as easily as an architect from a given pile of bricks can build either a chimney, a house or a palace. Nature does what I do every day. Take a glass of milk. If you drink it, it will manufacture human tissue, if a puppy drinks it, it will manufacture dog-meat. Besides, there is not so much difference as you might imagine between a fish, a chicken and a cow. The scales of a fish, the feathers of a chicken and the hairs of a cow are really one and the same thing. The feathers and the hair are nothing but transformed scales. Once I had learned how to cause my artificial tissues to form an external skin, I had no trouble whatever to produce scales, feathers or fur at will.

"So with the bones. Each bone, as you may perhaps know, is manufactured by what is known as its *periosteum* or outer skin.

When a surgeon is obliged to cut off a portion of a bone he is always careful to first turn back the periosteum, so as to be able to use the flap to cover the excised portion and grow new bone. By using living periosteum taken from animals I found it easy to produce bones of any size and shape I desired for my creations, so that when I succeeded in artificially making the periosteum from cells (from living cells first, and afterwards from my artificial cells), I had no trouble whatever. But I see I weary you with all this philosophical dissertation. My method was simply to go one step at a time, and a very small step at that! If you will come into my nursery I will show you some living specimens of my work, such as you never in your life expected to see."

"Some trees you have produced artificially?" said Silas, inquiringly.

"Not exactly," laughed Doctor Hackensaw. "This is a different kind of *nursery*. I want to show you my little girl, '*Hoochie*.' You saw her already when she was a baby."

"What! The little baby that was born from a cow?"

"Precisely. She is now eight years old, and the dearest little girl in the world."

"You call her Hoochie? What a queer name!"

"I call her that because she is the most precious thing I have. I hunted thru Europe and America to find perfect parents for her, and if she is not perfection, she is very close to it."

As he said the words, the doctor opened the door of the nursery quietly and motioned to Silas to look in.

There sat Hoochie on a low chair, surrounded by living toys of the most wonderful kind. In her lap she held a miniature elephant, the size of a kitten. By the side of her chair stood a three-headed dragon coming like a dog to be patted by its mistress. On her shoulder stood a fairy queen, while a boy fairy was flying toward her through the air. In a glass globe on the table was a living mermaid, while near by stood a miniature centaur making eyes at the tiny creature. There were several potted plants in the room of most curious shape. In one of them the flowers were living butterflies, in another they were humming birds. In still another each flower was a perfect hippocampus or sea-horse, while one flower pot bore a plant with a single flower, at the center of which, on a stalk, grew a living human baby of tiny size.

Silas Rockett could not repress an exclamation of delight and astonishment at the sight, and the noise caused Hoochie to look up. At sight of Doctor Hackensaw she gave a glad cry and came and threw herself into his arms.

"Well dearie," said the doctor, "how are Ethel and Methyl this morning?" Then, turning toward Silas, he added: "Ethel and Methyl are the two fairies—Ethel is the girl and Methyl the boy. By the way, how do you like my handiwork?"

"These living toys are wonderful, doctor. I cannot bring mself to believe that they are not real animals."

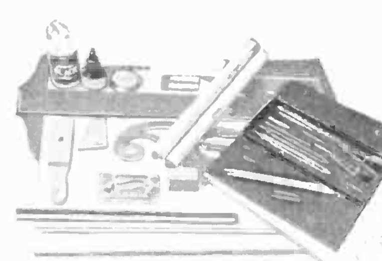
"They are real animals," returned Doctor Hackensaw. "They are real living creatures. In only one respect do they differ from other animals."

"And what is that, pray?"

"They lack a soul. I have the power to create any form of animal life that I wish. I can make living cells from inert mineral matter—combinations of carbon, hydrogen and oxygen—I can construct of these cells living creatures of fantastic shapes and kinds such as were never before dreamt of. I can create a monster or a creature of exquisite beauty, at will. But, so far, I have not yet succeeded in creating a soul."

"Just what do you mean?"

"I mean that these creatures, never having had any parents, cannot have any inherited instincts. A baby, when it comes into the world, possesses a host of instincts



inherited from ancestors from thousands of generations back. A baby can cry when it needs anything. The young of all mammals know how to obtain nourishment from their mother, and so forth. But Ethel and Methyl knew absolutely nothing when first made. I had to feed them artificially while teaching them to suck milk from their bottles. They do not yet know how to cry—I never taught them that! Instead, when they wish anything, they tinkle a small bell attached to their dress. They are very slow in learning even the most elementary things. Their vocabulary is limited to about a dozen words."

"They are backward, mentally, then?"

"Not at all. They are really bright children. But, until I had this proof before me, I did not realize how much we are indebted to our inherited instincts. The reason an ordinary child can learn so much in so short a time, is due to the fact that its parents have used *their* brains, and transmit some of the power to their children. Take two babies—one the descendant of well-to-do and educated persons for several generations back, and the other the child of illiterate parents for several generations, and you will find that the former, if placed in favorable conditions, will rapidly outstrip the latter, though placed in the same conditions. Heredity does it.

"Now my creations have no instincts, no inherited cravings or traits. You might think this an advantage, and it is, in a way, but it makes things very hard for me. My artificial animals have no safeguards to keep them out of danger. They need constant watching for they are as helpless as babies. They would step out of a seventh story window without the slightest hesitation, or walk out into deep water and be drowned. Teaching them is no sinecure, believe me!

"Then, too, they possess no inherited immunity to disease. When I first began my experiments, I could not understand how it was that all my animals would sicken and die without apparent cause. It was only when I sterilized the air in my laboratory and made everything germ-proof, that I could succeed in keeping my animals alive, and even then, a short trip out of doors was fatal to them.

"You see, the bodies of men and animals are provided by nature with a wonderful arsenal for fighting diseases. There are first the *phagocytes* which devour the disease germs that enter the body, then there are the *opsonins,* which help the phagocytes by dissolving the tissues of the harmful bacteria. There are also *agglutinins,* which tie up the bacteria into masses, and so hinder their free passage through our bodies, and the *antitoxines* which destroy the poisons produced by the bacteria. And the list does not end there.

"Well, I started out to produce these antibodies, as they are called, but found the task so complex and difficult that I was in despair until a bright idea struck me. I resolved to improve upon Nature. Instead of using a number of inefficient agents to fight disease, why not use one really effective agent and carry an ample supply of it at all times.

"By patient experimenting I found that a weak solution of carbolic acid, added to the blood, was sufficient to destroy any disease germs, and yet would not harm the body cells or tissues. To keep the body supplied with this special carbolic acid solution, I constructed a special organ composed of phenol-producing glands, and I place one of these organs near the heart of each of the animals I manufacture. My creatures are therefore more immune to disease than any animals formed by Nature."

"Is it possible? But talking about glands, how about the other glands of the body?"

"I found little trouble in making these. What gave me the most trouble were the special organs of sense. In the higher animals an organ like the eye or ear is so highly specialized that there was no hope of manufacturing either, artificially."

"Then what do you do?"

"I use what I may call 'buds' of eyes and ears, which buds I take from a *foetus* raised artificially in a glass jar. These buds, taken from a foetus a few days old, I insert in the proper position in the creature I am forming. There they grow into perfect eyes and ears. I can stunt or stimulate the growth of these organs until I get them of the exact size and shape I desire."

"I see, doctor. But now, frankly speaking, will you please tell me whether your invention has any practical use or not?"

"It is too early yet to say. Besides, we never know what the future of an invention will be. The first man who found that a bit of rubbed amber would attract small objects, could not forsee that this electricity would some day prove one of the greatest powers in the world. So with my creation of life. Altho I believe it has untold possibilities before it, so far I have scarcely attempted turning it to practical use. Still I have experimented in manufacturing meat and vegetables artificially. When done on a large scale the process should be cheaper as well as much more rapid than our present methods. In medicine and surgery, too, I can secure wonderful results, beautifying faces, replacing lost or diseased organs, etc. Then there are special uses. Here, for instance, is a Marconigram from a European monarch asking me how soon, and at what price I could furnish him an army of artificial soldiers! I have refused the order, altho I could produce excellent soldiers, without any bad habits, and who would obey every command implicitly.

"But possibly the most curious use I have yet made of my power, has been the production of a life-size seven-headed dragon for Mr. Lyons, the circus-manager whom you once met here. He wanted a dragon that would belch forth fire and smoke. He wished to use the creature in his circus for exhibition purposes. I drew the line at the 'fire,' tho I made a dragon for him that would breathe out smoke. But I expressly stipulated that I would only rent it to him for one week. He is to return it to-day, and, if I am not mistaken, I hear Mr. Lyons' step in the hall, now."

Doctor Hackensaw was right, for the door burst open and in shot Mr. Lyons like a bomb.

"Doctor Hackensaw," he cried in great excitement, "the dragon . . . . . the seven-headed dragon . . . . "

"Well?"

"Well, he got away from me and must now be ravaging the country! I don't know what to do, doctor, but can't you do something?"

Doctor Hackensaw quietly drew his watch from his pocket and looked at the time.

"Calm yourself, Mr. Lyons," said he, "everything is all right. I don't believe the dragon did any damage, but if so, it will do no more. It has been dead now for five minutes."

"Dead?"

"Yes, my experience with my *Tel-Automatic Lady* made me resolve never again to run the risk of turning a dangerous monster loose in the world. For this reason I would not sell you the dragon, but only rented it to you for a week. Moreover, to guard against accidents I resolved to limit the animal's life. One week and three hours after it left my hands, it was to die. To this end I placed a small alarm clock inside the monster, near its heart. At the proper moment the unwinding of the alarm would explode a small cartridge that would kill the heart instantly without injuring either the skeleton or skin of the dragon, as I thought you might wish these to exhibit in your circus. At the present moment your dragon must be lying dead somewhere. Buy an evening paper and you will learn where the body lies."

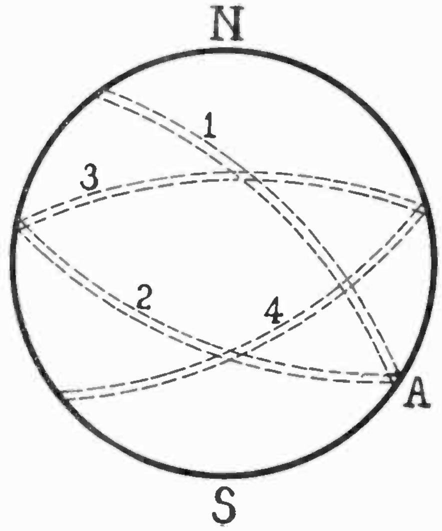
A Tunnel Through the Earth

By CLEMENT FEZANDIÉ

(*Continued from page 228*)

An almost perfect vacuum being thus produced, a spindle-shaped metal car is constructed in which the first passenger is to be dropped thru the earth. All being in readiness, the doctor rubs his hands with delight, and in his mind's eye sees the earth honeycombed with tunnels, which will solve all transportation problems, with no expense for motive power, when, like a thunder-bolt from a clear sky, the doctor happens to think of one little omission he has made—an omission that will render the tunnel useless—he has forgotten to take into consideration the centrifugal force of the earth!

Had the tunnel been bored thru the axis of the earth, from the North Pole to the South Pole, the car would fall through without any trouble, as there would be no centrifugal force at the poles. Were the tunnel bored thru the equator, however, as the earth is about 25,000 miles in circumference and turns once from West to East in twenty-four hours—the car when started would have this speed eastward of one thousand miles per hour. At the centre of the earth there would be no centrifugal force, and consequently the car, as it fell, would be continually scraping against the eastern side of the tube, the friction being so great that both car and passenger would be destroyed and would reach the center of the earth only in the form of a gas.



As Mr. Fezandié Points Out, a Tunnel Thru the Earth Could not be Made Straight, but if Ever Built, Should be Curved as Here Shown. For Instance, to Send Merchandise via Such a Tunnel System from Australia to New York, Would Require About Thirty Different Borings. Suppose N Represents the New York Side of the Globe, and A the Australian Side; Then the Curves 1, 2, 3 and 4 Represent the First Four Tunnels, the Carrier Falling First Thru 1, Then Back Thru 2, etc.

Obviously the path of the car would be the resultant of its initial velocity to the east of 1,000 miles per hour, and of the varying attraction of the earth. If unhindered, therefore, in its descent the path of the car would be a curved line not a straight one, and the tunnel, instead of being bored straight thru the centre of the earth should have been dug in a curved line that would pass a few hundred miles from the centre. Moreover a tunnel that would carry merchandise from New York to Australia, could not be used for the return trip, as a different curve would be required. To send goods from Australia to New York would require about thirty different tunnels, as is shown in the accompanying diagram, where N stands for the New York end, A for the Australian end and the curves 1, 2, 3, 4 for the first four tunnels, No. 1 being the tunnel thru which goods fall directly from New York to Australia, and Nos. 2, 3 and 4 the first, second and third tunnel respectively of the thirty tunnels thru which the goods would have to pass on their return trip in order to finally land in New York.

Thirty trips thru the earth would be quite a complicated journey, but as each trip would last only one hour, goods could be sent directly from New York to Australia in about an hour, and from Australia to New York, through the thirty tunnels, in about thirty hours—which is by no means a bad record.

But to return to our story. Here is the doctor, with his straight tunnel completed, and who finds himself unable to make use of it. At this juncture, the heroine of the story steps in and saves the day by suggesting that the car can be kept in the centre of the tube during its descent by electrifying it negatively, and by electrifying the tube negatively as well. The two like charges will repel each other, and the car will make the descent in safety.

This point settled, another hitch occurs. No passenger can be found willing to undertake the risks of this novel journey. But, of course, at the last minute, a poor boy, fifteen years old, volunteers for the task, and is accepted.

William, for such is the boy's name, takes his seat in the comfortable car, and looks about him while waiting for the signal to start. Careful calculation has shown that the time required for the entire fall through the earth from Australia to the "catches" prepared to receive the car on the New York side and prevent it from falling back, will be exactly 42 minutes, 13.4 seconds. Assuming that enough air remains in the tunnel to keep the car from coming within a mile of the surface of the earth at the New York side, the car would have to be drawn up the last mile by means of some suitable motive power, such as an electrically-actuated cable.

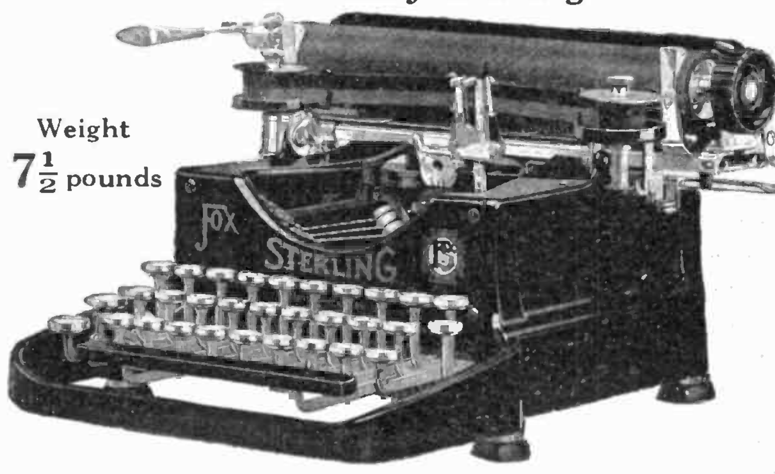
The formula for the calculation is as follows: $T = \pi\sqrt{\frac{D}{G}}$ in which T is the total time required for the fall, in seconds; $\pi = 3.1416$; D = the diameter of the earth in feet (20919360 feet); and G is gravity or the attractive force at the surface of the earth (32.17 feet per second).

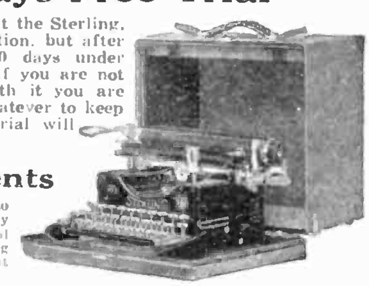
Hence the entire time required for the fall is $3.1416\sqrt{\frac{20919360}{32.17}}$ or 42 minutes and 13.4 seconds.

It must be remembered that, while for a body falling from above the earth to the earth, the attraction varies inversely as the square of the distance, for a body falling from the surface of the earth to the centre, the attraction varies as the distance from the centre. This is because the portion of the earth already passed pulls the car backwards instead of forward as before.

But again I am digressing. All being in readiness for the journey, a signal warns the boy that it is time to start. William has been coached by the doctor beforehand as to some of the surprises that await him on his strange journey, and knows that, to start the car, he must climb to the ceiling and let himself drop, head downward to the bottom of the car, a height of about eighteen feet.

He cannot help feeling some misgivings, but dutifully obeys. He climbs to the ceiling by means of a ladder on the wall, grasps a handle in the centre of the ceiling and lets himself drop, head foremost. But to his great surprise he does not reach the floor. The act of dropping has started the car on its journey, and now the boy and the car are both dropping at the same speed, and so, unless something happens, *the boy will never reach the bottom of the car*, but will remain suspended in the air midway between floor and ceiling! To him,





relatively to the car, the attraction of gravitation has ceased to exist! He is like a body without weight and will remain so during the entire passage thru the earth!

This may seem a startling assertion to make, but it is exactly what would occur under the conditions given. If a man had been let down into the tunnel by means of a rope attached to the car, his body would gradually have become lighter and lighter, and at the centre of the earth he would weigh nothing. It is natural to imagine that the same thing would happen if the car were dropped thru, but such would not be the case. It is obvious that if a stone were dropped into the tunnel, and a second stone dropped in a moment later, the second one would never catch up with the first until the other side of the earth were reached.

So with the boy in the car. The bottom of the car falls a fraction of a second sooner than the boy, and consequently the boy will never reach the bottom, but will remain suspended in the air during the entire trip.

Yet, here a new factor comes in. There is air in the car. This air offers a certain amount of resistance, and it is therefore possible for the lad to *swim* slowly thru the air to the top, bottom, or sides of the car, it being just as easy for him to swim upwards as downwards!

Were there no air in the car the boy must remain suspended between floor and ceiling, unless he happen to have a knife or other object in his pocket (the heavier the better). By throwing this in one direction, the reaction would send his body slowly in the opposite direction until he touched the car.

An interesting problem arises in this connection. Objects in the car having no weight, how many pounds could the boy lift? And would it be possible for him to throw his knife or any other object. It now has no weight. Try to throw a light body like a feather and notice what poor success you have. The feather is too light. If it had no weight at all, could you throw it any distance?

Right here we must understand the distinction between "*weight*" and "*mass.*" Mass is the amount of matter a body contains and may be easily understood by considering it as proportional to the weight of the body at the surface of the earth. Thus, William normally has a weight of 110 pounds and a mass due to 110 pounds. During the fall of the car, however, he weighs nothing, but he still has an unvarying mass.

Now, at the surface of the earth a body falls 16 feet during the first second of its fall. This is the amount of the pull due to gravitation. In other words, where gravitation is absent, a force which would raise one pound one foot in one second on the earth's surface, will raise sixteen pounds one foot in one second. Consequently, William in the car, his muscular strength being unimpaired, finds he can raise a weight sixteen times as great as before with the same amount of exertion he could lift a hundred pounds on the earth. Here he can lift sixteen hundred pounds the same height, in the same time, with the same effort, and once started, this weight will keep on rising until it reaches the top of the car, whence it will bounce down again at the same speed and the motion will continue until stopped by the resistance of the air and the elasticity of the cushions.

Another problem now arises. As the earth's attraction no longer modifies the relative positions of the boy and the objects in the car, will not all bodies in the car be attracted by the boy himself, and will he not, in turn, be attracted by the car?

The answer is "yes" in both cases. All bodies attract each other. But, in the case of the car, the attraction would be nullified if we assume the car to be spherical in shape. Sir Isaac Newton, in his *"Principia"* proved that a hollow sphere would not possess attraction for a body at any point within the sphere. Or, to speak more correctly, the opposing attractions would neutralize each other.

Hence the car would not attract the boy. The case is different as regards the boy and the furniture. The boy, if he placed his pen-knife in the air, a couple of feet from him, would certainly exert an attraction that would draw the knife toward him. But the motion would be very slow. Sir Isaac Newton has calculated that for two small objects like this, it would take about a month for the two to travel a couple of feet toward each other. As the trip through the earth lasts only forty-two minutes, the approach of the knife toward William would be imperceptible.

Another problem. If the boy should swim to the side of the car and should attempt to climb the ladder there, what would happen? The result would be that while the boy climbed in one direction, the reaction would set the car spinning around in the opposite direction. Also, if the boy should swim to the bottom of the car, and attempt to jump to the ceiling, the result would be startling, for up he would go, spinning like a top, at a very high rate of speed, and of course he would retain his crouching position in his flight! When he reached the uppermost part of the car, he would bounce down again and he would make several such up and down journeys before the friction of the air brought him to a stop.

When the boy and the car reach the center of the earth, as indicated by instruments in the car, there is of course no change in the effects of gravitation, and there will be none until the end of the trip.

The car is provided with instruments to show the distance travelled, and I had moreover put in a wireless telephone so William could communicate with the rest of the world during his trip. But, as this was in 1898 and Marconi had not yet made his wireless telegraph public, the editors thought a wireless telephone too impossible to admit of being used, even in a story, so they made me cut the wireless telephone out of my manuscript.

Finally William, after a forty-two minute fall reaches the other side and is taken in an elevator to the surface of the earth.

And then comes the final surprise of the trip. The boy has travelled from Australia to New York in one hour, and consequently he arrives in New York the night before he starts from Australia! The reason, of course, is that noon in Australia is twelve hours earlier than in New York, *so that the boy finishes his trip eleven hours before he starts!*

Again he has left Australia on a sweltering hot summer's day, and he reaches New York in midwinter, in the middle of a regular blizzard with three feet of snow! The reason is, of course, that the month of January, when the trip was made, is midsummer in Australia and midwinter in New York.

Although moving pictures and moving picture rights were unknown in those days, William receives a handsome reward for his trip, sufficient to enable him to marry the heroine, and the young couple, as in the good old days, live together happily forever and ever afterwards.

SYNTHETIC COAL DISCOVERED

Herr Prueckner, noted German inventor, claims to have discovered synthetic coal.

Prueckner is seeking patents in every country in the world for his process. He declared the necessary minerals were to be found in all countries and that the cost of production was surprisingly low.

Miracles of the Silver Screen

By E. M. STEVENSON

(Continued from page 227)

know how it's done. It's a mystery, but put on your thinking cap and maybe we can imagine we know.

Mr. Hurd, long a well known figure in animated cartoons, has at last found the way to do it. Never before have our funny friends been seen to play with their creator or anyone but themselves.

These live cartoons are made from a series of separate drawings of the different phases of the movements, which, when photographed consecutively, give a moving picture film. It seems tedious but after the first figure is made, the other movements are tracings thru celluloid with the position varied just a little.

The problem confronting the inventor was that of a means of multiple exposure and synchronizing the movements of cartoons and the human elements. In the same way the gunnery experts had to solve the problem of shooting a machine gun thru the blade of a whirling airplane propeller, and nearly every one knows now how that is done.

Such realistic touches are added as the talking cat. On the film of the natural photograph the eyes and mouth of the live kitten are made to show clear at certain times, such as in the illustration herewith, when he says, "Atta boy." You see the eyes blink in approval and the mouth move to form the words.

The multiple exposure system is necessary in order to have the cartoon figures come up clear and white against a real background, and at the same time hold all the brilliancy of the natural photography.

The cartoons are photographed separately, all the positions of the movements of the cartoons are made to coincide with the actual photograph, and the movements timed so as to be synchronous with that of the actual. A cartoon negative is superimposed on the actual negative and the exposure made for the positive. Then the film is reprinted with the cartoon negative for return to negative. This negative of the actual with reverse of the cartoon is reprinted for the last time with a cartoon negative superimposed, and by this multiple exposure the clear white and strong blacks of the cartoon are registered on a positive film, as well as perfect photographic value of the realistic.

All this more or less sounds like Greek to the average reader, and it is really only a task befitting the most painstaking expert in animated photography.

The almost miraculous sight of the cat, whose movements cannot be controlled, that knocks down the prize fighter, is one of Mr. Hurd's secrets, and we must content ourselves with the thrill of delight given us at seeing the performance.

The above description lacking only the particular mechanical secret of Mr. Hurd's method, gives an idea of the way these seeming impossibilities are performed.

FACTS ABOUT THE TELEPHONE

Eight million glass insulators are used annually in the Bell Telephone System.

Over 1.500 telephones are added daily to this system.

During 1921 the exchange and toll connections of the Bell System averaged 35.000.000 daily.

There are over 4.500.000 telephone calls a day in New York City.

The metal in the cable sheathing of the this system would fill 9.000 fifty-ton freight cars.

Seventy-eight per cent of the farms in Kansas have telephones.

Boston has more telephones than Australia and Belgium.

—*Telephone Review*

Auto Radiator as Hot Water Heater

(*Continued from page 244.*)

¼-inch nipple. The reducer at the intake or top hose was drilled through the top and tapped for an ⅛-inch pipe. Into this was threaded a steam radiator blow-off valve.

The hose at the outlet or bottom opening was reduced to ¼ inch in the same manner and led to the water supply by another ¼-inch line. This was protected from heat by wrapping with asbestos paper.

The water supply, in this particular case, consisted of a large barrel elevated behind a screen and which was filled daily by a few strokes on a small force pump drawing from the aforementioned cistern.

Heat was supplied by a common kerosene oil heater placed beneath the lower part of the radiator. This served to heat the shop in cold weather as well as heat the water. The radiator was erected close to a window so that in warm weather the upper part of the window could be thrown open and the heat allowed to escape. The barrel of the heater was also wrapped with several layers of asbestos paper.

The heat could be reduced in the room in the warm weather by erecting a sheet iron barrel about the entire outfit and leading the heat outdoors in the same manner as in the construction of a hot-air furnace.

With this outfit the barber was always supplied with at least ten quarts of warmed water, and as he only drew off a small quantity at a time, this supply was kept piping hot without any trouble.

Contributed by L. B. ROBBINS.

Einstein Relativity Explained in "Movie"

(*Continued from page 222.*)

viewpoint of physical fact, is part of the *system* comprising the earth and everything on the earth. It participates in the motion of the earth—and in particular in the rotation about the earth's axis. What this means is best exemplified by an experience every reader has had when a small boy or girl. Walking along the pavement, one drops a ball and catches it as it rises. One has taken several steps in the interval; the ball has kept step. It rises again, not at the *point in space* from which it was dropped, but at the point in the earth's atmosphere from which it was dropped. It has not lagged behind the rotating earth during the time in which it was falling and rising. And with the ball dropped from the high tower the case is the same—approximately. The top of the tower is rotating at the same angular speed as the base, and hence at a slightly higher *speed in the path*—just as the circumference of a wheel rotates faster than the hub. Accordingly the ball, maintaining this speed of revolution about the earth's axis, will move forward a very little bit toward the tower, and strike the earth a fraction of an inch out of a true line with the point from which it was dropped. But we can ignore this, and say that as seen from the tower, or from any point on the ground nearby, the ball fell in a *straight* line.

If we look at this incident from Mars or the Sun or any fixed point outside the earth, however, we do not share the motion of the earth and of the tower. The ball will fall in a very pronounced *curve*. Heretofore if we wished to make this experiment it has been necessary for us to drop the ball from the rear of a train, and note that with respect to the train it falls in a straight line, with respect to the earth in a *parabola*. Now we can regard the picture on the films as really representing the earth, and the audience, from its station outside, as freed from the necessity of taking a share in the earth's motion. To the man on the tower, the ball falls in a straight line; to the man in the audience it falls in a parabola. And this time, there is no good reason, scientifically speaking, for saying that the one is right and the other wrong. Each is absolutely right, from his viewpoint.

We are now ready for a picture of a truly relativistic occurrence, in which we again encounter this inability to judge which of two discordant observations of the same thing is correct. The illustration is highly fantastic, but none the less sound scientifically. We have a vast railroad viaduct extending thru space for millions and millions of miles. The little markers at the foot set off distances of 186,000 miles each—the distance traveled by light in a second. Along this viaduct runs a train of tremendous length also. At each end of the train there is a clock and a mirror. At points on the track so chosen that when the front end of the train coincides with one of these points, the rear end coincides with the other, we have two signal lamps. At the moment shown in the first of the three panels when the train and the chosen stretch of track are together the left-hand lamp sends out a signal.

Right here we must criticize the get-up of the film. The whole argument depends upon the fact that, running between two arbitrary points in space with nothing in particular between them, there is no way of judging the speed of the train. It passes nothing, it goes nowhere. We can state how fast it moves *over the track;* but that is all we can do, and that is not enough. But if we provide a background of scenery, as the director has done, the speed with which the train passes this background becomes an ever-present factor that appeals to the eye and mind. So we must expurgate the scenery if we are to carry on with the argument.

We haven't space for all the argument here, even at that. And it can be found in any book on relativity; in the film, it is given in the caption. The essential facts are, that the man on the train sees the light start from one end of his train, reach the other, and go back to the first end, as shown in the third panel. He must conclude that it has traveled double the length of the train.

But to the man on the track is presented a very different story. The light travels (along the track) from its starting point to the points at which it meets the advancing rear of the train, and then, being reflected, has to set out in pursuit of the retreating front end. It looks as tho the discrepancies due to the advance of the rear end, to meet the light, and the retreat of the front end away from the pursuing light, might just balance up; but the fact is, and can easily be shown by anyone possessing an elementary knowledge of algebra, that they don't quite balance. The two observers cannot possibly get away from the fact that they have seen the same traveler (the light-ray) cover the same course, and that they have measured the length of this course and got different results. It is from this fact, and from the utter absence of any ground for saying that one of the results is right and the other wrong, that all the curious paradoxes of relativity follow.

It would seem that the film, with the features of motion added to all the other explanatory features which are provided in books and lectures, ought to go a considerable distance further in making the mysteries of relativity plainer to the layman than has been possible in its absence. We are given to understand that the film is singularly complete; and this point, in the light of the necessarily fragmentary account to which we are restricted by the small number of pictures which we have before us, ought to be emphasized. We are telling here the story of the film, and not the story of relativity.

A "Free Pendulum" Clock

(Continued from page 224.)

the clock automatically corrects itself at the end of every minute.

As may be seen from the accompanying photograph of the mechanism, the pendulum carries a curved arm. When in the position shown in the photograph, a small arm, bearing on its end a roller, is suspended just above the curved arm of the pendulum. The interior of the clock work is so arranged that at the end of every minute, or rather somewhat less than a minute, as the clock is made to run only 59 and a fraction seconds per minute, the entire mechanism is automatically stopped. The pendulum making exactly 60 oscillations to the minute, is arranged in such a way that it will release the mechanism at the end of the next second stroke. The roller above mentioned is so arranged that at the time when the pendulum releases the mechanism it falls to the end of the curved arm just below it, and sliding off the slanting edge, imparts a slight push to the pendulum. The minute hand is arranged in such a way that it covers exactly one minute division on the face of the clock from the time the mechanism is started to the time it is stopped. The pendulum is so built and so delicately balanced that the very slight push that is given once every 60 seconds is quite sufficient to keep it going. In fact, the entire clock work may be removed from beneath the pendulum and the pendulum will keep on oscillating for a period of four hours, at the rate of 60 to the minute.

The clock work is wound either mechanically or electrically.

When the clock is first made, and the pendulum is to be regulated, a rough adjustment is first made by lengthening or shortening the distance of the weight from the point of suspension of the rod. When the pendulum is within 1 per cent. accuracy, the adjustment for absolute accuracy is made in a different way. A short weight on the opposite end of the arm bearing the roller is screwed backward or forward, thereby regulating the amount of force which the roller imparts to the pendulum, and so making its swing faster or slower.

Now since barometric difference will cause a variation in the time keeping of these clocks (1 inch barometric variation will mean one-third second a day difference in the clock), they are enclosed in an absolutely airtight compartment, which is filled with nitrogen gas. The airtight enclosure avoids the effect of changes in barometric pressure, and the atmosphere of nitrogen prevents oxidation of the lubricating oil.

WHY ONIONS BRING TEARS

The "gas" given off by a freshly-peeled onion makes itself evident in two ways—by a strong aroma which is at once apparent to the sense of smell, and by a smarting of the eyeballs, which, being very sensitive, are hurt by this substance to which they are not accustomed.

The nerves of the eye immediately signal the brain to turn on the tears or liquid which is secreted by the body as a natural eye-wash. This, flowing over the eyeball, forms a curtain which prevents the onion "gas" from coming in direct contact with the nerves and thus injuring them.

Tears are present in the eye at all times. When you wink, a tiny drop of tear-liquid is smeared across the ball of the eye and washes off particles of dust which may have accumulated. But when this liquid is produced so rapidly that it cannot be carried off down the nose by the trough at the corner of the eye, the tears overflow and run down the face.

The Amateur Magician

By JOSEPH H. KRAUS

(Continued from page 237)

trick, and I did want to see how the trick was executed.

"Up your sleeve," I shouted. The audience first glared at me and then looked at Hargrave. A pleasant grin illuminated his suave countenance. "Anyone else imagine that the glass of water went up my sleeve?" he asked. No one else did. Then Hargrave added. "Of course it went up my sleeve. Look!" He extended his arm upwardly and a water spout burst out from the arm pit. Then water spouted from his waistline and from his shoe. The water continued to spout for some moments, then stopped suddenly. Hargrave then introduced his water fountain, described in the September, 1921, issue of this publication. Thanking the President and the baseball-player, who by the way was not attired as one, Hargrave led them to the stairs connecting the stage with the auditorium floor.

Lanterns from Nowhere

Hargrave now picked up a black velvet cloth. He waved this about and then produced from behind him a Japanese lantern fully extended and lit. He hung this upon a wire, waved the cloth again and produced another lantern. Again and again he repeated the action until the entire room was full of Japanese lanterns, and finally from beneath the folds of the small cloth, no larger than a couple of feet square, a lantern, six feet long and about four feet wide, was produced. This was the trick which he wanted me to watch, but I told him that I'd be hanged if I saw how he could fold all those lanterns into such a tiny square, when I saw him later in the evening. Many other tricks were comprised in his repertoire, but the two just mentioned are so easily performed that I thought it best to describe them more fully. Referring to the disappearing glass, Hargrave described it as follows:

"The patter in that trick makes it effective more than the trick does. In the silk flag which I use, and which by the way is made up of two identical pieces sewed together at the seams, is a wire frame, the wire being soldered end on end. This frame is of the same size as the top of the glass. In covering the glass with the flag, I lift the wire frame so as to indicate how the glass is to be raised. At the same time, the other hand passes beneath the folds of the flag and extracts the glass full of water, placing it under cover of the table top, the flag and the table decoration in a compartment under the table, or if desired, upon a chair. With my hand still on the wire frame, but shifting it slightly, so that my rather unfortunate assistant may grasp the frame, I immediately direct him to walk toward the front of the platform, so that he cannot press down upon the table, discovering thereby that he is being deceived from that moment on.

Of course, when he releases his hold and I jerk the flag away, the ring sewed inside is pulled away with the silk banner. It slides from one end and is not noticed by either the victim or the audience. Of course, the rest of the trick is simple, and you described it in the article which I believe you called "The Wonder Fountains." I nodded in the affirmative. Hargrave then continued: "The second exhibition which you are so interested in, and which I have called, 'The Japanese Lantern,' is a little more difficult to perform without preparation. The Japanese lanterns are purchased at any novelty store. In each a flashlight battery, a bulb and socket are mounted. An automatic switch, which I am showing in this illustration, turns on the light at the proper moment. Each lantern is further equipped with a corset steel spring, so that it will snap open. These lanterns are then folded together and held in the position by a spring test tube clamp. Each test tube clamp is attached to a stout black thread at one end, and a little black button at the other end. The buttons hang loosely, just beneath the waistcoat, while half a dozen or more of the lanterns are suspended by pins from a little paper stub beneath the coat. Picking up the black cloth with one hand, and passing the other hand beneath the waistcoat with the fingers open, one of the buttons may be grasped between the fingers, that is, the hand is passed along the thread so that the thread passes between the fingers, and when the performer reaches the button, he has secured a grip on one or more of the threads. The black cloth which has been lifted in the left hand is then passed over to the right hand. Here care has been taken to bring the button forward, holding it under the fingers. The right hand with one corner of the black cloth is then passed over in proximity to the left hand, which grasps a corner of the cloth previously held by the left hand, and also the button. Showing both sides of the cloth, the performer moves his right hand to another corner of the cloth, permitting the black thread to slide between his fingers. By extending the arm slightly, one of the lanterns is pulled free of its attachment, and slides from beneath the waistcoat. It is a simple matter to detach the spring test tube clamp, permitting the lantern to open suddenly and lighting it at the same time. As one hand goes up to hang the lantern upon the stretched wire, the other hand reaches for another button, disposing of the test tube clamp, by dropping it into a chair *servante*. Not only can the lanterns be suspended from the waistcoat, but also from tables, chairs, drapery, etc. The large lantern which I produced is made like the smaller ones, but elaborately folded.

"By way of divertisement, there is an interesting little paddle trick which is being sold by street corner magicians. This is an ordinary wooden paddle made in the form of a tennis racket. Attached to it by a rubber band is a five dollar bill on one side and a one dollar bill on the other; both sides of the paddle are shown to the audience by a simple wafting movement, but during the course of seemingly exhibiting the other side, the paddle is given a half turn, so that in reality the same side is exhibited. This turning action taking place between the fingers is so slight that it is scarcely noticeable. Under cover of the palm of the left hand, the paddle is turned so as to bring the five dollar bill uppermost. Then the wafting movement is continued seemingly again exhibiting both sides of the paddle, but due to the slight turning action produced by the fingers, the five dollar bill remains uppermost. In this way a five dollar bill can be changed to a one dollar bill and vice versa. The method of performing the trick is illustrated in the diagram herewith."

AERIAL MUSIC

A five-passenger Fokker monoplane is being equipped at the army field at Mineola with a wireless sending set, so that Lieutenant Belvin W. Maynard, the "Flying Parson" and long-distance airplane racer, may take the machine into the clouds and broadcast a musical program to the radio fans on earth.

There will be plenty of room for the artists who are to sing and play horns, but it is not expected that there will be any line waiting near the plane when it starts into the air. One little point the press agent forgot when he sent out the yarn was that one of the selections will be "There's Music in the Air." Four seats will give plenty of room for a quartet singing "Sweet Adeline."

Lieutenant Maynard will make the flights for the benefit of the $2,500,000 fund sought by the American Legion for building a camp in the Adirondacks for wounded veterans. The General Electric Company is equipping the plane with wireless, and now where's the quartet?

S. S. Majestic World's Greatest Ship

(*Continued from page 219*)

THE present comparison pictureshows the world's largest and probably fastest steamship, the S.S. *Majestic*, of the White Star Line, which recently arrived in New York Harbor on her maiden voyage from Southampton via Cherbourg. This mammoth 56,000 ton vessel, measuring 956 ft. in length, made a remarkably fast trip in 5 days, 14 hours and 45 minutes. The new Mistress of the Seas is shown compared with 3—the S.S. *Mauretania*, 790 ft. long; 2—the S.S. *New York* (1888), first twin screw steamship, 627 ft. long; and 1—the first trans-Atlantic liner, *Great Western*, propelled by steam and side wheels, which arrived here in 1838 after a voyage of nearly two weeks. The *Great Western* was a paddle wheel steamer of 1342 tons, measured 236 ft. long, and her engine-horsepower was 450. The *Majestic* has eight turbine engines driving the same number of propellers, each 16 ft. in diameter, and capable of developing a maximum of 100,000 horsepower, enough to drive six ordinary sized steamships at least. The new Leviathan carries a crew of 1,000, she has 48 boilers with 240 furnaces, providing a heating area of 220,000 square feet, or about five acres. When fully loaded with passengers, crew and stores aboard, the gross weight of the *Majestic* is 64,000 tons.

The *Mauretania* holds the trans-Atlantic speed record of five days, eight hours and fifty-six minutes, from New York to Cherbourg. It is of interest in this discussion to mention that the giant S.S. *Leviathan*, formerly the *Vaterland*, has a length of 907 ft., and when the Germans built her before the war, they hoped she would surpass anything that might be built in the way of a ship for many years to come. The *Majestic* was purchased by the White Star Line from the International Reparation Commission. The *Majestic* was formerly named the *Bismarck*, and the Germans spent ten million dollars building her.

The *Majestic* is a veritable floating city, carrying when fully loaded, 5,100 people, which includes her crew of 1,000. She has nine steel decks aggregating a toal area of 7½ acres. One can take his morning promenade along the deck 50 ft. above the water line, and before he returns to his starting point, he will have walked one quarter of a mile. The officer's bridge deck is 102 ft. above the keel. The *Majestic* has three smoke funnels and is an oil burner.

WIRELESS 'PHONE ON S. S. PARIS

When you take a sea trip this year don't forget to carry with you the telephone addresses of friends left behind and "give 'em a ring" while on the Atlantic hundreds of miles from land. It may cost a little more than a nickel, but according to Capt. E. Maurras telephonic communication between land and sea has become practicable aboard the French liner Paris.

While the wireless telephone is still in its infancy the human voice already has been thrown across 600 miles from the Paris to Havre, the vessel's home port; in a few years communication between New York and Paris probably will be as commonplace as wireless telegraph.

"Conversation has been carried on at an even greater distance than 600 miles," the captain said, "but there was some difficulty in understanding every word. There is no doubt we are in the embryonic stage of development of the wireless telephone. I believe that it will be only a year or two before passengers making the trans-atlantic voyage will be able to converse with their friends on shore all the way across.

"On our recent experiment aboard the Paris the voice was transferred 600 miles distinctly and clearly."

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 addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

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

Hardening Copper

(609) Eric Carlson, Quincy, Mass., asks whether a process of hardening copper is a new idea. He further requests information on the uses for such a product.

A. There is nothing new in the idea of hardening copper. As a matter of fact you may recall that about six months or so ago, we had an article on hardened copper and lead in our magazine.

These materials, particularly the copper, when hardened, make a very fine knife which is, according to one of the inventors of this process, absolutely straight, as far as the edge is concerned. Many uses suggest themselves for hardened copper; bolts, nuts, washers, brushes, commutators, and in fact every use to which copper may now be put would be greatly improved if the hardened copper were used in the construction of the parts.

Automatic Gas Extinguisher

(610) H. Biegeleisen, New York City, submits a sketch of a gas burner attachment which automatically turns off the gas if the light blows out accidentally.

A. Altho we believe the particular contrivance which you have designed is patentable, and would also be practical, provided that it could be developed, we doubt very much the possibility of making such a device.

Gases as you know are very compressible, and you will have to exert considerable pressure within the chamber so as to push the piston over. Nevertheless, the idea is worth experimenting with.

Thalofide Cell and Talking Movies

(611) V. Bacevis, Elizabeth, N. J., asks whether a thalofide cell can be used in talking pictures.

A. The thalofide cell could, of course, be used in talking movies, this cell acting as the agent of transfer, changing the light rays into electrical pulsations.

Unless you have something very new in the art of talking movies, we do not advise that you experiment with this cell in that its principles and effects are well known.

Another Refillable Fuse

(612) Ernest J. Browne, Los Angeles, Calif., asks for advice on a refillable fuse.

A. Frankly speaking we would state that there are so many refillable fuse cartridges upon the market that we do not see where another one could possibly find room, particularly in view of the fact that your device hardly presents claims to improvement over other types.

Phonographic Inquiries

(613) F. H. Foerste, of Pelham Manor, N. Y., asks us several questions regarding Patent Law.

"Can anyone manufacture either lateral or hill and dale phonographic disc records without patent infringement?"

A. Many of the processes for the manufacture of phonographic discs are thoroly covered by patents. Unless you have some ideas of your own, you will find it necessary to use existing devices for their manufacture, which devices would undoubtedly be supplied by any of the large phonographic concerns. Permission would have to be obtained and royalties paid to the possessors of the patent covering the devices. If, however, you have an entirely new method, it will, of course, be permissible to manufacture either type of record without any license whatsoever.

"Providing the singers' or directors' names are not employed, can records now on the market be used for duplication?"

A. No! Good records could not be made very well in this manner; as unless the master record is obtained the results will be very poor.

"Does one have to pay a certain amount to the composer when manufacturing records?"

A. In most cases it is not necessary to pay the composer of a song anything, but a royalty of 2c. per record usually reverts to the publisher, who generally holds the copyright. This publisher may or may not have an agreement with the composer whereby the latter will receive his royalty from the money a publisher realizes when permitting records of songs to be made.

Chimney Windmill

(614) B. M. Garrison, of Columbus, Indiana, asks: "I have a simple invention of a windmill to be run by air drawn thru a small home chimney. Will it work this way?"

A. Theoretically, this would be possible, and we would advise that you construct a model of the device. You will find that there is hardly any draft at times, however, particularly when the air in the room is the same temperature as the air at the top of the chimney. Very little power can be derived from such a system, and it is not worth patenting.

Combination Cigarette and Cigar Holder and Pipe

(615) Noel S. Geyer, of Reading, Pa., submits a sketch of a combination cigar and cigarette holder.

"Of what value is an article made in three sections so that piece No. 1 is a cigarette holder, piece No. 2 is a cigar holder and adding No. 3, completes a good pipe?"

A. The idea is novel, and we believe a patent could be secured on the same with possible sale for these devices. We would suggest that, for the cigar and cigarette holders, No. 1 and No. 2, be combined, since it would be necessary to form a tip on piece No. 2 to have this act as a cigar holder by itself, which is rather impractical. The end would also be constantly contaminated with empyreumatic matter and nicotine, which would make its taste rather undesirable. Combination No. 1 and No. 3 should be used for the pipe instead of No. 1, 2 and 3.

Railway Mail Delivery

(616) J. D. Francisco, of Porterville, Cal., says: "An automatic electric rural mail delivery system might be composed of an overhead track made of two sufficiently heavy wire cables, with a third carrying the current. The carriage itself could be made of an electric motor suspended from the track with hangers or racks underneath to carry the mail pouches and mail bags. When leaving the Post Office, these bags would be arranged in order, so that the last one of a row would branch off at the proper farmhouse and automatically set the trip for the next bag. Each

house would be equipped with a hook or switch for taking off the end bag and a wire or track would slope slightly downward to the house itself so that the bag would be left right on the door-step. Another wire sloping from the house down to the main line would be used in a similar manner for sending mail out. Would you advise a working model with a view to getting out a patent on this system?"

A. This is not a new idea. A small Western town some years ago had such a system, except that instead of transporting mail to and from the Post Office, the device lay under a protected hood 500 or 800 yards from the house. When a letter was dropped into the carrier, an automatic switch was thrown, turning on the current to a motor in the carrier, which drove the carrier up a slope toward the house. At the house it closed the circuit for an electric alarm which announced the receipt of mail in this manner. The system is, however, impractical and expensive. In winter, extensive repairs would be constantly necessary. Ice might interfere with its proper functioning, and the system would encourage mail thefts. A far better idea would be to have pneumatic tubes running to every farmhouse. Altho more expensive than the electric system, in the end it is more effective and may be used in all weather. This system has proven itself to be very expensive both as to maintenance and repair, and may be discarded in New York where it has been installed.

Cigar Assorter

(617) Adolph J. Gustafron, of Chicago, Ill., asks:

"What are the possibilities of the following invention which will assort cigars according to their shade?" We now quote from a circular which he forwarded. "It consists of two metal boxes which contain strong lights, so arranged as to throw, with the aid of reflectors, a powerful light at an angle of 90° on a piece of plate glass. This glass is on a small stand under which the cigars are placed, and pressed up against the bottom surface of the glass. Directly above the glass is another box, which is small at the lower end, and gradually widens at the top. The top has a light proof chamber, which has in it a vacuum tube. The vacuum tube has a small terminal at one end, which runs to the center of the tube, and on the inner end it has a cross wire and circle which is positively charged. One half of the inner surface of the tube is covered with mercury, on which a certain chemical, negatively charged, is baked. When a cigar presses against the glass it changes the light rays reflected on the vacuum tube according to the shade of the cigar. These rays have an immediate effect upon the chemical and release negatively charged electrons, which vary in number according to the strength of the rays of light, and the current flowing thru the path between the electrodes varies according to the number of electrons released. This flow of current is registered on a milliammeter connected in series with the vacuum tube. The milliammeter will be arranged with electrical contacts at each division, which will make the connection with an indicator when it stops over any certain division, which in turn sets a dog on the arm of the machine, which presses the cigar against the glass. There are a number of these arms revolving around, and when one makes contact with a certain chute, the cigars are deposited therein and the dogs reset, while the arm continues its revolutions until it reaches a hopper which places another cigar in position.

A. From a scientific standpoint, this machine could be built, but practically we believe it never will. The concern in question has endeavored to induce the layman to buy stocks in the organization giving him a mass of pseudo scientific bunk to ponder over. Obviously, a machine of this nature would be in great demand where the quality of cigars are arranged according to color. The vacuum tube arrangement, which is the main feature of the invention, was described in this magazine then called the ELECTRICAL EXPERIMENTER, several years ago, and is technically known as the photo-electric cell.

Solenoid Action for Piano: Pocket Book and Bottle Holder

(618) B. M. Grita, of Adams, Mass., asks:

"Would this device for a piano be patentable? Each piano key is used as a switch, so that when the key is pressed, the circuit to a magnet is closed. These magnets are placed under every hammer, to which hammers armatures are attached. Pressing the keys would thus cause the hammers to operate.

A. This is not an original idea. A similar electric piano, yet far simpler than yours, was described in this journal, then known as the ELECTRICAL EXPERIMENTER, nearly five years ago. This latter was even so arranged that it could be played by means of the ordinary "roll."

He then asks:

"Could a patent be obtainable on a pocketbook made in book form which would fool crooks?"

A. This idea might be patentable, but would hardly earn a fortune for the inventor. There are many similar devices, for instance, a pocket flask container made in this shape.

He continues:

"In a chemical laboratory, bottles are placed in each corner, and it is not always possible to find the desired chemical. What is the value of a pair of lazy tongs into which you could place the bottles containing the chemicals. In this way pressing upon the tongs will cause the bottle to be produced."

A. We do not think this is practical as it is only one nuisance taking the place of another.

Book Review

THE NORTH AMERICAN ALMANAC. Stiff covers, size 5¼" x 8", 122 pages. Profusely illustrated. Published by the North American Almanac Co., Chicago, Ill.

This almanac is certainly an advance on the ordinary production. It gives holidays, church days, anniversaries, in full detail month by month. Every month has an appropriate quotation from some one of the poets. An interesting feature is the weather statements. For each month a little summary of the weather conditions in this region, not at all in the nature of predictions, but entirely statements of what may occur, as an average, is given. The comic element is not neglected, for some very amusing caricatures are given. The astronomical part is taken care of with maps of the sky for each three months of the year, constituting a sort of planetary. From Prof. Henry J. Cox of the U. S. Weather Bureau comes a short treatise on forecasting the weather, the natural history of birds and a whole variety of interesting information follows. A large section is devoted to advertisements and if we believe these, you can have a good complexion if you use the right kind of soap; it tells you how to have the shave-luxurious, how to have attractive golden hair and all sorts of wild medicines which as presented, certainly do not accord with the rest of the book. The almanac section is, however, admirable.

WITHIN THE ATOM. By John Mills. Cloth covers, 5" x 7½", 846 pages. Illustrated. Published by D. Van Nostrand Co., New York.

This book restricted in its field ostensibly to the minute cosmic system of the atom, as it may be termed, with its nucleus for the sun, and electrons for the planets, is excellently compiled and is a very good presentation of the very last developments in the study of atomic constitution. The book is amusingly as well as most scientifically written. We commend our readers to such a passage as that which immediately follows the tenth chapter; it is a very well put dialogue between two characters, one Proton and the other Electron. In the 134 pages preceding this dialogue, there is enough matter to imply pretty serious reading on the part of anyone taking up the book, and the little break that this dialogue gives will certainly be a rest to say the least. We do regard the omission of an index as a fault, and we are so sure that future editions of the book will be called for, that we sincerely hope the publishers will remedy this defect at an early printing. We naturally would be interested in knowing just what the author says about relativity, but there is no index to direct our search. He speaks of the quantum, giving a great deal of space to it, and the availability of energy receives good treatment. Such semi-popular subjects as the magnitudes of electrons and radioactive disintegration are given, and the experiments on which modern atomic theories are based and the relations of them to chemistry are all thoroly and adequately treated.

STUDY QUESTIONS IN ELEMENTARY ORGANIC CHEMISTRY. By Alexander Lowy, Ph.D., and Thomas B. Downey. Flexible covers, 6" x 9", 91 pages. Published by D. Van Nostrand Co., New York.

This pamphlet is for a very specific purpose. It supplies what the author terms "study questions," in connection with the elementary organic chemistry course in the University of Pittsburgh. We can imagine no more useful appendix to a chemistry course in any institution than the adequate utilization of these questions. It is divided into forty-five parts, some with over 50 questions, others with perhaps only a dozen, and while meant for students, it is not too much to say that anyone who would pass an Edison examination on the questions creditably, would certainly understand the theory of chemistry. We recommend them to all chemical students. The book is stapled from side to side, which is a pity, as it does not improve the comfort of reading it.

SWOOPE'S LESSONS IN PRACTICAL ELECTRICITY. By Harry Noyes Stillman and Erich Hausmann, E. E., Sc.D. Cloth covers, 5" x 7½", 625 pages. 488 Illustrations. Published by D. Van Nostrand Co., New York.

When we mention that this is the sixteenth edition of what Prof. Swoope has designated an

(*Continued on page 292*)

Radio Amplification —Best Methods

By ROBERT E. LACAULT

(*Continued from page* 254)

a battery, or by changing their positions in the amplifier, trying the different transformers in only one stage of amplification.

Almost any noise in an amplifier may be eliminated by methodic and careful search and it will generally be found that the cheaper types of transformers give much more trouble than the better types, designed and built by experienced firms. One of the details of construction which should be looked for by the buyer is the assembling and size of the iron cores, which if too small become saturated easily and produce distortion when used in a multi-stage amplifier.

It is hoped that the little information and few suggestions given in this article will be of some use to those who contemplate making an amplifier for the betterment of their receiving set, and to conclude we would say that for best results it is necessary to use good materials, for, as the saying goes, "the cheapest is the most expensive in the long run."

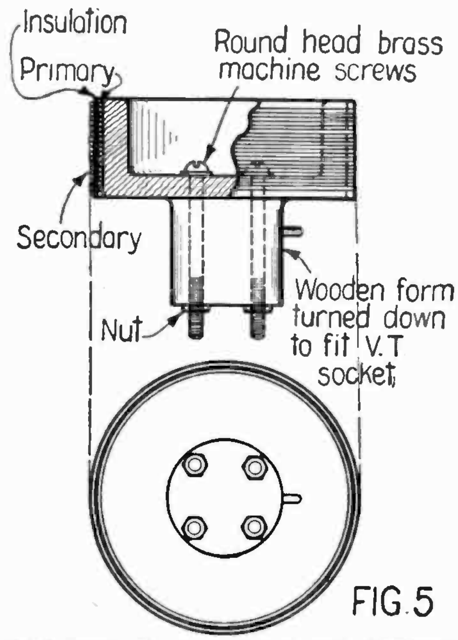


Fig. 5. Details of Construction of Radio Frequency Transformers for Short Wave Lengths.

BRIGADIER-GENERAL CARTY

President Harding's nomination of Col. John J. Carty, vice-president of the American Telephone & Telegraph Company, to be a brigadier-general in the Signal Officers' Reserve Corps has been confirmed by the United States Senate.

When America entered the war, Col. Carty, then a major in the Reserve Corps, was at once called into active service. He organized twelve battalions of volunteers from the personnel of the Bell Telephone Companies which formed the backbone of the Signal Corps in the first phase of the emergency. During the war he served in France as colonel on the staff of the chief signal officer, A. E. F., and made plans for the marvelous long-distance telephone and telegraph system with which our army covered all of France and which was extended even into Germany and to London and Liverpool. After the armistice he served as communication officer for the American Commission to negotiate peace.

Col. Carty has received a number of foreign decorations, and from our own Government the Distinguished Service Medal for exceptionally meritorious and distinguished service.

The Book that brings Radio *into the home* ~

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WHAT THE BOOK CONTAINS

Section 1. HOW RADIO ENTERS THE HOME. Contains just the information sought by the man who wants to buy a set. What set shall I buy? How much does it cost? What will it do? This section answers a hundred such questions. All types of sets are described from the least to the most expensive. Full installing and operating instructions.

Section 2. HOW TO RECEIVE MOST EFFICIENTLY. Important receiving accessories are described in language that the layman can understand. For the benefit of the amateur, technical data are given on audio and radio frequency amplification, erection of antennae, battery charging, regeneration, etc. Valuable receiving-circuit diagrams are published for the first time.

Section 3. VACUUM TUBE TRANSMISSION FOR THE AMATEUR AND EXPERIMENTER. Everything from A to Z about transmission with new, completely revised transmitting-diagrams, incorporating Radiotron transmission and Kenotron rectification. Valuable operating instructions are given, and the use of mica condensers for transmission is emphasized.

Section 4. GENERAL INFORMATION — A VERITABLE GUIDE BOOK TO RADIO. Government laws, National Electric Code Radio Rules, vacuum-tube "Don'ts," radio glossary, specifications for a scientifically constructed amateur station, complete price list of all R C A equipment.

FOR the first time a book is published at a small price which gives the public all that it should know about radio. It is called "Radio Enters the Home," and it is written by experts. It tells how to enjoy popular radio broadcasting, and it gives complete descriptions of apparatus and installation instructions. No book so richly illustrated, so accurate, and yet so understandable has thus far been published.

The book is divided into four sections. Over 200 illustrations, 112 pages, size 8'' x 11''. The technically uninformed man will find in sections written especially for him the simply presented facts that he seeks; in other sections are data and diagrams that appeal to the trained amateur.

PRICE, AT YOUR DEALER . . . . 35 cents

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Sales Division, Suite 1805
233 Broadway, New York City

Radio for the Beginner

By ARMSTRONG PERRY

(*Continued from page* 250)

moves again and the magnetic field rises like the inner tube when the air is shot into it, only much more suddenly. It strikes the ether as the drumstick strikes the head, sending radio waves in all directions. The radio telephone transmitter keeps a steady stream of waves flowing into space. In the radio receiver their presence is made known sometimes by a steady, musical note or hum.

Then come the impulses from the voice or instrument, thru the diafram, the carbon, the microphone circuit and the antenna circuit. The sound of the voice or the instrument dies like any sound. It travels only a few feet. But the changes that the sound makes in the electrical waves are exactly in time with the sound waves, and those changes are passed on into space, down thru the receiving antenna on your roof, and into your radio receiver. The radio waves produce an electrical current in the antenna. Its oscillations are many times too rapid to be heard as sound, but the receiver has a valve that helps reduce their number. This valve may be a *crystal detector* or it may be a *vacuum tube detector*. Both do the same kind of work but the vacuum tube does it so much better that its final result is a sound much louder than the receiver with a crystal detector can produce.

From the detector the pulsating current goes to the receiving telephone. Amplifiers may be installed on one side of the detector or the other so that the energy of a local current may be added to that which is weakened by its long journey thru space. The current passes into an electro-magnet which is a part of the telephone or the loud-speaker. Its pulsations are right in time with the vibrations of the diafram at the transmitting end. The changes produced in the microphone circuit have been passed right along thru the transmitting antenna, thru the hundred or the thousand miles of space between the transmitting and the receiving antennas, and thence thru the detector and the other parts of the receiver.

In the electro-magnet they cause variations in the current. Variations in the current cause variations in the pull of the magnet. The diafram of the receiving telephone is mounted so that it feels the slightest pull of the magnet. If the voice at the transmitting end is giving out sound waves at the rate of 1,000 per second, the magnet varies its pull 1,000 times per second and the diafram also vibrates 1,000 times per second. In vibrating it compresses and rarefies the air and creates sound waves as the drum does. These sound waves give a very good imitation of the voice at the transmitting end. With a properly designed horn to intensify them, they have sometimes given so good an imitation that persons who heard them without knowing their source, thought that the singer or speaker was right in the room, instead of hundreds of miles away. Eventually, and probably in the near future, inventors will give us apparatus that will not only reproduce voices and music consistently with as great volume as the original sound or greater, but also with as good quality or better.

CASTS TEN-TON LENS

A ten-ton speculum for the Frye Observatory of Seattle has been cast at Vancouver by T. S. H. Shearman, astronomer. This is said to be the largest telescope glass in the world. Charles H. Frye, a wealthy packer of Seattle, let the contract to Shearman last year, when no casting plant would undertake the job. Mr. Shearman claims to have perfected a special annealing process which will enable him to cast a glass any size.

The sands used in the manufacture of this speculum, which is valued at $360,000, came from five countries. The new Frye telescope will have a total length of fifty feet.

The Radiophot—Television By Radio

By H. GERNSBACK

(*Continued from page 235*)

vibrate at all, the light pencil is not visible at all because, as we stated before, the light ray can only be reflected when the narrow mirror begins to vibrate. At rest there can be no reflection of the light ray, because the latter does then not fall upon the mirror at all. The more the mirror vibrates, the wider the light band becomes, as is shown in our separate insert illustration. In other words, if at the sender photo-electric cell number one is fully illuminated, it will send out a strong impulse, which strong impulse is received at the receiving end exactly as if at the present time a broadcasting station was sending out a loud note, you would hear it in the telephone receiver loud. If it was sending a weak note, you would receive it weak in the phones as well. Just so in the author's television scheme. The more light there falls upon the photo-electric cells, the more the tiny mirror in front of the receiver electro-magnet will swing back and forth. Therefore, the entire imaginary small square upon the ground glass will be illuminated.

If, on the other hand, a black object falls upon photo-electric cell number one it will not send out an impulse and for that reason the electro-magnet number one at the receiver will not energize the tiny mirror and, consequently, the square of the unit number one on the ground glass will remain black. It will be seen from this that any shade from either darkest black to lightest white will be transmitted instantaneously.

The entire picture is made up by such impulses and is thus reconstructed upon the screen where we can view any picture, whether it be at rest or animated. In other words, it makes no difference, if we turn the sender on a scene that is at rest, or whether we turn it at a horse race; the effect will be of the same degree of perfection.

There is no doubt that this scheme can be made to work, and we would be very much surprised if television by radio were not an accomplished fact during the next two or three years. The author wishes it distinctly understood that the proposal has not been worked out and exists only in theory so far, but there is no point in it which is not sound, and which cannot be turned into practice today. It is simply a matter of building the device, and making minor improvements as would be found necessary in actual practice. It should also be understood that this idea is not only applicable to radio, but it is possible to use the same instruments on wire lines with equal facility.

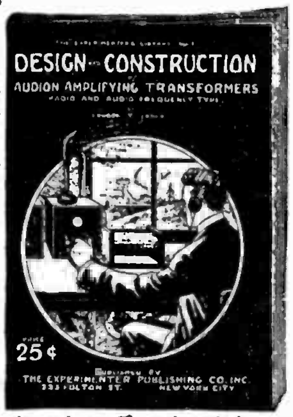
This television scheme would then resolve itself into wired wireless with which we are all familiar. One may ask if the voice currents and the radio currents will not mix up and distort the picture at the other end, or even make it impossible to receive it. This, however, is not the case at all, since we can use such widely different lengths of waves as we are already doing today with the Squier wired wireless, where no mixing up ever occurs in a well-balanced outfit.

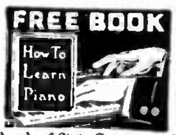
NOTE.—The television scheme, discussed in this article, is the basis of a patent application of the author.

JACK PINE FOR NEWSPRINT

Possibility of utilizing jack pine for making newsprint paper is engaging the interest of members of the Canadian Pulp and Paper Association, who in recent years have watched with apprehension the steady dwindling of the spruce forests, heretofore regarded as the only considerable source of supply for newsprint.

Successful experiments with jack pine under both the sulphite and ground wood processes of manufacture have been carried out.





Book Review

(*Continued from page 285*)

elementary text-book and that it has been re-written, revised, and enlarged by Prof. Harry Noyes Stillman and Prof. Hausmann, and has already reached a sale of 73,000 copies (the present edition brings it up to nearly 80,000 copies), the review seems hardly needed. The system on which the book is written is excellent. It is divided into lessons, none of them too long; every paragraph has its caption, then at the end of each lesson comes a series of questions, and when such a method harmonizes with the lesson, a series of problems are given. Other problems are intercalated thru the text and 488 illustrations add greatly to the value of the book. It may be said to cover the whole subject of electricity. At the end of the text tables of data are given, which, added to those in the text, make a total of 28 tables. It would take a long review to tell what is in the book; if we wish to state what is omitted, which should be included, the category would be very short.

ATOMIC THEORIES. By F. H. Loring. Cloth covers, 5½" x 8¾", 218 pages. Publisht by E. P. Dutton & Co., New York City.

This very interesting book is devoted to the atom. This unit has gone thru many changes from the atom of Epicurus to Soddy's, Rutherford's, and Langmuir's atom. Many others than the three named are of course concerned in evolving what the modern conception of an atom is; the presentation of the atom as a little planetary system is the work of many men. It is impossible, in the limits of our space, to give this book the review which it deserves. It is really an admirable presentation of the modern theories of the atom, of the ionic theory and of its applications to chemistry with numerous graphical formulas in plano and stereo-chemistry, and its explanations of advanced chemical theories and of Langmuir's postulates make exceedingly interesting reading. This is so true that we would recommend the book as a literary presentation of the subject as well as a scientific one. Isotopes have considerable space given to them which is certainly good judgment, even if our German friends may not succeed in finding the philosopher's stone hidden in the isotopic labyrinth.

COMMERCIAL ENGRAVING AND PRINTING. By Charles W. Hackleman. Embost cloth covers, 6" x 9¼", 846 pages. Profusely illustrated. Publisht by Commercial Engraving Publishing Co., Indianapolis, Ind.

Nearly 800 pages of closely printed matter with over 2,000 illustrations constitute this book. The range of subjects treated in it is shown in the fact that it requires a two-column 12-page index to even incompletely state them. Commercial photography is given first, covering the photography of difficult polisht objects and glassware, machinery and all sorts of goods; advertising photography, the effect on half tones of the photographic print paper used, and most elaborate treatment of photographic technique comes next, and proportions follow. Art room accessories, the air brush, shading machine, retouching, white lining, grouping of photographs, the use of cut-outs, combination of photographs and wash drawings, are all here. We then come to the larger subject of methods of treatment, following a nice treatise on line drawings. At last half tones are reached, and here we are told everything about them, whether black and white, or polychrome, vignetting and all the various ways and methods of the half-tone operator are given.

We are interested in noticing the picture description of the half-tone meter, in connection with which the scale of depths for half tone etching adopted by the American Photo Engraving Association is given. Of considerable interest to many will be the section on rotary photogravure or "Rotogravure," so many examples of which are now met with in the press. Color plates are treated exhaustively. Paper and book binding conclude the technical part of the book, and special sections at the end of the book are given on patents, trade marks and copyrights, on mailing lists, and postal information, filing of plates and of copy. No one interested in photo-engraving and editorial work, writing or allied lines in any way whatever, should do without this book. It is a veritable cyclopedia, with its folding plates and excellent printing of all illustrations.

GERMINATION IN ITS ELECTRICAL ASPECT. By A. E. Baines. Cloth covers, size 5½" x 9", 185 pages. Publisht by E. P. Dutton & Co., New York, N. Y.

This book is quite an elaborate presentation of the relation of electricity to the germination

(*Continued on page 294*)

Book Review

(*Continued from page 292*)

of seeds. We have read a great deal about the use of electricity in agriculture and here is given quite a long series of experiments and demonstrations with numerous illustrations, on the subject of electrical stimulation of growth. The author is quite a devotee of electricity as an agent for many life-phenomena, and the attractive way in which the book is produced with its quite adequate index, makes it very commendable.

STORAGE BATTERIES. By C. J. Hawks. Cloth covers, size 5¾" x 9¼", 157 pages. Publisht by the Wm. Hood Dunwoody Industrial Institute, Minneapolis, Minn.

The Dunwoody Institute of Minneapolis publishes from time to time courses of instruction in science for the use of its students. These are first mimeographed. From year to year corrections and additions are made and eventually it is felt that the book or treatise is ready for putting into permanent printed form. The Institute caters to workmen who are employed during the daytime, so that a very clear and concise treatise applying each to its own subject, is what is required. There are several questions given for answer, and there are several sets of questions, ten in number for each section, so that the total of over 100 questions certainly gives a very good review of the book. An interesting feature of the work is that references are given to other sources, so that the student can use this manual as a basis for quite extensive reading. It has numerous illustrations and we highly recommend it.

THE NEXT WAR.—An Appeal to Common Sense. By Will Irwin. Cloth covers, size 5" x 7½", 161 pages. Publisht by E. P. Dutton & Co., New York City.

This book is a dreary presentation of the horrors of modern warfare. A version of the parallel column is sometimes used in the illustrations, involving comparison of old and new ways and methods. The shocking expense of preparation for war and the wretched result of it, are very well brought out. It shows that from 1793 to 1910 the cost of all wars was but a fraction of what the World War cost. During its last year a single hour of the World War cost money enough to build ten magnificent high schools. The whole thing is a very melancholy presentation of what may be termed one of the greatest stupidities of mankind. Thus a view is given in one of the illustrations of the campus of the University of Michigan, at Ann Arbor. This great university, with 10,000 students, and graduating annually about a thousand men and women with collegiate degrees, costs but a fraction of the expense of building a single battleship. The last chapter is called "The Tempter." It depicts the magnificent position of America, taking the ground that her power and wealth may tempt her to follow such a path as that taken by Germany. It is an eloquent epilogue. We strongly commend the book.

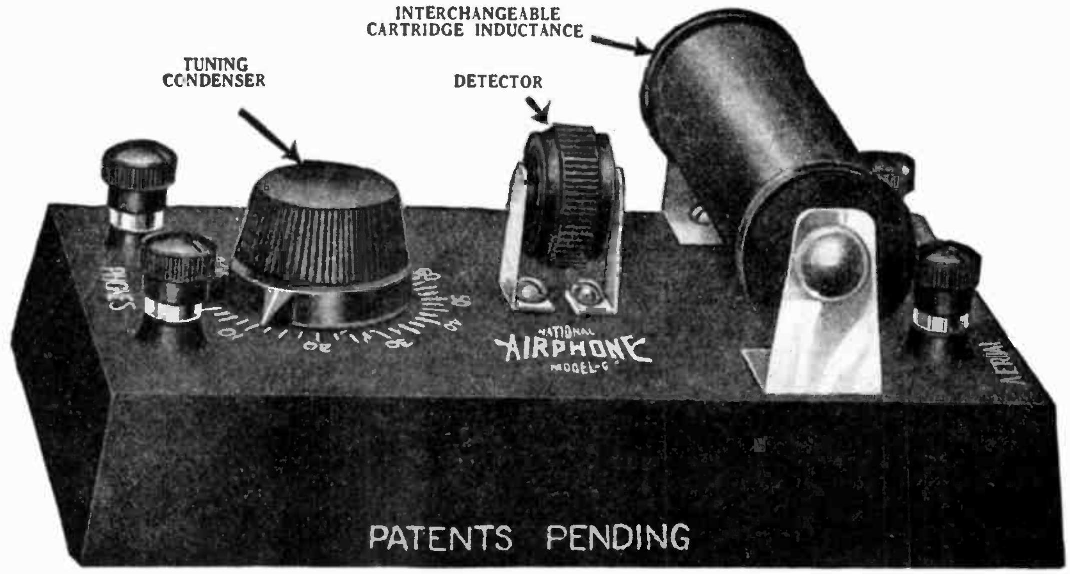
Auto Theft Prevention Hints

By FRED C. ALLEN

(*Continued from page 236*)

Remove ignition distributor arm, but be sure there is not a car of the same make in your parking vicinity, else the would-be thief may take the distributor arm out of the other car and put it in yours. And if you do take your distributor arm out, be sure and fasten your hood snaps, otherwise the would-be culprit will know just what you have done. If you have not been careless, and have fastened the hood securely in its place, the thief may pass along to the next car.

If you chain the rear wheel of your car to a tree, be sure the extra wheel on the rear of your car is securely locked; if it is not, you may have to ride home from the Country Club dance on one wheel, trailing behind you the heavy chain you bragged about the week before when one of your friends had his car stolen. Of course, when this incident occurred, you told him in a superior tone of voice, "I told you so, Bill."



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A New Radiophone Easily Operated by a Child
Most Practical for the Office and Home

To operate simply connect aerial, ground and head-phones. Will receive radio broadcast entertainments and commercial reports within a radius of 25 miles; Code signals 1000 miles and over depending upon coils used.

Outstanding Points of Superiority:

1. Most Compact Radiophone Receiving Set Made: 6½" long, 4¼" wide, 2¾" high—small enough to put in coat pocket or desk drawer.

2. Rugged construction throughout, nothing to get out of order, insuring long life in service.

3. Entire casing constructed of hard rubber composition. No wood, no warping, no losses through leakage.

4. Ultra-sensitive Foolproof Detector; entirely enclosed in composition case. Air and dustproof, no fussy minerals, no Catwhisker, no balls nor spring. To adjust for maximum sensitivity simply rotate the black disk slowly.

5. Elimination of all switches, current taps and switchpoints prevents loss of electrical energy.

6. Use of interchangeable cartridge coils gives wide range over which radiophone broadcast or radio telegraph signals can be heard. 25 miles or over for radiophone concerts; up to 1000 miles for telegraph signals depending upon coils used.

7. Two Cartridge tuners, wave length 150 to 400 meters, supplied with each outfit; one takes in general broadcasting stations (360 meters), the other from 500 to 1000 meters.

8. Variable Mica Condenser used is acme of simplicity—high capacity, impossible to short-circuit.

9. Anyone without previous experience can operate a NATIONAL AIRPHONE, no delicate adjustments necessary, no fussing.

TRADE MARK NATIONAL AIRPHONE CORPORATION REG. U.S. PAT. OFF.

18 Hudson Street
NEW YORK

Freaks of Railroad Radiophony

By A. P. PECK

(Continued from page 248)

atus was located in the front end of the Pullman car itself, thru remote control relays.

The receiving apparatus at that time consisted of a Grebe C. R.-9 and a Magnavox. With this combination of apparatus they were able to keep in constant communication with the station at the Hoboken Terminal for a distance of 28 miles.

On one of their trial trips, a band of musicians were hired to give concerts along the line. These were enthusiastically received by amateurs in the towns and cities thru which they passed, many of whom, having transmitting sets, called the station on the train and congratulated them upon the perfect modulation and loudness of the signals received.

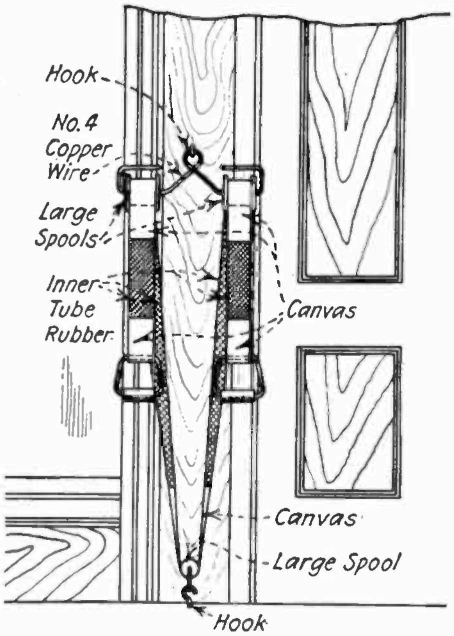
It is planned in the very near future to have every car equipped with radio, and every set in the cars to have its own receiving apparatus. This would be used by any of the passengers wishing to receive messages differing from those being received by the loud speaker situated in one end of the car. It will be seen that this will enable the busy business man to keep in constant communication with his office, as well as receive the various stock reports and other news of interest to him while traveling.

Another use that radiophony could be put to in railroading would be that of reducing the danger of collisions to a minimum. Trains equipped with a duplex system of radiophone transmission and reception would be in constant communication with each other in dangerous places, and by exchanging information of locations, the engineers would know whether or not they had a clear track, even tho the visual signals were obscured by sleet or snow.

Old Inner Tube Contest Winners

(*Continued from page 247*)

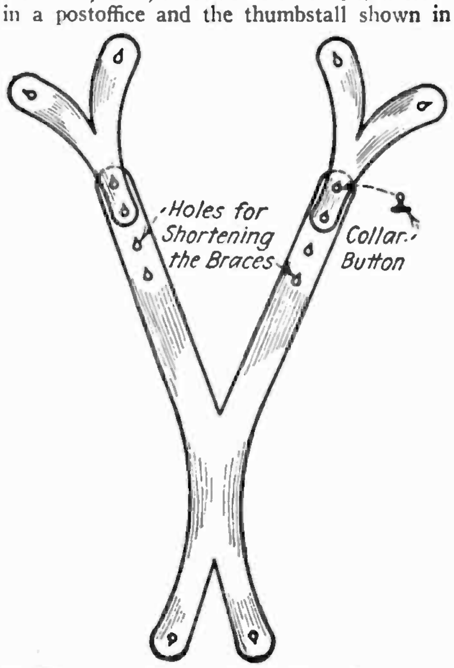
In addition to the first prize winner, all other suggestions accepted and published in this contest are paid for at the rate of $1.00 each.



A Home Exerciser Made as Illustrated Above, Makes Good Use of Inner Tubes. This Exerciser Can be Adjusted in Strength by Employing Several Tubes Instead of One.

Joseph A. Deibel of 1018 Second Avenue, Rock Island, Ill., is awarded first honorable mention for a mat. He says: "Cut the tube in two at the valve stem; then slit it across its entire length. From this cut strips one-half to three-fourths inch in width, using a yardstick and a razor blade for this purpose. The strips are then laced, as shown in the figure. If red and black tubes are used, very pretty effects result. The ends may be left frayed or another strip of the inner tube may be cemented in place with rubber cement. This mat may be washed whenever desired."

Ernon V. Oliver of 1186 Borthwick Street, Portland, Ore., informs us that he is a clerk in a postoffice and the thumbstall shown in



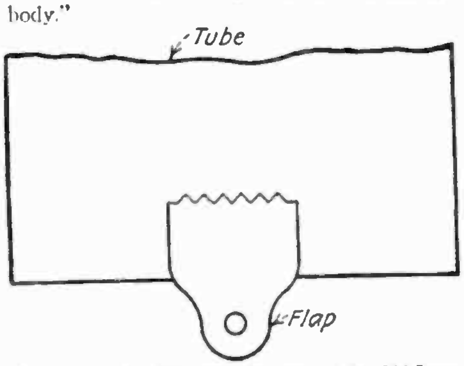
The Writer Here Shows a Simple Method of Cutting a Pair of Suspenders From An Old Inner Tube. These Suspenders Are Quite Strong and Durable, Yet Possess Sufficient Elasticity.

another of the illustrations has increased his efficiency in the handling of mail from a rate of fifteen letters per minute to around forty. The device is cut from old inner tubes with a pair of common scissors.

Strips of rubber 2 inches wide and arranged as shown in the accompanying illustration make a very good exerciser, according to Truman R. Hart, of 20 Elm Street, Ashtabula, Ohio. Bent wire, about No. 4 copper wire, will serve the purpose and spools with at least 2-inch faces form the necessary parts. Canvas is used over the bearings and for holding the handles in place, which canvas is cemented to the inner tubes as illustrated.

Mr. Charles Mohr, of 36 Rue de Sévigné, Paris, France, demonstrates his method of making a pair of suspenders from inner tubes, employed by him during the period of the war. Needless to say, these suspenders lived up to their advertised elasticity.

Lester Levy, of 986 East 163d Street, Bronx, N. Y., submitted a method of making water wings. He says: "Cut off a good section of the tube, about 20 inches long. In the center of this make an opening and insert a bicycle valve. Then place it around the user's chest and mark the size. After this is done the tube is cut at the mark. In each end of this cut section insert a flap, as shown in the accompanying illustration, and cement the ends of the tubes together. The tube is then pumped up like a tire, placed around the body and a piece of cord passed thru the openings in the flaps. This, when tied, secures the life belt to the swimmer's body."



How to Insert a Flap into the End of An Old Inner Tube, so That the Same May Be Used as a Life Preserver. This Flap, Made of Canvas, Having a Ring Fastened Into Its Free End, Permits of the Tying of Two Ends of the Inner Tube Together, When the Latter Has Been Inflated and Placed Around the Swimmer's Body.

Experimental Electro-Chemistry

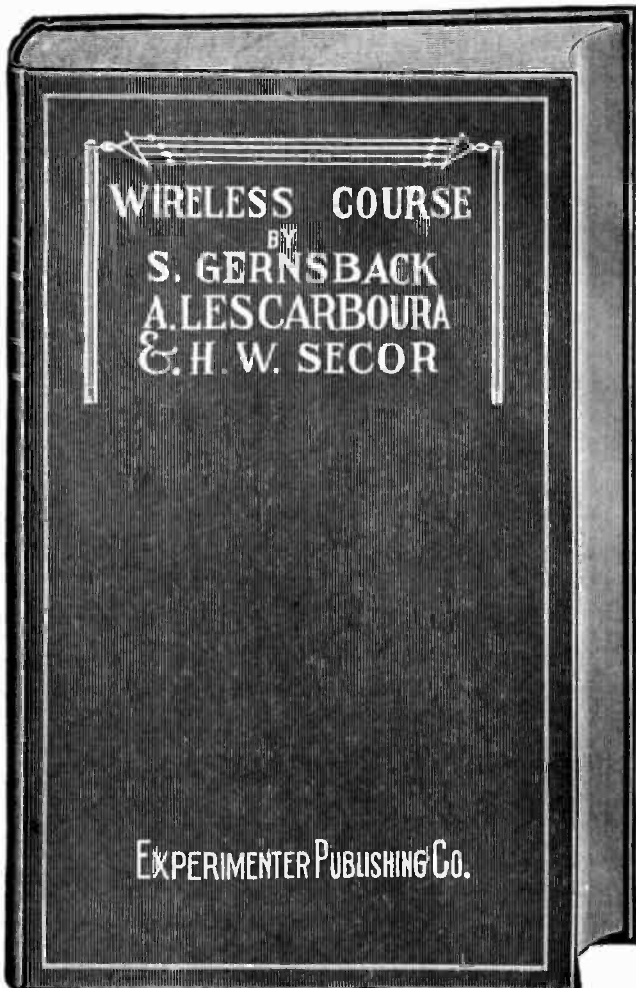
By RAYMOND B. WAILES

(Continued from page 243)

of G, a wire connected with the ground or water pipe, the potassium ions become discharged, or they become ordinary potassium atoms, and hence react with the water in ED, forming potassium hydroxide as one constituent. This potassium hydroxide renders the water in ED electrically conductive, and if a sensitive galvanometer connected with a lemon battery or other weak battery be connected to it by means of the immersible wire electrodes E, the galvanometer will show a deflection, whereas with the pure water before the experiment no movement of the needle could be observed.

The flask EF and dish ED should rest upon insulated stools (glass plates with porcelain insulators I, I). The static machine should be operated for, say, several hours, as the output in amperes of the machine is very, very low, and the rate of decomposition of the potassium is proportional to the current density or strength.

This experiment shows, apparently, that ions can be isolated. Now that we have determined their rate of movement and even isolated them, we will put them to work in the next installment.



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Can the "Lusitania" Be Raised?

By JOSEPH H. KRAUS

(*Continued from page 217*)

charge of dynamite will not blow the ship to pieces as your newspaper contemporaries have claimed, but will merely cut a hole in the top deck. I will then attach chains and cables to the safe and other objects I desire to remove and have them hoisted up to the surface and we will come back millionaires. I believe I can complete the work in two weeks of good weather. Of course, it may take several months in order to secure two weeks of really *good* weather, but the upkeep of the *Blakely*, which has been chartered by the *Lusitania Salvaging Corporation*, is rather expensive, and it is necessary that we complete our operations as soon as possible. We do not intend to raise the vessel, but we are going to remove the most valuable parts of its cargo."

It may be of interest to note here that in the Leavitt deep sea diving armor, the body is under atmospheric pressure at all times. The *Lusitania* was one of the ships insured by the British Government, and therefore anything saved may be claimed by the British Government. This question will have to be decided in international courts. Any ship on the waters is considered the property of the concern owning the ship until the vessel is sunken or abandoned. A ship is not abandoned as long as there is one living person aboard.

H. Ensor, lecturing before the *Engineering and Scientific Association of Ireland* as long ago as February, 1919, discussed the difficulty in raising the craft. Mr. Ensor raised a ship of 3,000 tons, but stated that the *Lusitania* was subject to an enormous pressure of at least 140 pounds per square inch and therefore this pressure may have crushed her sides in. This the writer does not believe, inasmuch as the seams along the deck of the vessel are not watertight and those near the watertight compartments will probably give, due to the strain, whereupon the water rushing in will equalize the pressure within and without.

Count Zanardi Landi, managing director of the *Liverpool and London War Risk Association*, has devised a diving suit which he claims makes it possible to work in depths of 500 feet, withstanding a pressure of 1,500 pounds to the square inch. He proposes to float the vessel by its own buoyancy, which, in his opinion, is the only way the vessel can be raised. He further thinks that there is no reason why the vessel should not be lifted in its entirety, inasmuch as she was one of the strongest vessels ever built. Before the war, Count Landi salvaged the *King Alfred*, a British battleship of 37,000 tons, but it was not as ponderous an undertaking as the raising of the battleship *Maine* in Havana Harbor.

Simon Lake, renowned inventor of submarines, who has built submarines for foreign countries and for the United States, agrees with Count Landi. Simon Lake has also invented a deep sea apparatus, and proposed the raising of any vessel, regardless of the size, using his special apparatus for that purpose. Attaching buoyant chambers to a ship is not practical in his opinion, and his proposition is to fill the vessel, or at least partially fill it, with melted paraffin as a sealing material and conveyor and with balsa wood. His salvaging device was described and illustrated in the October, 1919, issue of this journal, at which time the writer was aboard as a witness to the first public demonstration given by him.

Simon Lake's Ideas

Simon Lake, who needs no further introduction, said: "In the salvaging of a vessel like the *Lusitania*, the question naturally arises, 'Why can't she be raised by forcing

(*Continued on page 303*)

Can the "Lusitania" Be Raised?

(*Continued from page 301*)

the water out of her, the same as a submarine is raised?' The answer is, of course, she can be so raised, but inasmuch as she has not the necessary appliances, whereby she can do so herself, those appliances must be brought and applied to her. In other words we can restore buoyancy by either pumping the water out of her, or forcing it out by compressed air, or attaching tanks to the vessel and raise it in that manner. The use of air in a submarine is entirely practical, because she has been designed with sufficient strength to permit that being done as she can be hermetically sealed, being built like a steam boiler, but the ordinary cargo or passenger vessel cannot be sealed. It will perhaps not even stand a pressure of five pounds per square inch, or 720 pounds per square foot, if applied under her decks. Neither are these decks or side seams caulked and cementing or caulking a vessel at the bottom of a 285-foot column of water is not a very simple matter.

Why Tanks or Floats Cannot be Used

"Applying buoyancy to the vessel in the form of many thousands of barrels requires that they be held down and stored into the hold of the ship by divers. This means that just as many operations for connecting of the air hoses are necessary. Of course, we are assuming here that vessels such as wooden vessels, having but very little negative buoyancy, are not considered. Air bags, of course, are an improvement and some of them will lift 10 to 15 tons."

Mr. Lake continued: "Lieutenant Hobson, shortly after the Spanish-American war, used air bags in his futile attempt to raise the steamship *Macedonia* sunk off Long Branch, New Jersey, but not in very deep water. These bags are often ruined by chafing against the beams of the vessel. The pontoon method, such as was used some years ago in raising the steamship *Atlas*, sunk in the Hudson River, near Cortlandt Street Ferry, is all right in comparatively still water, but disastrous where there are any waves. For instance, the *Atlas* after being securely roped and chained, had pontoons attached to the chains. The swells from ordinary ferry boats cost the salvaging company a loss of $35,000 by breaking the heavy lifting chains. It would be quite impossible to pass these chains under a ship such as the *Lusitania*, however. We often find that if we have a vessel at the bottom of the water possessed of a negative buoyancy of 5,000 tons, and attach pontoons thereto which by calculation should give a positive buoyancy of 6,000 tons, that the vessel will not raise. I had such an experience at the Baltimore Dry Dock Co. when the *Argonaut* (the name of the salvage vessel attached to the communicating chamber on Simon Lake's craft) failed to come up as promptly as I expected she would. The center tank was empty, which should have been ample to raise her. Then the forward and after tanks were emptied and she still remained at the bottom, it was necessary to pump nearly all the water ballast out before she broke loose. This was because of the fact that she lay at the bottom where there was soft mud and she had gradually settled in it. This soft mud formed a packing and prevented the water flowing around the bottom quickly.

Simon Lake's Method Applicable to the "Lusitania"

"In my method of raising the vessel, I intend to use a self-contained method of floatation. The work can be stopped at any moment and continued again when desired. Thus I simply restore the original buoyancy to the vessel. On the salvaging vessel I have

(*Continued on page 305*)

A NON-BREAKABLE BLANK RECORD INVENTED

A non-breakable blank made out of a metallic product, that will record when placed on any make phonograph one's voice, musical instrument, band and orchestra playing has been invented, patented and will soon be on sale in music stores found throughout the country.

This new record, which is made in six, eight and ten inch sizes, blanks, will sell for twenty-five and fifty cents for use by individuals who may desire to make their own records. The invention permits recording of any sound and reproduction without changing the reproducer on an ordinary phonograph. Ordinary steel needles are used to make the record and to reproduce it.

Made of a special composition, the record has about the same weight as steel. It is like aluminum in appearance. It is impossible to damage it even by scratching, bending or otherwise mutilating it, as the record preserves the sound-grooves without variation by expansion or contraction. In making a record from a blank, it is possible to speak into the sound box of an ordinary phonograph to reproduce sound exactly. As unusual as it may seem, there is no metallic sound on reproduction. However, the best records can be made by the use of a special reproducing horn, which can be attached to any machine. This reproducing horn will be made by a certain Eastern manufacturing concern and will retail at a small price. The record may be played at least one thousand times with a steel needle or five thousand times with a wooden needle. Furthermore, it can be replated four or five times without diminishing the sound. Previous recordings are obliterated by reproduction. The inventor said that it is possible to put the blanks on the market at twenty-five and fifty cents, as the metals used are common and not costly.

An instrument is now under development, to record sound waves via radiophone for transmission to phonographs. This will soon be put on the market. The instrument can be used on any make of machine, and will make it possible to record music hundreds of miles away and record it permanently without great loss of volume. The inventor said that the steel records will record about eighty per cent of the actual sound volume. The composition of the record is, of course, secret, but he said that the metal is comparatively soft. The expansion and contraction is not as great as in wax.

With the aid of this new record, it will be possible for one from home to send a personal message to home, recording his own voice. The record need merely be dropped in a postal box after affixing a stamp and writing the address on a label.—*A. H. Kolbe.*

CAMPHOR AS A BY-PRODUCT

The first shipment out of Brockton of camphor as a by-product of the shoe industry was three tons.

The camphor is from the chemical department of the Walk-Over plant. The originator of the camphor business as a by-product is Stanley P. Lovell, superintendent of that department.

Can the "Lusitania" Be Raised?

(Continued from page 303)

tanks in which melted paraffin and balsa wood are found. This is pumped into the sunken vessel by centrifugal pumps, passing thru a pipe surrounded by another, thru which steam flows, so as to prevent the liquid from solidifying before it reaches the bottom. The cost of the operation is very light. The liquid hardens almost immediately after passing into the vessel and, being lighter than water, floats up to the roofs of the respective decks and forces the water out. Simultaneously with this operation, I intend to surround the vessel with pipes which will force jets of compress air between the vessel and the bottom upon which it rests so as to practically neutralize any suction.

"I do not know why there is so much controversy over the *Lusitania*, as there are countless other vessels presenting less hazardous work with as much promise of good financial returns. For instance, in just a few days I have located 16 vessels which were not even registered, and have pumped thousands of tons of coal from old barges sunk in Bridgeport Harbor. Some of the coal recovered is known as Peacock coal, and has not been seen here for 35 years or more."

In the Simon Lake apparatus there is a long steel tube communicating with the mother ship above and the operating vessel below. This operating vessel has an air chamber to which compressed air can be admitted with a door in its bottom to permit divers to pass to and from the operating vessel.

Merritt & Chapman Wrecking Co., probably the largest wrecking concern in this country, is not of the opinion that the *Lusitania* will be raised or any part thereof recovered.

The Williamson Method

Captain Charles Williamson is the inventor of an industrial sub-sea apparatus for universal use. It may be of interest to the readers to consult the February, 1920, issue of SCIENCE AND INVENTION magazine, then called the ELECTRICAL EXPERIMENTER, where an article on this device appeared.

With Captain Williamson's apparatus the film pictures for "Twenty Thousand Leagues Under the Sea," "Wet Gold," "The Williamson Submarine Exhibition," and other motion pictures were actually taken below the surface of the waters. Asked whether in his opinion, vessels such as the *Lusitania*, could be raised from the bottom of the ocean, Captain Williamson said: "Any vessel lying on the ocean's floor at depths such as the craft referred to are or at even greater depths, which crafts, if they are yet staunch enough to withstand the strain of removal can most assuredly be salved of not only their contents, but their entire bulk, and be refloated, just as positively as tho they were merely lying but a few feet beneath the ocean's surface or in a dry-dock. It is quite impossible to perform any sort of work upon a ship by men enclosed in the heavier metal armors. The movement of the parts such as the arms or legs, are very limited in these apparatuses. Observation is relatively poor and endurance is likewise greatly shortened."

The Williamson apparatus is a very simple construction in the form of flexible, cylindrical working sections, at the end of which is an operating chamber.

After the salvaging vessel is properly anchored, the operating chamber is released—it floats. A unit working section made up of ten or more smaller units, is then clamped in place by clamps similar to those used on the bulk-head doors of ships. The operating chamber is released and again the apparatus

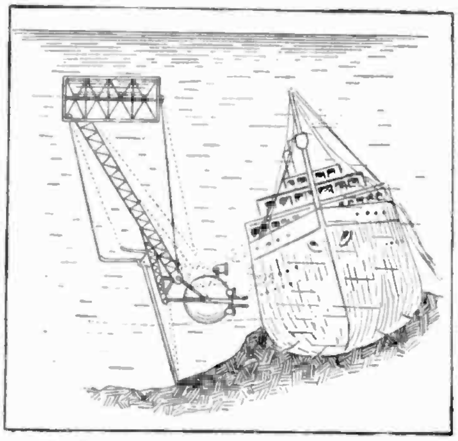
(Continued on page 307)

Can the "Lusitania" Be Raised?

(*Continued from page 305*)

floats away. Extra sections are placed on top secured to the section and the working chamber begins to sink deeper and deeper; at all times the entire apparatus is buoyed by the water displaced. We now have a veritable hole in the water, at the bottom of which is a large operating chamber from which any form of work can be conducted, the operators there performing their work at all times under atmospheric air pressure. Tools of any form are dropped into an air-lock, and may be reached at from the outside; the hands being in steel gauntlets, powerful enough to withstand the pressure, yet free enough to permit of their proper operation. A steel plate could thus be attached to the sides of the vessel, as for instance, the *Lusitania*, using ordinary tools. If the operating chamber is anchored either to the vessel or to the bed of the ocean, while the vessel at the surface of the water rocks up and down, the cylindrical communicating cylinder will expand and contract like the bellows of an accordion.

Another invention which aside from the Soisson apparatus, described in the September, 1918, issue of this journal, yet resembles it and which has recently been patented, is the salvage apparatus of Chas.



The Salvaging Apparatus of Charles W. Eveleth, is Illustrated Above. The Rodlike Device Extending from the Bottom is an Anchoring Point. This is Bracketed to Permit the Spherical Housing Containing the Marine Workers to be Shifted Forward in Contact with the Vessel, Whereupon These Workers May Drill Holes in the Sides of The Sunken Vessel and Insert Bolts for the Attachment of Pontoons. The Float from Which This Apparatus is Suspended is Shown Here Below the Surface of the Water, to Which Position it is Permitted to Sink by Filling Ballast Tanks with Water. Telephonic Communication with the Divers is Possible at All Times from a Parent Ship, Not Shown in the Illustration.

W. Eveleth. The operation of the device will only be discussed here. The wreck having been located by sounding or otherwise, the cage and the associated parts is lowered until the globe with the human operators therein is placed in the vicinity of the wreck. Telephonic communication with the vessel in attendance is at all times possible. The position having been obtained by manipulating the propellers, a bracketed arm with a pointed anchor on the bottom, is permitted to rest upon the bottom and the globe rocked forward on its anchoring point, until the buffers engage the sides on the wreck. The mechanics there can now drill holes into the wreck and insert bolts of the expansible kind and attach the necessary floats to the vessel. This operation is continued all around the wreck until floats have been secured along the sides from stern to bow. It would seem that in ordinary merchant vessels, equipped as they are with thin steel plating, more like an egg than anything else, the entire sides of the vessel would be ripped off if any attempt were made to inflate the tanks.

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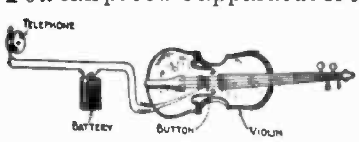
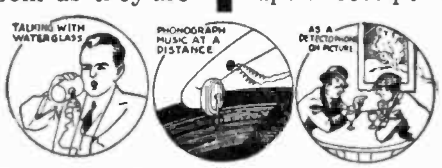
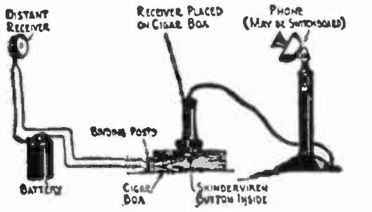
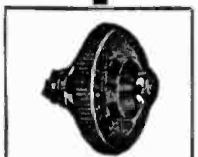


One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world.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



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



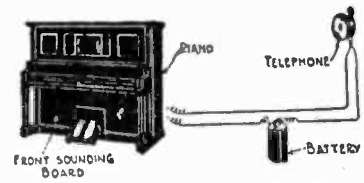


Actual size.

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

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

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



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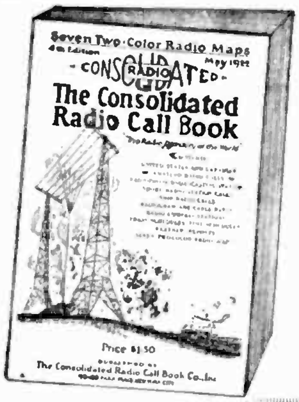

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