April

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Ralph H. Berndt, Treasurer and General Manager, W. C. DuComb Co., Inc., Detroit. "LaSalle has been the instrument to my success."

Annetta L. Koch, Assistant Manager, Hotel Secor, Toledo, Ohio. "When I enrolled with LaSalle, I was a bookkeeper of average ability. The results of my training soon became apparent. I was promoted to Auditor and then to Assistant Manager. My salary was increased substantially—which increase in several months completely paid the entire cost of the training."

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At sixteen, Ralph H. Berndt—his schooling ended with the eighth grade—entered the Carnegie Union Steel Mills, at Youngstown, Ohio. His wage was $2.15 a day, and his working day was twelve hours long.

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His apprenticeship was short. Almost before he knew it, an opening came with W. C. DuComb Co., Inc., Detroit, and he got the place—as Accountant, then Auditor! Raise followed raise.

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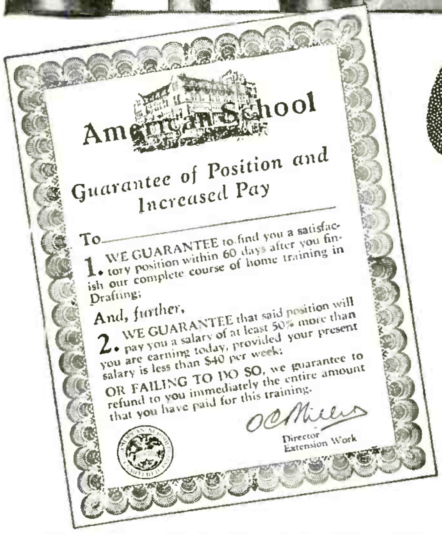
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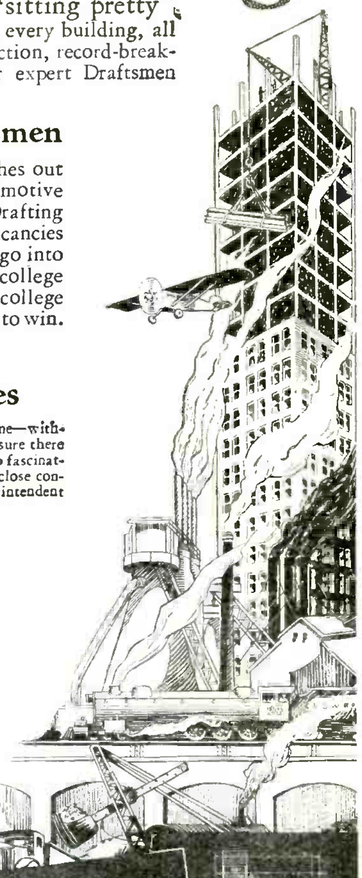

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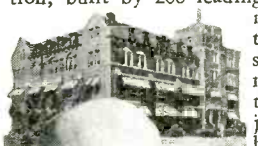

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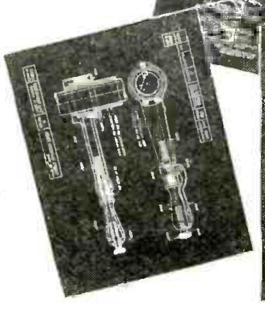

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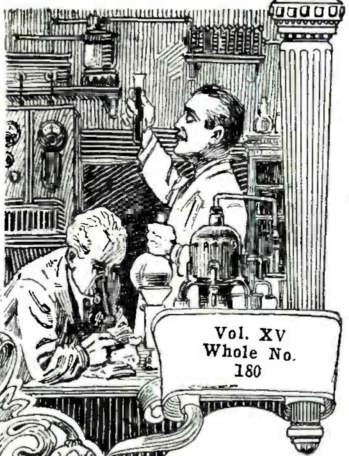

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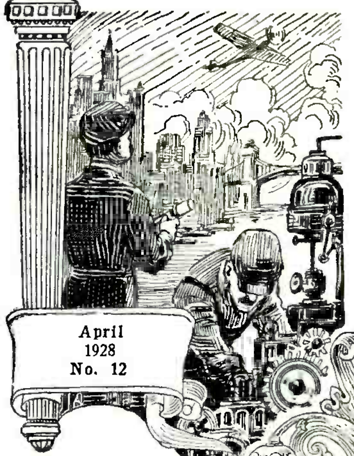

Formerly ***ELECTRICAL EXPERIMENTER***
COMBINED WITH "THE EXPERIMENTER"

EDITORIAL, ADVERTISING AND GENERAL OFFICES:
230 Fifth Avenue, New York City

Vol. XV
Whole No. 180

April
1928
No. 12

Published by Experimenter Publishing Company, Inc. (H. Gernsback, Pres.; S. Gernsback, Vice-Pres. and Treas.; C. E. Rosenfelt, Sec'y.

Publishers of SCIENCE AND INVENTION, RADIO NEWS, RADIO LISTENERS' GUIDE, AMAZING STORIES and FRENCH HUMOR

IN MAY ISSUE

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Predicting Earthquakes

The very latest method of predicting earthquakes by scientific methods. The system is astonishingly simple, and should prove very valuable in the future.

Testing Cloth

This article, written by an eminent chemist, explains how to determine by simple tests what kind of cloth your suit or dress is made of. Rayon tests are included.

Death to Household Pests

The latest means of annihilating household pests, such as insects, rodents, etc.

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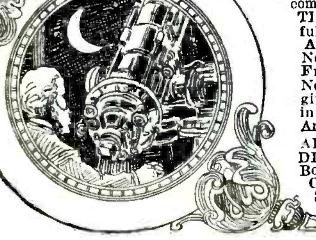
HOW TO SUBSCRIBE FOR "SCIENCE AND INVENTION." Send your name, address and remittance to Experimenter Publishing Co., 230 Fifth Ave., New York City. Checks and money orders should be made payable to Experimenter Publishing Co., Inc. Mention magazine desired, inasmuch as we also publish RADIO NEWS, AMAZING STORIES, RADIO LISTENERS' GUIDE and FRENCH HUMOR, a weekly. Subscriptions may be made in combination with the other publications just mentioned at special reduced club rates. Send postal for club rate card. Subscriptions start with the current issue unless otherwise ordered. ON EXPIRATION of your subscription we enclose a renewal blank in our last number to you, and notify you by mail. Then, unless we receive your order and remittance of a renewal, delivery of the magazine is stopped.



SCIENCE AND INVENTION is published on the 10th of each month. There are 12 numbers per year. Subscription price is $2.50 a year in U. S. and possessions. Canada and foreign countries, $3.00 a year. U. S. coin as well as U. S. stamps accepted (no foreign coin or stamps). Single copies, 25c each. All communications and contributions to this journal should be addressed to Editor, SCIENCE AND INVENTION, 230 Fifth Ave., New York City, N. Y. Unaccepted contributions cannot be returned unless full postage has been included. ALL accepted contributions are paid for on publication. SCIENCE AND INVENTION Monthly Entered as second-class matter May 10, 1924, at the Post Office at New York, N. Y., under the act of March 3, 1879. Additional entry at Dunellen, N. J. and San Francisco, Calif. Title Registered at the Patent Office.

SCIENCE AND INVENTION is for sale at all newsstands in the United States and Canada. European Agents, S. J. Wise Et Cie, 40, Place Verte, Antwerp, Belgium.

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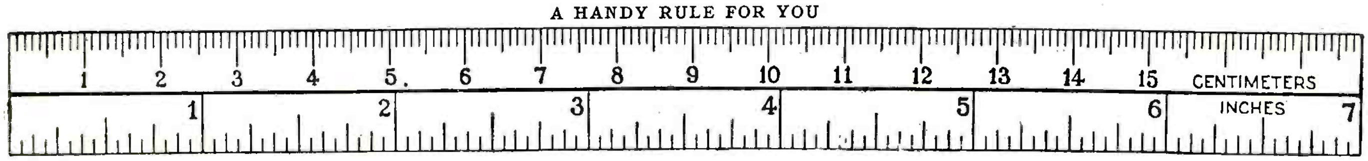

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Volume XV
Whole No. 180

Science and Invention

APRIL, 1928
No. 12

HUGO GERNSBACK, *Editor-in-Chief*
H. WINFIELD SECOR, *Managing Editor*
DR. T. O'CONOR SLOANE, PH.D., *Associate Editor*

Editorial and General Offices - - - - - - - - 230 Fifth Avenue, New York

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

A MAGAZINE WONDER

By HUGO GERNSBACK

NOT so many moons ago, King Outis VII of Erehwon sent us a most flattering letter about this magazine. He said he had derived great enjoyment from it and he would be pleased to meet all of the men responsible for the making of this magazine. He let it be known that he would pay all the expenses for the round trip and would entertain everyone while in his Kingdom royally. So in due time, we chartered the *Leviathan* and set sail to the country of Erehwon. At the dock we were met by the King's Premier, who professed astonishment at the thousands and thousands of people who had embarked upon the World's largest steamship to heed the King's summons. We in turn assured the Premier that it was quite impossible, for reasons we would explain to the King in person, for all the people responsible for the making of the magazine to come at this time.

In due time, we were presented before the noble King. As his Palace proved far too small to hold the thousands of people we had brought along, it was made an open air affair in one of the country's large stadiums.

One by one we undertook to present to the King the people responsible for bringing to life a modern magazine. First, there were of course, the editors. Then also naturally, the staff of artists. Next, the advertising staff of the magazine. Then following, several hundreds of charter subscribers. We hastened to explain to the King that we should have brought along over 100,000 more readers of the magazine, all of whom are responsible for the magazine—because without the readers we could not publish it; but we thought there were not vessels enough to bring this great crowd, so we had just chosen a select few. We next presented the head of the institution which makes our engravings. Then in rapid succession came the heads of the printing establishment and paper manufacturer. When we came to the paper manufacturer, there was a cluster of several dozen men arrayed around this particular manufacturer. The King inquired who these men might be. We explained that it would be impossible to print the magazine without the materials that went into the making of the paper. We told him that our paper first was made of sulphite pulp and one small group of men were responsible for that. Then there were several dozen representatives of the chemical houses who furnished the chemicals for making the pulp and bleaching it.

There was the head of the coal mine who made excuses that he could not bring all of the miners. The King courteously asked what coal had to do with the magazine. It was explained to him that without coal, no steam could be generated and steam was needed to make paper. There were also represented a number of water-power engineers who furnished the water-power to make paper. Another head of another chemical house was introduced to the King, and who explained that his house furnished the clay sizing used on the cover stock. Then there were several hundred people who, for lack of time, could not be introduced. These good men were responsible for making the machinery with which paper itself is made. The printer, himself, had a big delegation running into many hundreds, most of whom could not be introduced either, for lack of time. There were linotypers, compositors, proof-readers, pressmen and dozens of others. Grouped around them again were many hundreds responsible for the manufacturing of the printing presses, linotype machines, and general printing machinery. The binding class, that department that binds the magazine, also could not be represented in full force, because they again numbered thousands, so we only introduced the head men of the force of a modern bindery.

The photographers' turn came next and they had a good sized army to introduce as well. In this group were photographers, hand-tool men, chemists, color men, etchers, expert chemists and dozens of others, all responsible for furnishing the engravings that go to make up a modern magazine.

At this juncture, the King noticed an unusual number of miners among the guests. He waxed curious to know why there were so many. We hastened to explain to him that there is practically no metal that does not enter into the making of a modern magazine somehow. Steel is used in machinery such as the linotype machines and printing presses. Lead and antimony, sometimes also bismuth, tin and copper go into the type metal. Copper and zinc constitute brass used for rules. In photo-engraving, silver is used for sensitizing plates and paper, and gold for toning. These are not all the metals used by any means.

The King snorted his appreciation at this information, but suddenly espied a living hen among all the guests. He wanted to know what the hen had to do with producing a modern magazine. It was quickly explained to him that eggs were used in the photo-engraving process to supply albumin, in the making of the half-tone engravings in connection with the magazine, without which, the cuts could not be produced. The King was much surprised at this information.

The King next noted a Chinaman among the guests and wanted to know what he had to do with the magazine. We informed him that our draftsmen, in making the original drawings of the magazine, used only the imported China ink, which this particular Chinaman produced and exported.

Suddenly the King noticed one of his own bronze-complexioned subjects among the guests. Upon inquiry it was found that he had been invited for the simple reason that he was a Chief of the King's graphite mines, who exported graphite to the United States, where it was used not only in the making of pencils, but in quantities in the electrotyping process. That seemed to please the King a great deal. He was quickly informed, however, that the head of practically every one of his industries in the whole country could have been summoned, because each one was representative of some part that goes into the making of the magazine. There grew, for instance, in the King's own country, sisal, which goes into the making of string and cord for tying up magazines.

Then in rapid succession we introduced to the King the heads of the various railroad and steamship companies that transport the materials that go into the making of the magazine, as well as retransporting the magazines to the four corners of the earth. Even the U. S. Government was represented in the rôle of the U. S. Post Office, which does the lion's share in seeing that the magazine gets to its destination.

There were on hand, the heads of some hundreds of news companies who distribute the magazine to some 35,000 newsdealers throughout the world. Lacking room, of course it was impossible to bring along the 35,000 newsdealers, so we had only brought along a few hundred of the most representative ones.

The ink manufacturer had brought along several hundred men himself, all of which were responsible for making the ink that goes towards making a magazine. There are, of course, many separate industries, such as producers of rosin and makers of lamp-black, that go into the making of ink, and the King was informed most minutely on this subject as well.

The monarch next wanted to know who all the pretty girls were that had clustered together in one aggregation. We informed him immediately that they were secretaries, stenographers and typists, as well as editors and proofreaders and many others who had directly to do with the production of the magazine.

The firm that did the composing had several dozen girls that performed various jobs in connection with the magazine. The printer had a number of girls who were either bookkeepers or stenographers, through whose hands passed the bills for the magazine, and the same was true of practically every other industry connected with the production of the magazine.

The heads of the telephone, telegraph and radio corporations who take care of the magazine's message service, were of course represented in full force as well. It would be impossible to produce a modern magazine without telephone and telegraph. The radio company was represented not only on account of the radio messages that the magazine sends and receives, but their department of radio pictures was well represented too, because the magazine receives photographs by radio from abroad and through long wire stretches in the United States quite frequently.

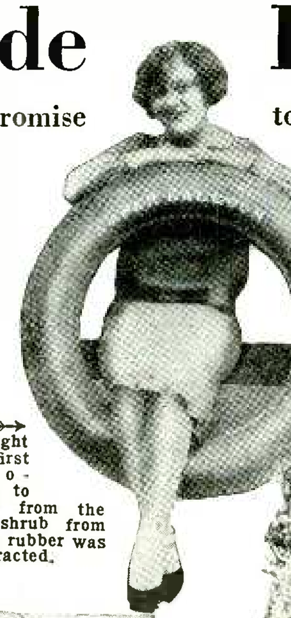
It had taken the whole day to introduce the various factions to the King, and yet, we had not even gotten down to one-half of our presentations. We noticed that the King frequently yawned. As a matter of fact, we knew he was getting tired. Said he, "This has been a most remarkable experience for me. I had no idea when I sent my message to you, that it would be necessary to present to me practically all the civilized inhabitants of the globe, but it seems you are right, and you carried out my summons to the best of your ability. Of course, I will be glad to pay the bill, although it is ten-thousand fold greater than what I expected. The Chancellor of the Exchequer will see to it that your army is transported home in due time."

We thanked the King profusely and were about to withdraw, when he noticed a particularly sticky individual who insisted on shaking hands with him. This individual exuded a peculiar odor and the King wanted to know who he was. We told him that he was indeed quite important, and without him it would be difficult to make the magazine. We told the King that he was the glue manufacturer, who manufactured the glue used in fastening the cover to the magazine. But the King had fainted, and being tired ourselves, we repaired to the King's dining hall, where dinner awaited.

Rubber Made From Shrubs

Guayule and Cacti Promise to Supplant Rubber Trees

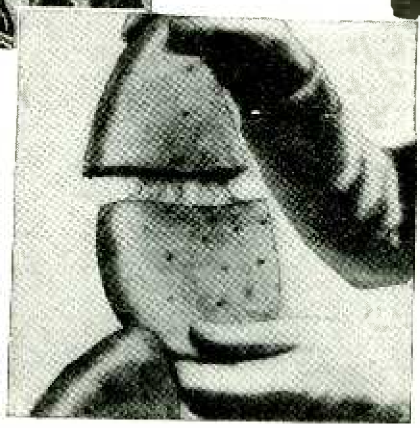
RUBBER has innumerable applications in our everyday life, and more than 50,000 articles now in common use are made entirely of rubber or make use of it in some part of their construction. Rubber independence is a factor of vast importance in international politics



At the right is the first automobile tire to be made from the guayule shrub from which the rubber was extracted.

C. G. Marshall is shown below inspecting a three year old guayule plant which Sec. Hoover says can be grown in the United States. The plant will yield as high as 20 per cent rubber. The shrub shown below is only about half grown.

Dr. John C. Wishmann is shown above inspecting the cactus from which he has succeeded in procuring a rubber substitute. The cactus lobes are cut from the stalks which are left to grow another crop.



The photo at the right shows one of the cactus lobes which has been cut apart. Notice the sticky gum stretched across the gap from which the rubber is produced. The lobes are first cooked and then the gum is pressed out as a liquid.

The photographs reproduced here show the two plants from which a rubber substitute was obtained. The first automobile tire made from this rubber substitute may be seen at the top. More than 2,000 acres of the guayule shrubs have been planted in California. The production of rubber from plants in this country has been taken up as a subject of investigation by Thomas A. Edison.

and in the maintenance of world peace. During the last war, Germany keenly felt the inadequacy of its rubber supply when it was cut off from the outside world. The United States produces less than 3 per cent of the rubber which it uses. The havoc wrought in Germany from lack of rubber would be mild in comparison to that certain to follow a rubber famine in America.

Recently, Dr. John C. Wishmann of Los Angeles, has patented a process of procuring a rubber substitute from the cactus. Cactus lobes are cut from the stalks and are macerated and cooked half an hour. The gum which is of the color and consistency of molasses is then pressed out. The by-products are removed and the gum is mixed with mineral compounds until it forms an elastic, sticky mass. The photograph on this page shows the mucilaginous gum film which exudes from a freshly-cut cactus.

While Edison and other noted inventors have been endeavoring to find a substitute for rubber, the United States Department of Agriculture Experimental Station, has grown acres of guayule plants, in San Diego, California, and has been able to produce guayule rubber which compares favorably with that grown in the tropics. The guayule plants yield from 7 to 10 per cent rubber, and even as high as 20 per cent rubber has been extracted.

More than 2,000 acres of the guayule shrubs have been planted in Monterey County, California. The shrub grows to a height of only two feet, requires seven years to mature, needs very little care and does not have to be tapped daily. Without a doubt, the United States may now control its rubber future.

In order to obtain rubber from the guayule the whole shrub, root as well as branches, is first crushed by a series of rollers in the presence of water. After crushing, the mass is fed with additional water to a tube mill. These mills contain flint pebbles and revolve slowly on a horizontal axis, and a further disintegration of the fiber of the shrub is accomplished. This action, which is called "worming," transforms the rubber substance into small, round, spongy particles. These particles of rubber, being lighter than water, float on the surface of the discharged liquor from the mills, while the bulk of the fiber and other impurities sink and can be readily separated. The particles of rubber which rise to the surface of the settling tanks into which the liquor from the tube mills is run, are skimmed off and collected. These are further purified and are then worked into sheets, well washed and dried. Guayule rubber, when extracted with acetone, in tensile properties is comparable to the plantation crepe obtained from the rubber tree in the tropics.

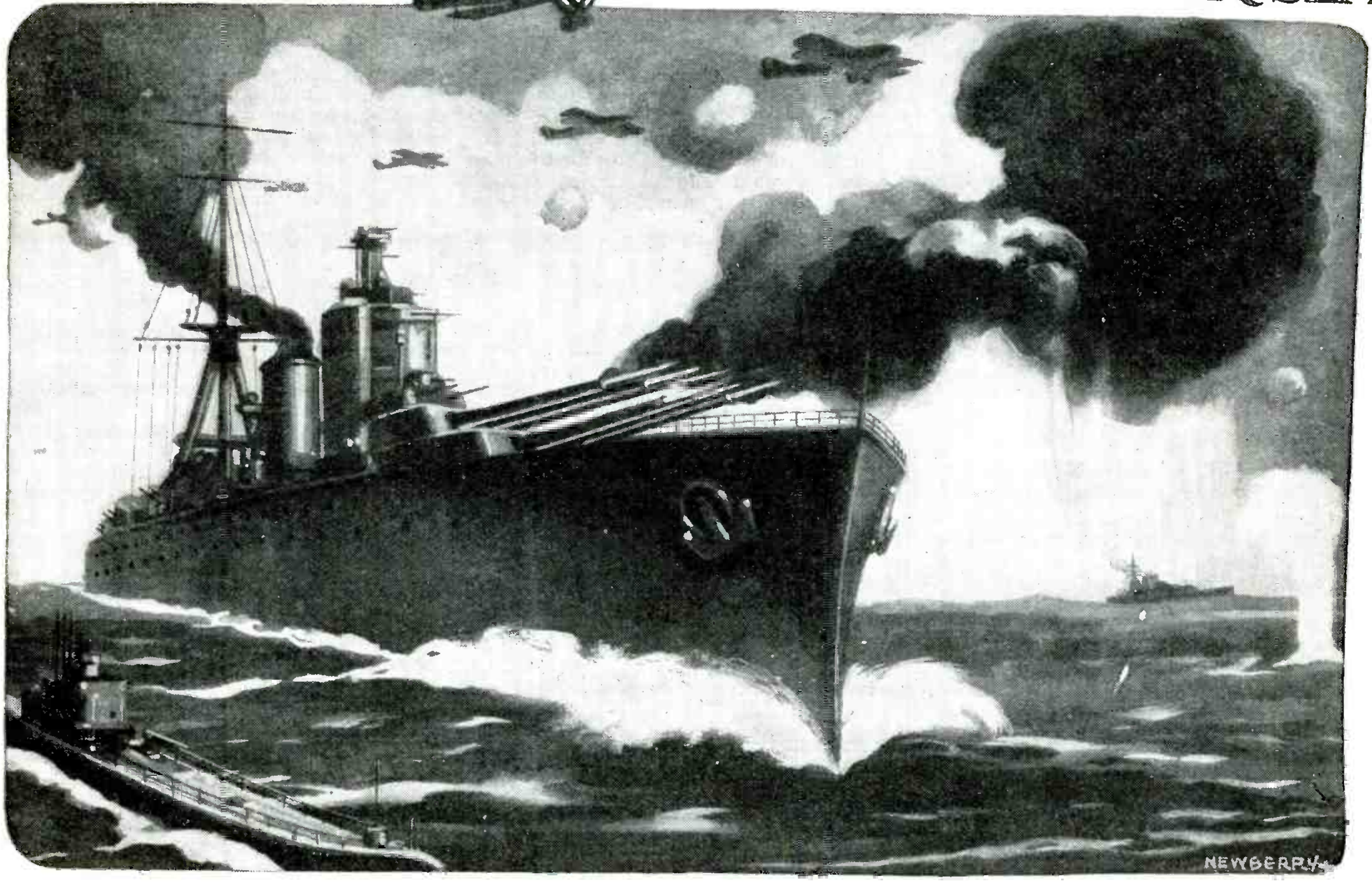
AT last America has found a way to grow its own rubber and become free from the danger of a foreign monopoly. The United States now produces less than 3 per cent of the rubber which it uses, but as explained in this article, we may control our rubber future. Thomas A. Edison is actively interested in devising improved methods for speeding up rubber production from plants.

Notwithstanding the limitations of necessity imposed on the results so far, the United States Bureau of Standards, after exhaustive tests, states that the guayule shrub by suitable treatment and when properly prepared, will yield rubber which compares favorably with that from the rubber trees, and can be used to a large extent as an equivalent. Guayule rubber mixes readily with compounding ingredients and appears to have a greater capacity for dispersing them than does ordinary rubber. The tests conducted by the Bureau show the usual dropping off in tensile strength and elongation properties with aging. They also show the marked improvement in this regard brought out in the suitable treatment of the shrub. The drop in tensile strength and elongation properties in the case of the treated product compares favorably with results obtained from first latex crepe of tree rubber under similar conditions.

The guayule shrub will grow readily in warm climates such as Arizona, South Carolina and California. It is estimated that in order to supply one-quarter of the rubber needs of this country, 640,000 acres of this shrub would be required. Even though we should produce rubber to meet a quarter of our needs it would prevent the domination of a foreign monopoly.

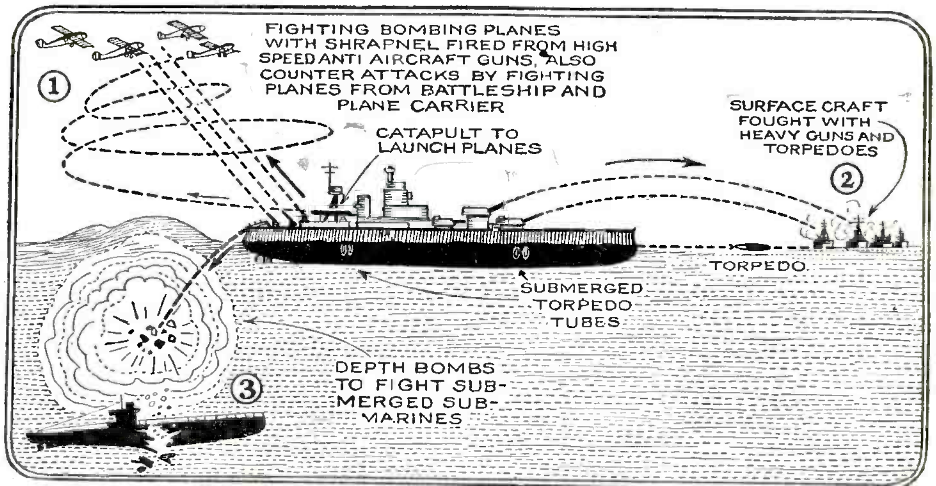
All natural rubber contains resinous matter which is inelastic. Para rubber contains the least of all, about 3 per cent, African about 10 per cent and Guayule contains about 40 per cent. These resins can be extracted by means of solvents, such as acetone. The purest kind of rubber is now made synthetically. In England, it was at first made from acetone and later from fusel oil. The German Chemical Trust has succeeded in making synthetic rubber from coal. Artificial rubber is a chemically pure hydrocarbon, is free from ash and other impurities, and for electrical work is more uniform and reliable than the natural product. It is as a substitute for hard rubber, that the synthetic product has thus far scored its chief success. Dr. Burgdorf of Germany estimates that the capital required for a plant having a capacity of 3,000 tons of artificial rubber per year would be between ten and fifteen million dollars, exclusive of equipment necessary to provide material to start. For further details on Guayule rubber, refer to "The Story of Chemistry," by Prof. Darrow.

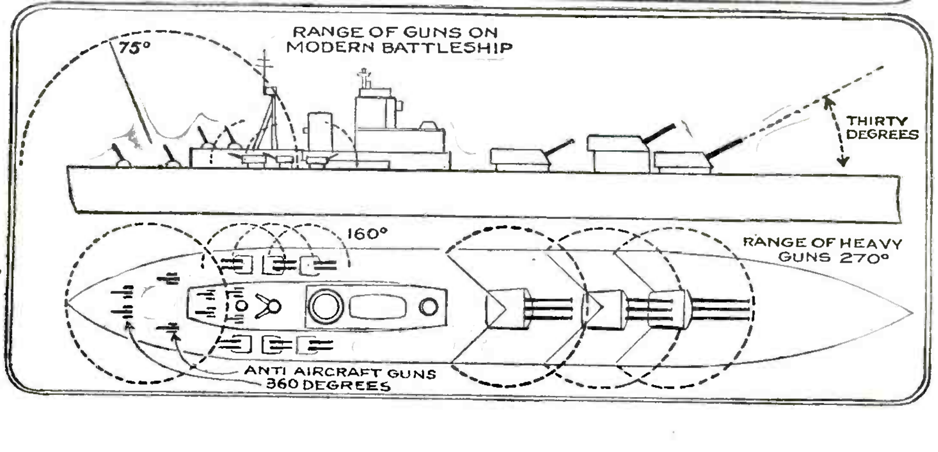
NAVY NOW FIGHTS IN AIR ON SURFACE UNDER SEA



By H. WINFIELD SECOR

ENEMY aircraft, such as bombing planes, are fought by means of the anti-aircraft guns, and they are also open to attack by fighting planes launched by catapaults from the warships, supplemented by other planes launched from special airplane carriers. Naval architects have had to practically redesign the super-structure, and protective armor decks of war vessels, so as to withstand the effect of aerial bombing. Enemy surface craft is attacked by fire from the big and medium-size gun batteries, the big guns attacking first if the range is considerable. A very interesting diagram is the lower one, which shows the vertical as well as the horizontal range of the revolving turrets carrying the 16-inch guns on the new British battleships. While a maximum range is attained when a gun is elevated to 45 degrees vertical angle, the big guns on modern warships are not designed to be elevated more than 30 degrees, which gives the desired all-around results. Many of the big guns on our warships cannot be elevated more than 15 degrees, with a consequent loss in range. The anti-aircraft guns have an average elevation range of 75 degrees, and can be swung around through 360 degrees. Surface craft are also attacked by torpedoes fired from submerged tubes on war vessels, as well as from deck tubes. Submarines are attacked when submerged by depth bombs, usually dropped from destroyers.





The diagrams at the right show how modern naval battles have to be fought in three zones. Fighting planes and anti-aircraft guns attack the enemy in the air; surface craft are attacked by gun fire, airplane bombs and torpedoes, submarines are fought with depth bombs.

How to Make Ocean Flying Safe

The author has had wide experience in both flying and designing planes and dirigibles; our readers are here given a vision of future ocean flying

By WILLIAM P. SULLIVAN
Aeronautical Engineer

THE crossing of the Atlantic Ocean by airplane has been in the past few years and up to the present time a matter of great risk and daring for the ones attempting such a flight. Planes have accomplished the feat and also failed in attempts but always coupled with the glare of a sporting proposition which precedes almost any new development likely to create a vast change in our present methods. This is natural in any case where there is something yet to be achieved and the inventing of daring risks for someone to accomplish will continue as long as man yearns for glory and publicity. Real accomplishment, however, follow these trail blazing endeavors only after they have been brought to man's attention and improved upon scientifically.

WHY PARIS-NEW YORK FLIGHT FAILED

The present continuous, non-stop flights over great distances will not be the method by which the oceans will be spanned in the future. Failure to negotiate the Paris to New York flight was due to the plane being loaded to unsafe capacity with fuel sufficient to cover the great distance without a stop, a minimum of food and supplies for the pilots and little or no equipment so vitally necessary for such a voyage. Aside from the slight technical and publicity values derived, such long non-stop flights are for the most part foolhardy and perilous adventures, the prizes and glory accompanying such feats being well earned by the brave men that have been fortunate enough to successfully accomplish them. At any rate they do not embody, to any great degree, a sound commercial aspect and the only logical reasons for crossing the ocean by air; namely, to reduce still lower the time of travel between the two continents, the financial gain resulting from this saving of time and the carrying of sufficient cargo to make the trip profitable.

To the layman these present-day trips mean nothing aside from the thrill derived when a much heralded attempt to fly the ocean finally proves successful. He commences to calculate how a trip say from New York to Paris by air without a stop, could become a commercial proposition. But he does not have to go far before he discovers that the weights of the fuel and supplies the plane would be forced to carry to complete the total distance, together with proper equipment, would sum up nearly equal to the useful load that the plane is designed to carry. His conclusions would be that only the plane and its pilots could make the trip, leaving little or no margin for cargo, or what is termed pay-load. In general he believes that flying between the continents is entirely beyond the realm of commercial aviation and will never become practical.

COMMERCIAL FLYING SAFE AND PROFITABLE

Commercial aviation has reached a point today in many countries of the world where it has become a safe, profitable means of transportation and inherently the fastest, which places it foremost in the field of modern conveyances. This has been accomplished through the enthusiastic and continued efforts of engineers in designing aircraft with a view to safety, ease of operation and the very life of commercial aviation itself, economy, together with efficient airways management. The airplane must take its place in the commercial field as a long distance carrier along with the railroad train and the steamship. It relies on its greater speed for its value to commerce and this speed becomes noticeable only when moderately long distances have been traversed. To cover long distances profitably the airplane must be economical in operation so that the ratio of pay load to total load carried, is high and the cost per pound-mile cut to a minimum.

In the tests of the Bellanca monoplane this plane was loaded to within a safe limit with fuel and supplies and kept aloft for over fifty-one hours, making a world record for continuous flying against time. Such a test proves the efficiency of the plane as regards its load-carrying capacity, fuel consumption, etc., and determines commercial value. This plane could leave New York, cross the Atlantic Ocean and arrive at any of the European capitals with ease, but in doing so no additional technical data could have been formulated. The trip negotiated by Chamberlain and Levine was a dangerous one, the pilots were cut off from communication with the continents while over the ocean, and their lives depended on the successful mechanical performance of the plane and motor, to say nothing of stormy weather conditions encountered during the extremely long period in the air, especially when flying over Europe at the end of the journey.

IN the May issue of this journal you will find a new department that is sure to make you smile, because of its ridiculous ingenuity.

PHONEY INVENTIONS

will portray absurd inventions for producing useful results. For example: A collar button you cannot lose!; a self-cooling, noiseless soup-spoon, and others. Everyone can become a phoney inventor. Don't miss it!

The Atlantic Ocean is a haven for severe storms at all seasons of the year which at times hamper our greatest ocean liners. These storms however, like most atmospheric disturbances are concentrated at low altitudes. As steamships are confined to one altitude they must travel over the surface of a sea, which in turn is also disturbed by the storm and are in reality far worse off than an airplane would be under similar weather conditions, provided the airplane is properly designed and equipped to fly at sufficient altitude above the storm area.

OCEAN AIRWAYS OF TO-MORROW

Future transatlantic airplanes must, like all transportation vehicles, maintain schedules of departure and arrival at destinations. They must carry enough load to make such a venture feasible. Continuous, non-stop flights over great distances at all times will not be practical. If, for example, a flight to be made between two distant points were divided into two equal parts, the fuel supply carried would be cut one-half, and the equivalent weight of fuel unnecessary to carry given over to cargo or pay load. Most all our present-day facilities of transportation are economically designed to operate only over comparatively short distances without refueling.

FLYING THE OCEAN IN SECTIONS

An airline for all practical purposes between New York and London would therefore necessarily be flown in sections, the length of each determined by economy and conditions involved. Leaving New York the first portion of the journey would be made by land planes over an organized airway in various stages, landing at flying field stations for re-fueling and changes in planes similar to our successful airways systems of the present day, to the terminal of the ocean going airliner. This furthermost point by land could be located on the coast of Newfoundland, which is approximately 1000 miles from New York. This could be reached in three stages by land planes. Here the passengers, mail, etc., would be transferred to the high altitude ocean-going plane. This plane with its special equipment and facilities would easily negotiate the much shortened journey across the ocean to the coast of Ireland, undisturbed by normal ocean storms. Flying at high altitudes would enable the plane to easily over-ride atmospheric disturbances of the lower levels. The speed of the plane would be greatly increased by operating in a rarefied atmosphere, which would also minimize the elapsed time in the air for this portion of the journey. The value of this cut in time would offset the extra costs entailed in ascending to and descending from the higher stratas.

HIGH ALTITUDE FLYING

Experiments are now being conducted in Germany with a view of developing an ocean-going airplane, capable of flying at an altitude from 30,000 to 40,000 feet and at a maximum speed of 300 miles per hour. Flights have been accomplished by planes in special tests and the data recorded is of extreme value for the development of this type of plane.

The first test planes are small in proportion to the proposed types for the future airlines and are being constructed entirely of metal. In the fuselage or body is a sealed chamber arranged like a cabin, in which the passengers can be comfortably accommodated. A blower system is installed to supply the cabin with oxygen when rarefied atmosphere is reached and operated in conjunction with the heating and ventilating of the cabin chamber. The power units are equipped with superchargers for maintaining maximum horsepower at all altitudes.

TRANS-OCEANIC PLANES OF THE FUTURE

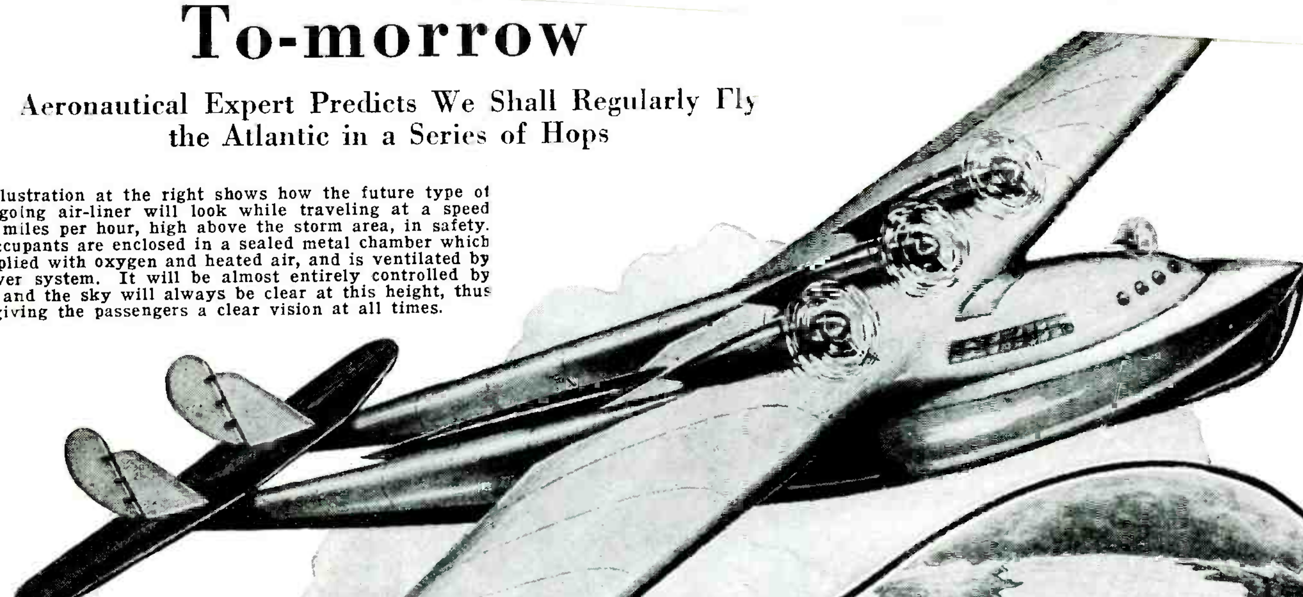
The eventual type of trans-ocean planes no doubt will be designed and constructed from the valuable data supplied in these experiments. They will be large multi-motored airliners, beautifully furnished and equipped with all modern conveniences for the comfort and entertainment of the passengers, who will be transported with as much, if not more, safety than our present day railway and steamship lines provide. Just as a traveler of to-day takes the different methods of transportation to reach the terminals of our steamships, so will the future traveler be transported to the terminals of the airliner of the ocean, which like all successful ventures will be designed for the one purpose intended, that of crossing the ocean from one fixed point to another and maintaining a rigid schedule of departures and arrivals.

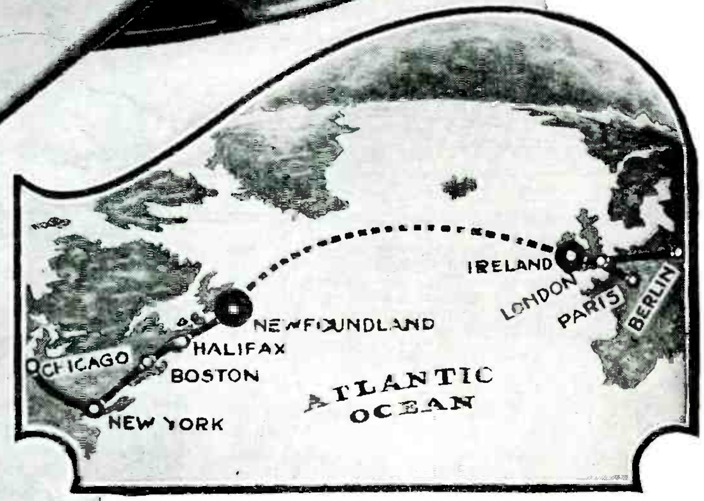
Until such plans mature and planes are built each for its specific class of work, the crossing of great bodies of water such as the Atlantic Ocean will remain an adventure for a few pioneers who are willing to "take a chance" in the interests of progress.

Trans-
To-morrow

Aeronautical Expert Predicts We Shall Regularly Fly the Atlantic in a Series of Hops

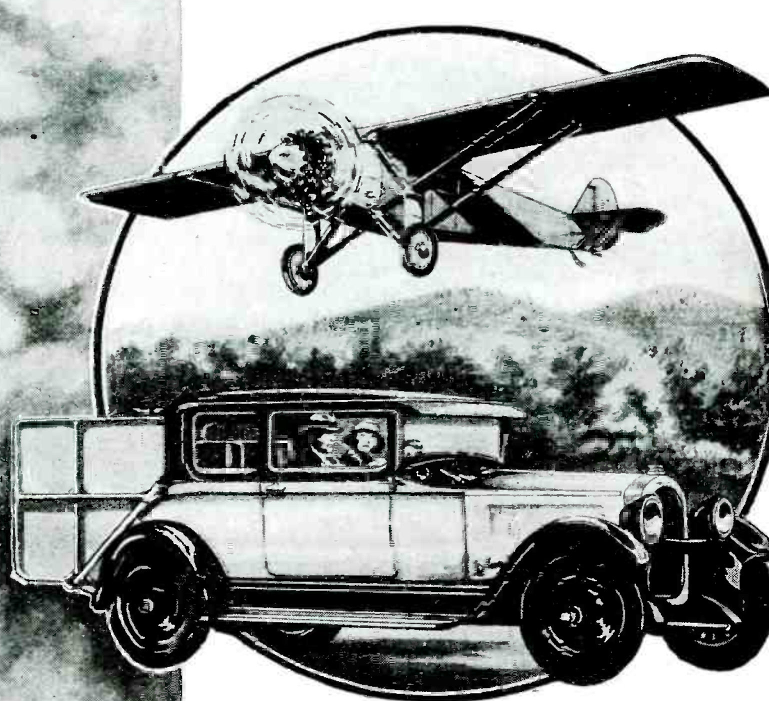
The illustration at the right shows how the future type of ocean-going air-liner will look while traveling at a speed of 300 miles per hour, high above the storm area, in safety. The occupants are enclosed in a sealed metal chamber which is supplied with oxygen and heated air, and is ventilated by a blower system. It will be almost entirely controlled by radio, and the sky will always be clear at this height, thus giving the passengers a clear vision at all times.





The above map shows a proposed route over the Atlantic Ocean. The large circles represent the location of terminals for ocean-going planes. These are reached by traveling in land planes over the various air routes. A flight from New York to London is divided up into several stages, with only 1,900 miles of travel above the ocean.

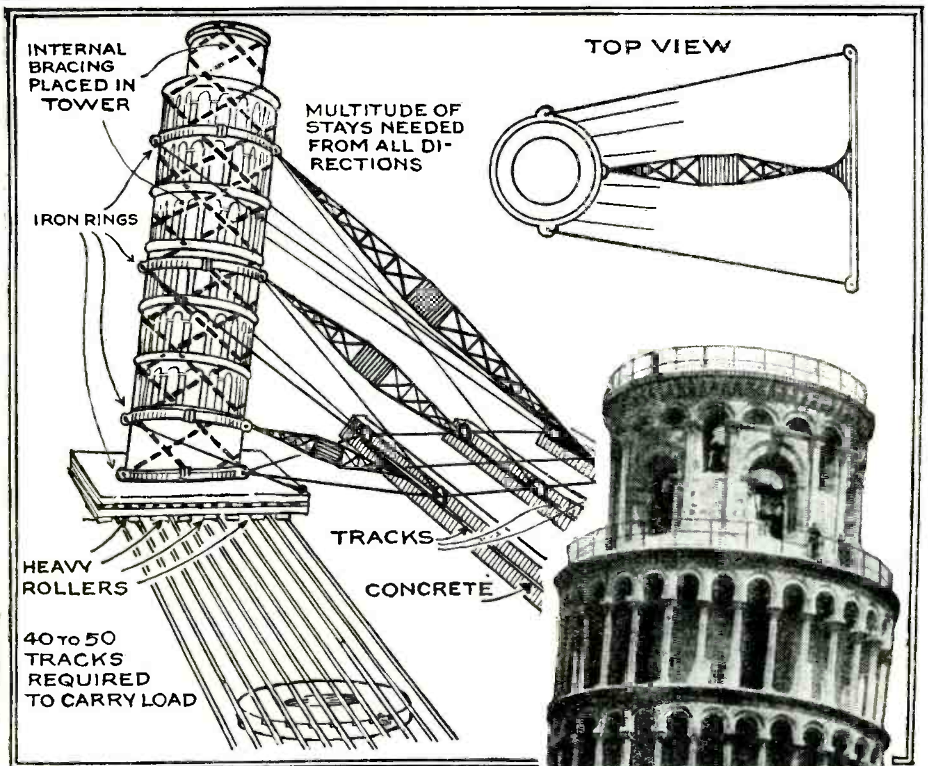
Trans-oceanic flying will soon be an everyday occurrence and passenger service to all parts of the world will be maintained at all times, in spite of the inconsistency of the weather. An aeronautical expert predicts that we will soon fly the ocean in a series of hops. The plane will be a specially built flying boat equipped with all the luxuries and conveniences of present-day civilization.



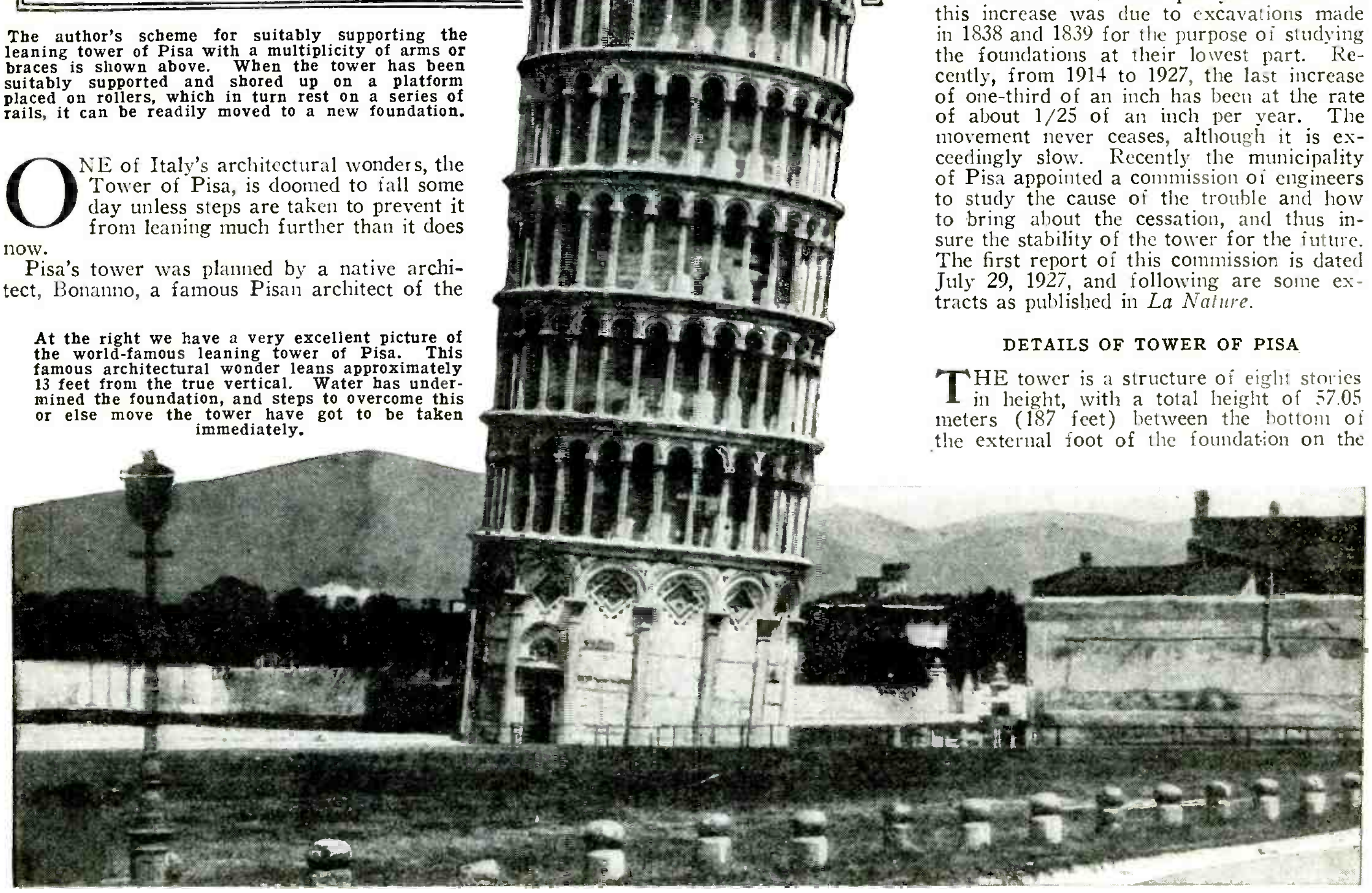
Above, the efficiency of an airplane and an automobile are compared. A modern auto would have to be fitted out as shown in order to carry sufficient oil, gas and water to complete a non-stop trip, equal in distance to that of Col. Lindbergh's. Furthermore, the automobile would take three times as long in doing so. The speed, efficiency and comfort is greater in the modern airplane than in the automobile.

To Save

Modern Engineering



The author's scheme for suitably supporting the leaning tower of Pisa with a multiplicity of arms or braces is shown above. When the tower has been suitably supported and shored up on a platform placed on rollers, which in turn rest on a series of rails, it can be readily moved to a new foundation.



At the right we have a very excellent picture of the world-famous leaning tower of Pisa. This famous architectural wonder leans approximately 13 feet from the true vertical. Water has undermined the foundation, and steps to overcome this or else move the tower have got to be taken immediately.

ONE of Italy's architectural wonders, the Tower of Pisa, is doomed to fall some day unless steps are taken to prevent it from leaning much further than it does now.

Pisa's tower was planned by a native architect, Bonanno, a famous Pisan architect of the Twelfth Century, some 753 years ago. While Bonanno was an excellent architect, he evidently must have been somewhat careless on his foundations. Instead of investigating the site upon which the tower was to be built, he only went down into the swampy soil a few feet, and then started to build. As a matter of fact, the foundation for the tower was only ten feet, which certainly was not sufficient, particularly in a swampy soil for a tower some 179 feet high and 51 feet 8 inches in diameter.

As soon as Bonanno had gotten some 40 feet up with his tower, it was noted that it began to list on one side, out of perpendicular. He, however, hoped for the best, and continued building; at the same time he made the pillars on the sinking side higher than on the other side, in order to compensate for the sinking. This, however, did not seem to do much good, for still the tower proceeded to lean more and more.

For sixty years, the unfinished marble tower was left standing, when the Pisans called in Benenato. He continued to build it up to the fourth story, and still the tower sank. After Benenato had died, the Pisans called in a German by the name of William of Innsbruck, who also tried to force the tower back to the perpendicular by making the pillars of the fifth and sixth stories longer on the sinking side than on the other. He too became discouraged and quit the job, and for another hundred years the tower stood unfinished.

Finally, another local architect, Tommaso Pisano, proceeded to finish the tower. He merely added the bell cupola on the sixth story and further inclined his cupola toward the perpendicular. The tower by that time was finished, and had its present appearance.

Recent measurements have shown that the tower is still sinking, although very little at the present time, but sufficient so that in time to come, unless something is done, it will surely fall. Once the top of the tower goes beyond its center of gravity, the tower must crash down.

Since 1817, the overhang of the seven stories has increased a minimum of about one-twelfth of an inch per year. Part of this increase was due to excavations made in 1838 and 1839 for the purpose of studying the foundations at their lowest part. Recently, from 1914 to 1927, the last increase of one-third of an inch has been at the rate of about 1/25 of an inch per year. The movement never ceases, although it is exceedingly slow. Recently the municipality of Pisa appointed a commission of engineers to study the cause of the trouble and how to bring about the cessation, and thus insure the stability of the tower for the future. The first report of this commission is dated July 29, 1927, and following are some extracts as published in *La Nature*.

DETAILS OF TOWER OF PISA

THE tower is a structure of eight stories in height, with a total height of 57.05 meters (187 feet) between the bottom of the external foot of the foundation on the north side and the upper part of the last story 56.705 meters (186 feet) on the same side. Opposite this the corresponding south side is only 55.803 meters (183 feet), while the outside part of the foundation proper of this side is (—1.78) or 1.40 meters (4.59 feet) lower than the north. The interior has a diameter of 7.65 meters (about 25 feet). The thickness of the masonry between the first and the sixth cornice is about 2.47 meters (8.10 feet), while between the first cornice and the upper edge of the foundation its thickness is 4.12 meters (13.5 feet), and finally this foundation, which in-

the Tower of Pisa

Methods Can Save Tower

By HUGO GERNSBACK
Member American Physical Society

creases inside and out, has a crown of 7.365 meters (24 feet) of thickness, with an interior space of 4.65 meters (15.25 feet) diameter, (the exterior circle being 19.75 meters (64.69 feet). The height of this foundation is 2.70 meters (8.85 feet) to 2.80 meters (9.28 feet), of which the last 0.40 meter (15 inches) of the base is laid up without cement, as footing stones.

NATURE OF THE SUPPORTING SOIL

THE supporting soil, according to Canavari, consists of:

1—Layers placed there of natural sand or clay, with a depth of 4.50 meters (14.7 feet) or 5.50 meters (18 feet), and containing the water-bearing stratum into which the foundation penetrates.

2—A layer of gray clay, 1 to 2.50 meters thick (3.28 to 8 feet).

3—Clay and sandy layers fine yellow or greenish, sometimes with turf, to a depth of 10.50 to 11 meters (32 to 34 feet), containing an artesian stratum.

4 — Finally, the blue compact clay with the remains of marine and fresh water shells (especially Cardium edule), in which foundations had to be established in order to have a basis somewhat consistent and not affected by subterranean water. Now this water has a slow current toward the sea, and without a doubt draws along with it solid matter finely divided, leaving a void; and besides, there are springs which reach the surface at the foot of the monument, and whose rising speed has been rated at 7 cm. (2.8 inches) per second; finally, in its original construction, as well as in 1838 and 1839, excavations were made on the south side.

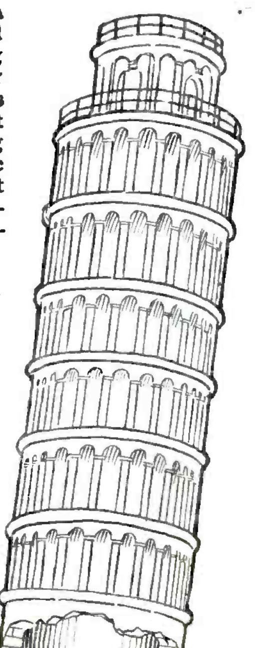
CAUSES OF THE INCLINATION OF THE TOWER

THE pressure in the masonry of the tower is considerable. Cuppari gives a maximum of 15.3 kgs. per square centimeter (about 216 lbs. per square inch) under the plinths of the first row, and 10.12 kgs. (144 lbs. per sq. in.) on the foundation soil. In the face of an uncertain soil and one which is charged with water in motion, it is not astonishing that the tower sank, and that it did so irregularly. The former soil under the campanile was at the level of 3.729 meters (12 feet) and the present level is at 2.75 meters (9 feet), and there is a circular depression giving a paved area of 24.30 meters (79.7 feet) diameter, whose northern edge is at the level 2.72 meters (9 feet), and the southern at the zero point.

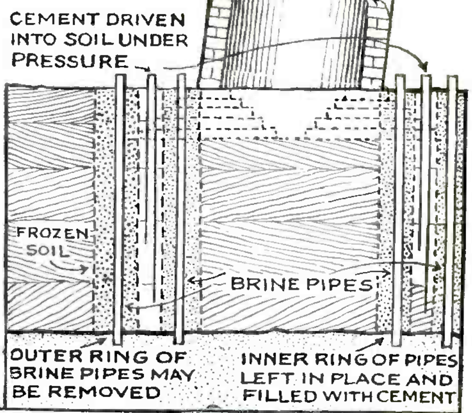
According to this, the principal cause of the progressive inclination of the tower of Pisa seems to lie in the presence of moving water, which produces voids and weakens the soil beneath the foundation, so the following measures are necessary:

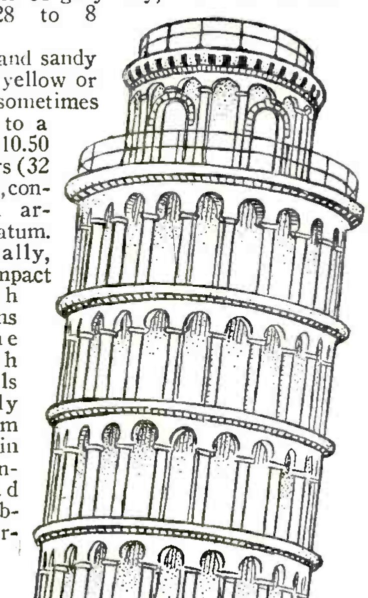
1—To prevent all flow of subterranean water.

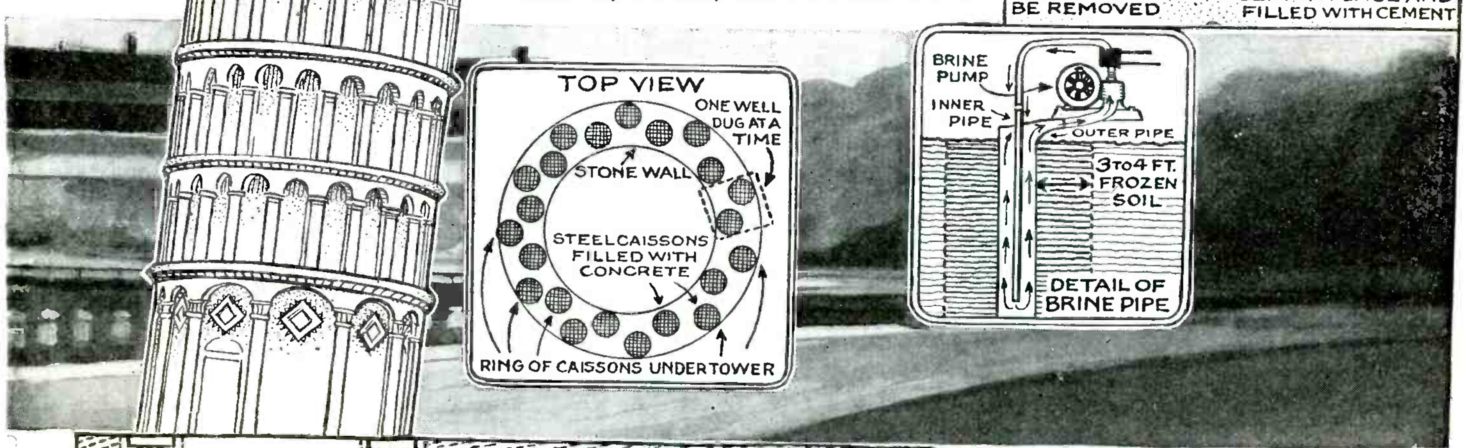
2—To consolidate the soil. For instance, by injecting cement into the voids of the part of the masonry which was laid up dry, and into the pores of the soil so as to displace all or part of the water. This puts aside any solution, which has recourse to excavation, or to a lowering of the level of the water-bearing layers; on the other hand, the injections of cement risk part of this cement being carried away by the water, and to abut against the non-absorbent argillaceous layer.

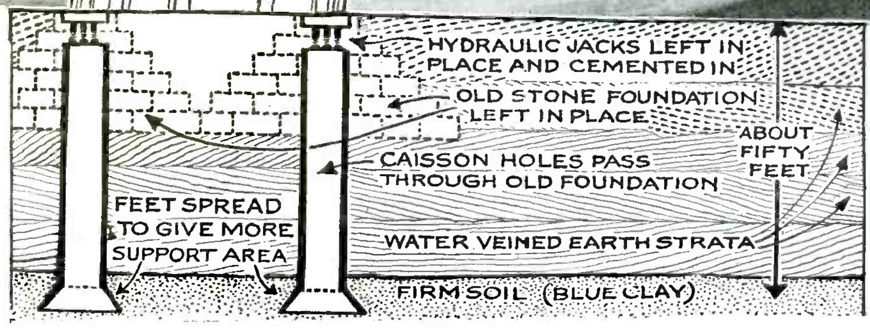


The diagram below and at the right shows how a famous French engineer proposes to freeze two circular rings of soil about the base of the tower; he will then pump in cement under pressure and in this fashion he eventually will build a water-tight foundation under the tower in its present position. A detail of one of the brine pipes is shown below.









The large diagram at the left, together with the insert, showing a top view of the circular wall of the tower, illustrates the manner in which a famous American foundation company would go about building a substantial foundation under the Tower of Pisa. According to this scheme, the tower would be left in its present position, while caissons would be sunk progressively around under the tower, these being filled with cement.

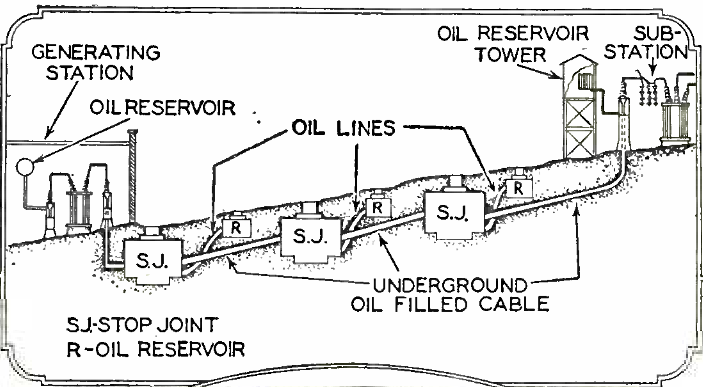
MOVING THE TOWER TO NEW FOUNDATION

MANY schemes have been proposed how to save the tower, and several are shown in these pages. The first one, which is also the

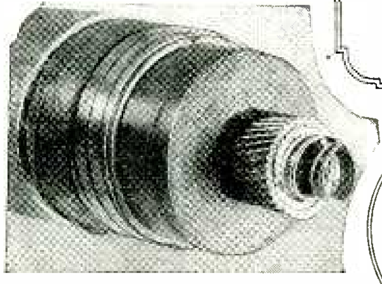
(*Continued on page* 1135)

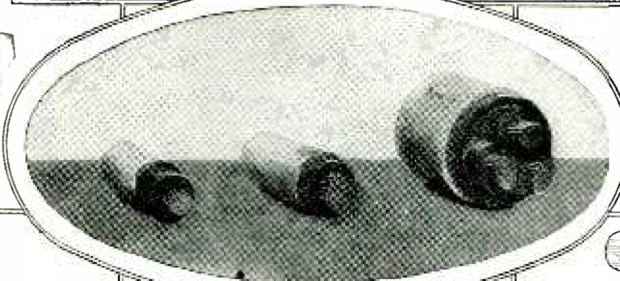
AN OIL-FILLED ELECTRIC CABLE

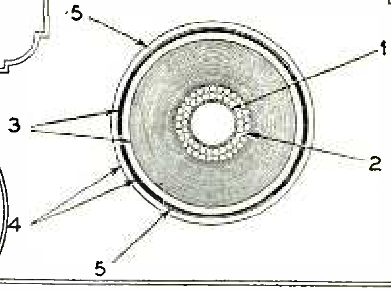
One of the outstanding achievements in the electrical power transmission field is the development of the oil filled underground cable which has been put into use quite recently. The cable connects the Hell-Gate generating station to the Dunwoodie sub-station, a length of twelve miles. Each section of the cable has its own oil reservoir and own oil supply, as shown at the right. The reservoir allows for the contraction and expansion of the oil. Below is a section of the cable used.

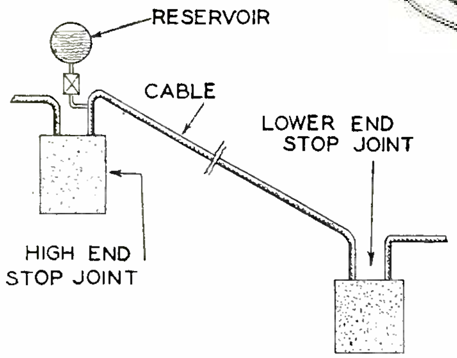


A cross-section of the 132,000 volt oil filled single conductor cable is shown below. The spiral copper sleeve is shown at 1, 2, the copper conductor, 3, lead inner sheath, 4, outer lead sheath, 5, a copper spring. The oil flows through the hollow core in the center. The oil in the cable core is maintained at a pressure of about 40 pounds and impregnates the spaces between the strands of copper wire, soaks through the insulating material and ultimately reaches the outside lead covering.

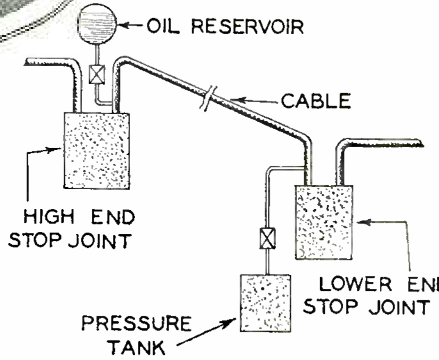








Above we have a photograph of three high tension cables which may be compared with the oil-filled cable at the left. The drawing at the left shows a section of the cable. The stop joints prevent the flow of oil from one section to another, and the reservoir will receive the oil pushed out of the cable during thermic expansion, and will give it back to the cable during contraction. Where the grade is exceptionally steep, or the section unduly long, a pressure tank with a valve is installed at the lower end of the cable, as shown at the right.

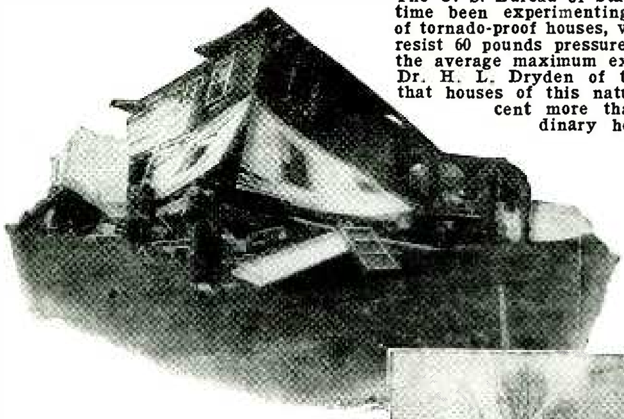


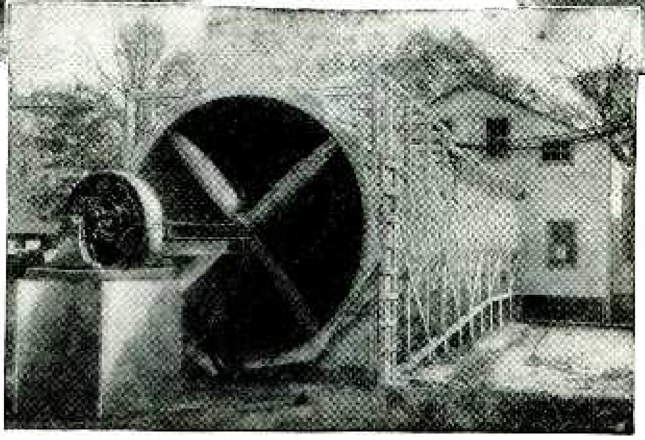
Photos courtesy New York Edison Co.

TORNADO PROOF HOUSES

By S. R. WINTERS

The U. S. Bureau of Standards has for some time been experimenting with the erection of tornado-proof houses, which will be able to resist 60 pounds pressure per square foot, or the average maximum exertion of a tornado. Dr. H. L. Dryden of the Bureau, predicts that houses of this nature will cost 30 per cent more than an ordinary house.

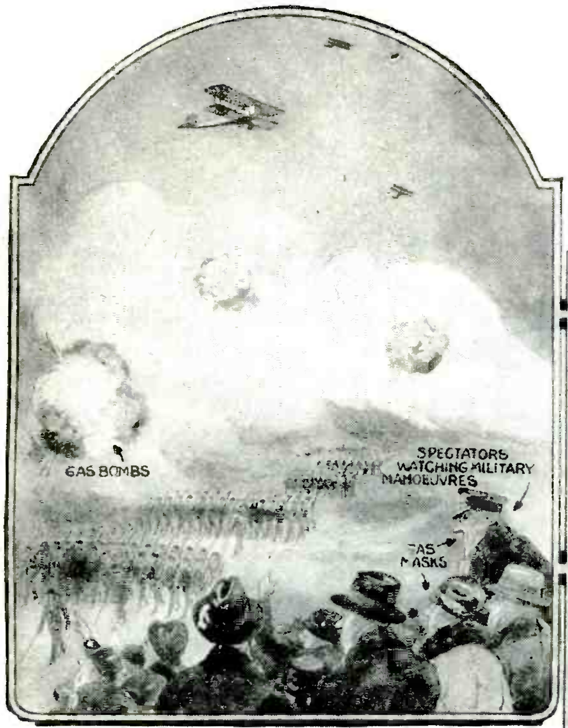




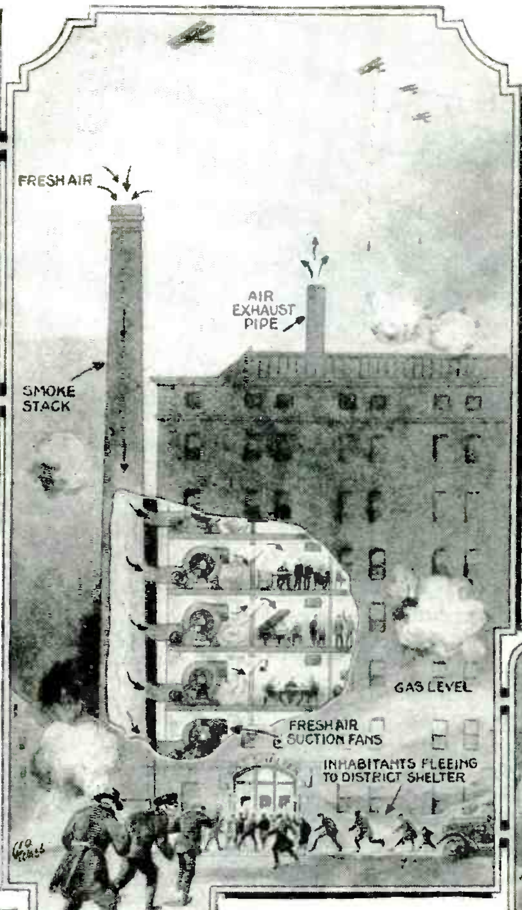
The photo above shows a home in Maryland which was demolished by a tornado which exerted a pressure of 75 pounds per square foot. At the right is a photo of a wind tunnel erected at the U. S. Bureau of Standards for developing artificial winds at 70 miles per hour. The tunnel is used in designing tornado proof sky-scrapers, homes and other structures. Tall buildings and chimneys can be erected to withstand a pressure of 60 pounds per square foot. Eight inch solid brick walls are recommended for dwellings in the tornado belt; however, twelve inch walls have superior stability and hence greater ability to resist high wind pressures.

The above photo shows a house from which the roof has been lifted by a tornado. The U. S. Dept. of Commerce has devised a building code which will prevent this in the future. With roofs having a rise of four inches or less per foot, 30 pounds per square foot loading on the horizontal projection shall be assumed. Roofs having a rise of more than three inches, or less than twelve inches per foot, shall withstand a live load of 20 pounds per square foot. The Bureau of Standards claim that the major portion of the damage in the recent Washington tornado, was due to the disregard of building requirements. Thanks to the wind tunnel, however, the Bureau is now developing tornado-proof homes.

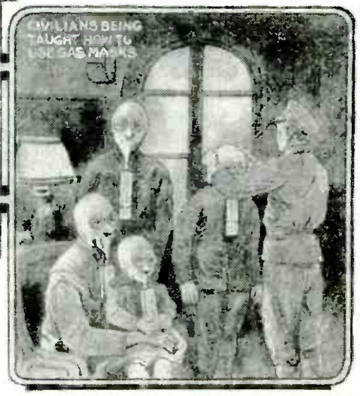
The World Organizes Against Gas Attack



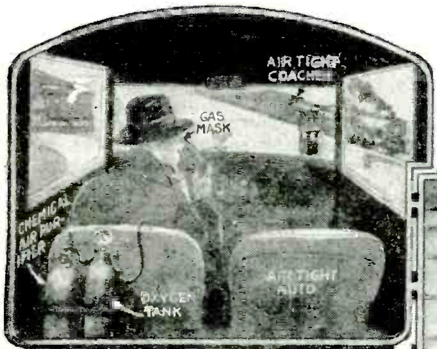
European military experts are watching with interest the efforts of the Russian Soviet Government to develop and perfect the use of poisonous gas in warfare. The civilian population will be equipped with gas masks, as well as the army. The army and the people are taught how to use these masks during real poisonous gas attacks as shown in the above illustration.



The Red Cross organizations of the various countries have advanced the plan of building a war-gas shelter, such as that shown at the left. Fresh air is sucked down through a large smoke stack which supplies the various floors of the building. An air exhaust pipe will be provided, as an outlet for the bad air. The intake stack will rise far above the gas level, thus assuring fresh air for the inmates of the building at all times. Food, water and hospital supplies would be stored in small quantities in gas-proof receptacles. These shelters also contain stocks of chemicals for neutralizing the atmosphere, such as, chloride of lime, and potassium permanganate, which in case of penetration of the shelter by gas could be pulverized in a machine. Each shelter would also contain instructions printed on gas-proof material. A number of experts have pointed out that most of the shelters so far conceived are insecure and consider it an impossible task to train and instruct the citizens how to conduct themselves during a gas attack.



The people of Russia are now being instructed in the use of gas masks. The civilian population will be equipped with the old model masks. Today gas masks are considered a household necessity in Russia.



Here we have an illustration showing an air-tight automobile, equipped with an oxygen tank and chemical air purifier. The gassed citizens would be removed to safety in a coach of this nature. Furthermore, the driver is equipped with a gas mask. This precautionary measure against gas attack was suggested at the International Conference of the Red Cross.

The Russian government is also providing workmen with protective gas masks, and at the left we have a view of a factory of the future in which the workmen are protected in this manner. A system has also been advocated whereby working men may remain in their quarters by creating shelters which could not be penetrated by the gas.

At the right and also below we have two methods suggested for security against gas attack. One is a resident gas-tight cellar, the other, a subterranean movie theatre.

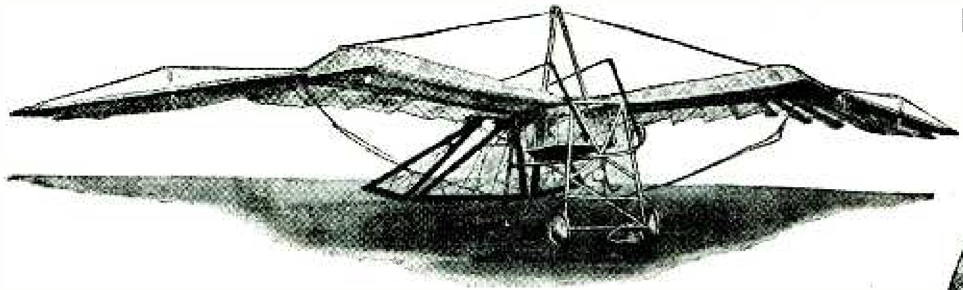
Subterranean cellars have also been suggested as a means of retreat in case of gas attack. A fresh air pipe having its outlet high above the gas level will lead down into the cellar. Here the fresh air passes through a charcoal filter and thence out into the room. The air would be drawn into the room with electric suction pumps. The suction process could be regulated in such a manner that the pressure from the inside would always be greater than that from the outside.

At the left we have a subterranean movie theatre as a place of amusement and retreat during a gas attack. The theatre would be connected to the surface with elevators, escalators and stairways. Huge quantities of fresh air would be drawn in, filtered, and then passed out into the theatre. The pressure on the inside will be greater than that on the outside so that any poisonous gases which may find their way down below the surface will be prevented from entering the theatre.

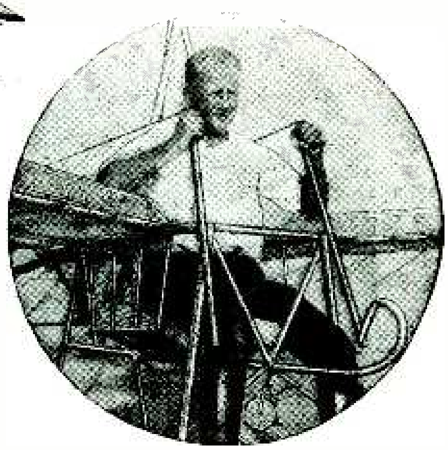
Can We Fly Without Engines?

Gliders Have Flown Over an Indefinite Route, Aided by the Wind—But How About Straight Flying?

By F. E. LOUDY
Aeronautical Engineer



The photograph at the left shows a new wing-flapping machine or ornithopter which is propelled by foot power. The ornithopter weighs only 100 pounds and has a wing spread of 25 feet. The fuselage measures 8 feet in length. Below is George R. White, the inventor.



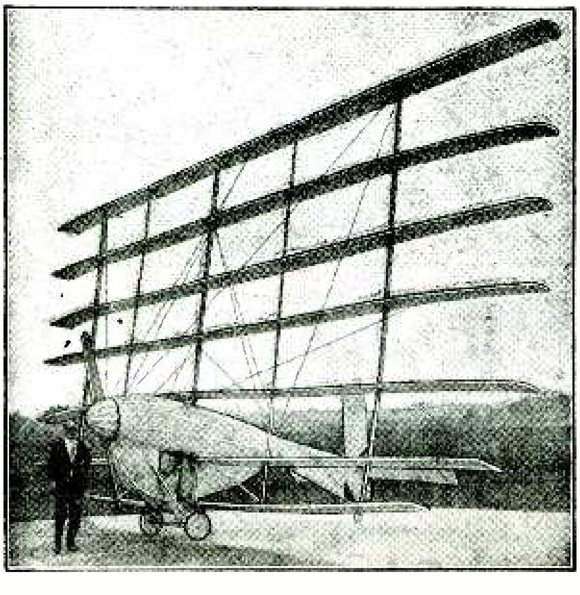
HUMAN flight began with the attempt to navigate the air by engineless air craft. With the advent of the automobile engine prolonged flight became a possibility. With the increase of power of airplane engines and their adaptability to multi-engine aircraft, long distance flights became practicable. In recent years, however, there has been a tendency towards a reversion to low powered airplanes, thence, to gliders, and now we have reached a stage where attempts are being made to navigate the air with aircraft which utilizes the power of the human body to drive them.

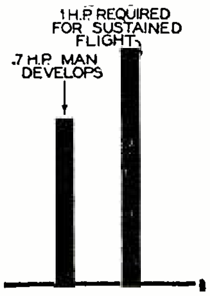
The first Wright airplane was powered with a 10 H.P. engine. A. V. Roe flew a triplane in 1909 with only 9 H.P. From that time up to three years ago larger powered airplanes were in vogue. Due to the restrictions placed upon the size of German aircraft immediately following the World War, attempts were made to make efficient planes of very low power. The reaction to this was the great interest displayed in England on low powered planes of two and three years ago, the most notable examples of which were the Handey-Page "H.P." monoplane with 8 H.P. which had a landing speed of 23 miles per hour and a high speed of 30 miles and also the English Electrical Company's "Wren" of 7 H.P. with a landing speed of 25 miles per hour and a high speed of 49 miles.

DEFINITION OF "GLIDING"

GLIDING, which consists of coasting through the air after starting from a hill, in a motorless plane, and soaring, which involves flying in a motorless plane in windy air, usually found in the vicinity of mountains, has become very popular in Germany where a recent world's record was established for motorless flight by Ferdinand Schulz, who remained aloft for 14 hours and 7 minutes. Numerous soaring flights have been made where the pilot has succeeded in circling time and again above his starting point. Soaring birds like the eagle, hawk and buzzard utilize this "internal work of the wind" for attaining great height or for remaining aloft for long periods of time without flapping a wing. However, in the case of gliders, it is purely a sporting proposition and to make a trip from one point on the earth's surface to another by this means, consistently, is a virtual impossibility.

Before discussing the practicability of man-propelled aircraft it is well to review the early history of these attempts, and also to denote the amount of "power available" of a human being. A helicopter operated by human power has not been attempted. In 1909, Roy Knabenshue made several successful flights in the State of Missouri in a small airship, the propeller of which was operated by means of bicycle pedals and a chain drive. In 1921 a jumping-balloon was successfully flown at Scott Field near St. Louis, Mo. This device consisted of a small hydrogen-filled balloon, with sufficient buoyancy to lift a man, and it had on its under side a propeller revolving in a horizontal plane which was operated by hand by means of an endless cable belt. This balloon did not have a valve. The propeller being used for descent as well as ascent. On one occasion the propeller became jammed and the pilot had to remain aloft until the sun went down, which cooled the gas and permitted him to descend.





The chart shows that the average man can develop only .7 horsepower. It takes approximately 1 horsepower to operate a flying machine.

The photograph at the left shows W. F. Gerhardt's "cycleplane" which "flew" in 1923. The plane had seven wings, and some idea of its height can be obtained from the man standing near it. The propeller was driven by foot-pedals.

MAN'S ENERGY LIMITED—AVERAGES .7 H.P.

AS a sporting proposition this is a very interesting device, but has no practical value.

The question arises as to how much power is available within a human body for operating an aircraft of the helicopter or direct lifting propeller type, an ornithopter or wing flapping type, or a regular airplane where the propeller is driven by the arms or legs of the pilot. For sustained periods it has been proven that an average man can develop 0.7 H.P., for such activities as long distance swimming, cycling or rowing. The maximum horsepower that has been developed in running the 100 yd. dash in 10 seconds is 7 H.P. Therefore, in order to operate a heavier than air machine by human power for any period of time and successfully get from one place to another we could count on approximately 1 H.P.

In 1923 Dr. W. F. Gerhardt succeeded in flying the 7 winged cycleplane here shown, a distance of several hundred yards at an altitude of about 4 feet. This flight was made at McCook Field, Dayton, O. on a calm day, but the machine and pilot were towed by an automobile until a velocity of about 25 m.p.h. was obtained. The flight was proclaimed successful because for a short period of time the tow line remained perfectly slack. The propeller was driven by foot pedals. This flight clearly demonstrated that the power required for such a flight of short duration was probably in the neighborhood of 2 horse power.

Recently at Cocoa, Fla., Mr. Geo. R. White, a former Army Aviator, succeeded in making a flight of .8 mile in his manually operated hand driven ornithopter at a height of about 2 feet above the sands of the beach. However, Mr. White attained a velocity of about 30 miles per hour by being first towed by an automobile before he cut loose. Mr. White is shown with his machine, in the accompanying photos.

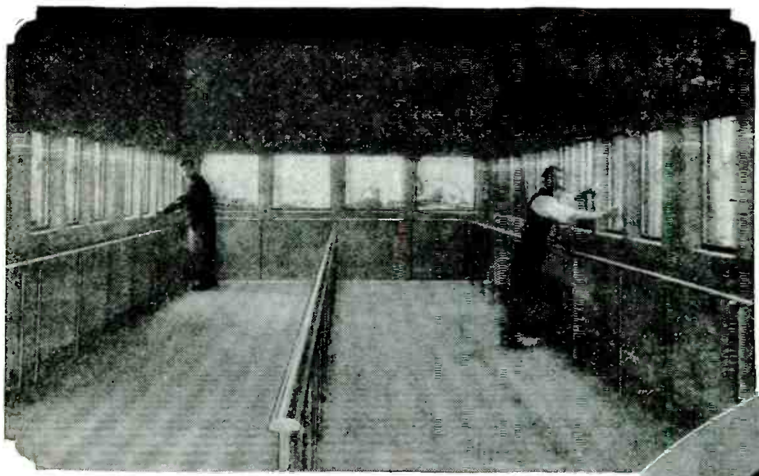
Neither the flights of Dr. Gerhardt or of Mr. White can be called successful demonstrations of the feasibility of flights by human power, as they were both virtually catapulted before they flew on their own power. It will be admitted, however, that the first flight of the Wright Brothers on Dec. 17,

(*Continued on page* 1153)

LIVE INSECTS EXHIBITED IN NATURAL SETTINGS

By COUNT A. N. MIRZAOFF

France Opens First "Vivarium" Where Tiny Insect World Will Be Publicly Exhibited



Above we have a photograph showing the interior of one of the "Vivarium" rooms, in which many curious insects will be kept.

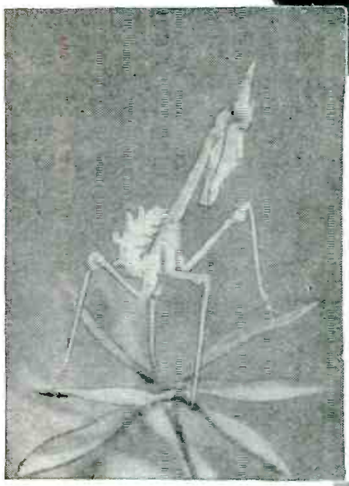
THIS unique foundation has been officially opened in order to carry out the wish of the great entomologist, Henri Fabre, and to continue his work in a more practical manner than has ever been attempted by any nation. In this vast Vivarium, which comprises several acres of land in the suburbs of Paris, there are special gardens provided in which plants and herbs from climes all the world over are being propagated, so that these innumerable living insects will find their living conditions as they were in the country from which they were taken. In order to make this task successful, it was necessary for the government to appropriate large sums of money, and many gifts were contributed by the admirers of the famous friend of the animal world, Henri Fabre.

To Dr. Jeannel credit must be given for having originated this unique institute, which is considered far superior to any in existence from the point of view of the immense collection of cold-blooded animals.

This living museum is not only intended for the scientists alone, but its main purpose is for the education of the general public. A visit to this Vivarium will disclose some remarkable departments, where various temperatures are kept exactly as they are at the places where the insects came from. Here you will see little cages in which are planted miniature trees; in some others you will see various kinds of moss growing in humid air; and in still others, flowers and vegetables are growing profusely, which con-

(*Continued on page* 1133)

Special plants and herbs from all parts of the world are being propagated, so that the small creatures will find their living conditions similar to those to which they have been accustomed. Photograph at the left shows one of the attendants cultivating these imported plants. In order to make this "Vivarium" successful, the government appropriated large sums of money to the cause.



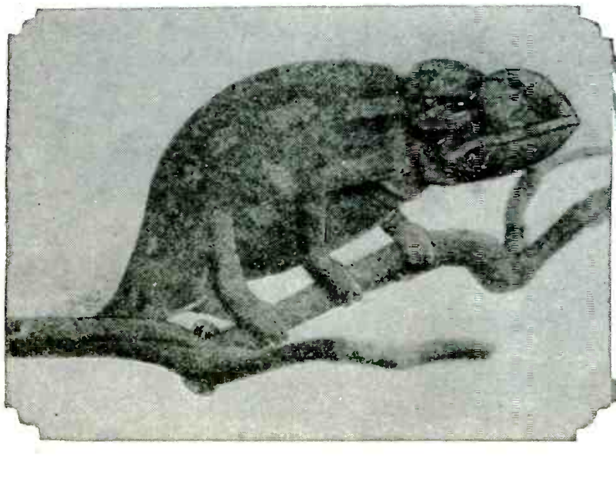
In the photo at the left we have a view of another interesting insect which comes from middle France. It resembles a miniature horse of the Apocalypse, as may well be seen.

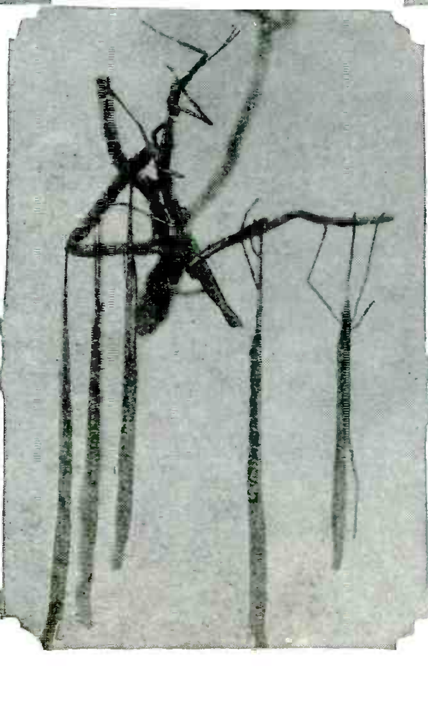
Below we see a most curious insect known as the "Praying Mantis," so called because of the position which it assumes when at rest. The forelegs seem to be lifted in supplication and the insect appears to be praying.

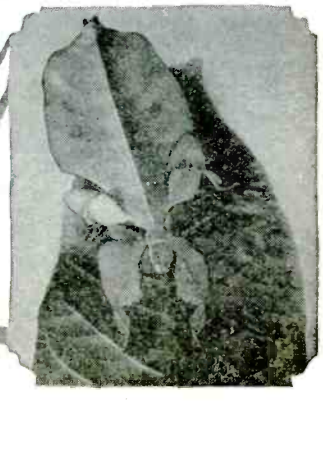
In the photograph below we see another group of insects which are grown in the "Vivarium." These insects hang from the branches of trees and bushes and seem to be a part of them. In appearance they closely resemble a stick.

Below we see a chameleon which has been imported from French Algeria. The chameleon resembles a frog or toad and was photographed while in an enraged condition, as may obviously be seen.

Below we have a wonderful example of insect camouflage. The small insect rsembles a leaf, being of the same color and having a ribbed back. When resting upon a leaf, it is impossible to see it. Nature has provided her defenseless charges with this means of protection. The photo at the left shows another fine example of this sort of protection.



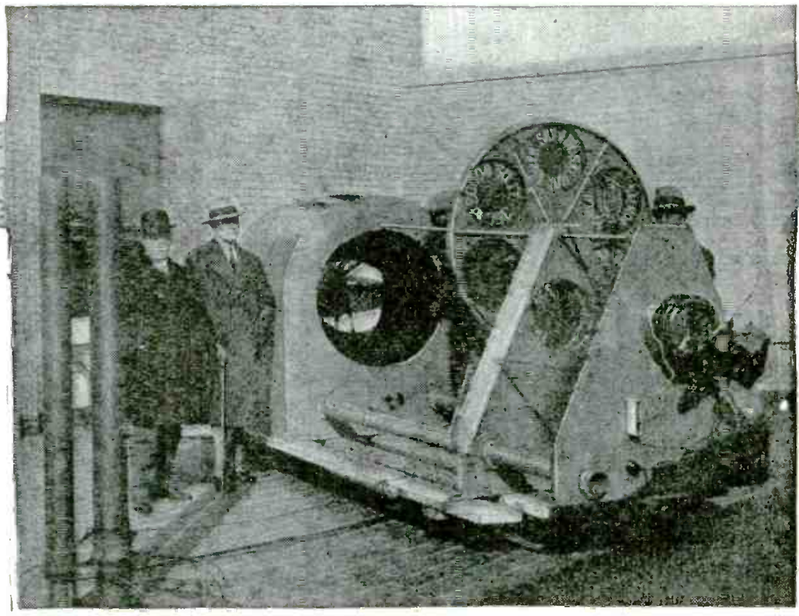




Scientific

A Photographic Picturization

It is almost impossible to keep up with ence. This is truly a scientific age. On the advances made in

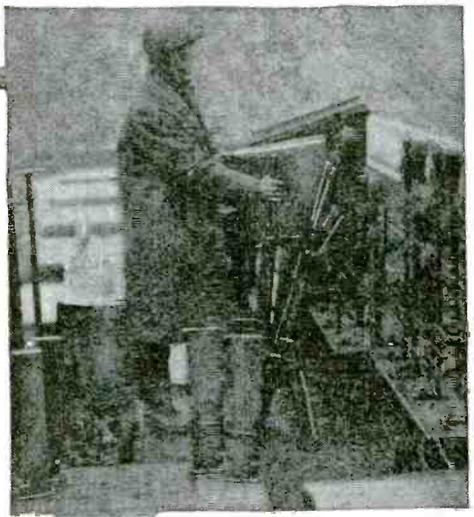


A sky advertising projectograph, a German invention recently demonstrated here, is shown in the above photo. The stencils containing the advertisements are mounted on a rotatable disc. A carbon arc light is used to project the ads on the clouds at night. Due to the rotating disc the pictures are projected over a wide area when using the clouds as a screen.

At the top of the page to the left, is shown the smallest gasoline driven automobile in the world, which is less than three feet in length. The inventor is shown guiding the car as it runs along the roadway. Correct in every detail, equipped with pneumatic tires, and a miniature gasoline engine, the auto is one of the most unique models ever built.

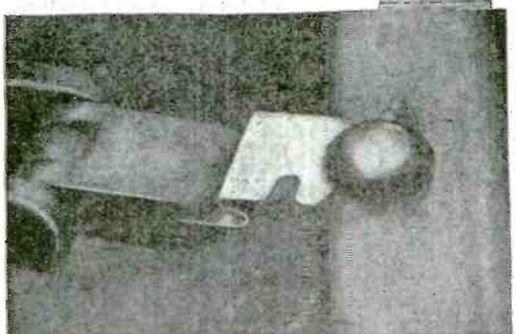
There is no end to the uses to which rubber can be put. The picture above shows a section of a sponge rubber mattress which gives a maximum of comfort. The mattress was recently demonstrated in England.

At the left is one of the latest novelties. It is a small camera which is built in the side of a hand bag.



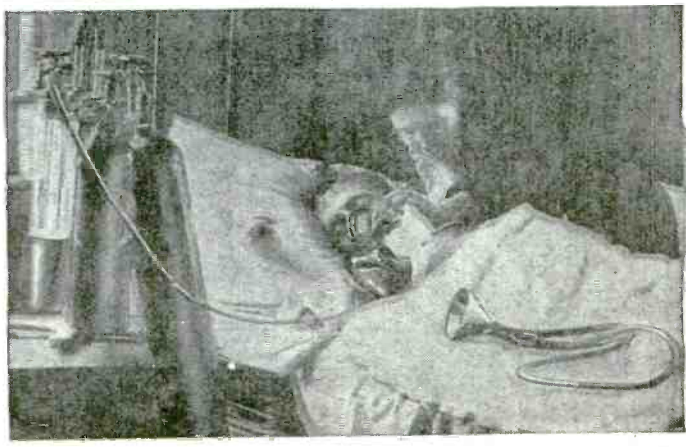
The above photograph shows how the strings for the "corn stalk fiddle" shown at the right are cut out from a piece of the stalk. The fiddle is a musical instrument peculiar to the corn belt and is made entirely of corn stalks, as may be seen in the photos.

Hiccoughs may now be relieved by using the apparatus shown below. Mrs. John C. McCarthy is demonstrating how Dr. Russell Sheldon checked her husband's hiccoughs with an apparatus for administering anaesthesia. The patient had been afflicted with hiccoughs for ten days.



The photo above shows one of the detonators placed in position on the line after the magazine of the machine has been loaded. The automatic arm which places these small bombs on the track may be clearly seen. This is undoubtedly one of the best ways of cautioning the engineer, as he cannot fail to hear the report of the torpedo.

Recent bad weather in and around London has kept the fogmen very busy on the railways. A new railside machine has been put into use recently and has proven to be so successful that it is expected to be installed soon on the majority of English railways. The above photo shows one of the fogman controlling the apparatus with levers, outside of the London Bridge Station. A pull on one of these levers causes a torpedo to be placed on the rails.



Above is a photograph of the new apparatus which abolishes distress from hiccoughs and gives instant relief.

Progress

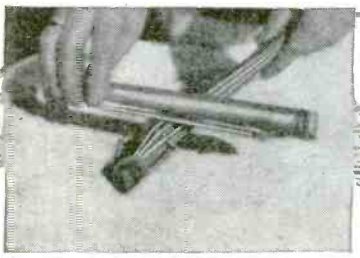
of Modern Scientific Advances

the rapid strides taken in the field of sci-
these pages we can portray but a few of
many different fields.

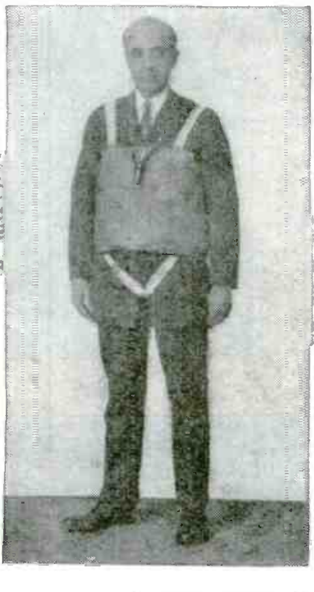
A remarkable photograph showing a motor boat actually leaping through the air by the force of its own momentum is shown above. The motor boat had just struck a piece of ice and the wave which resulted caused it to skip or jump up into the air, resulting in the unique picture.

The largest disc of optical glass ever cast in the United States was recently uncovered at the U. S. Bureau of Standards. The disc, which is 70" in diameter, 11" thick, and weighs 3,500 lbs., was found to be perfect. The disc was cooled slowly for nine months and will be used for a new reflecting telescope at Ohio Wesleyan University.

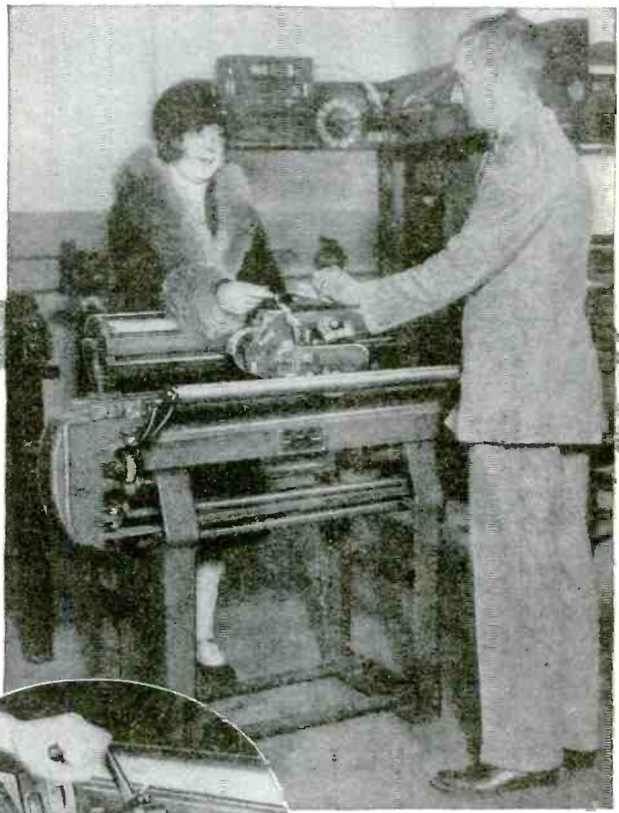
Aero-sleighs are becoming popular in Russia. The photograph at the right shows one of the starters in an aero-sleigh race near Moscow. The sleigh is fitted with a motor which drives an aeroplane propeller. It skims along the surface of the ice or snow on three runners or skids which may be seen in the photo. The sleigh is under control of the operator seated in the foremost end, and may be steered in any direction desired by the operator.

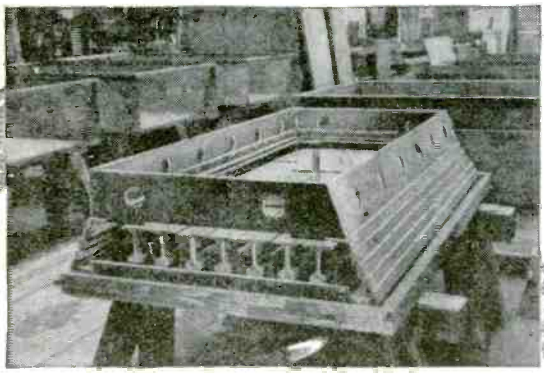


Above is a photograph of the completed "corn stalk fiddle." The strings of both the fiddle and bow are cut from the stalk, in the manner shown in the photo at the left, and are raised above the stalk by small wooden cleats. The instrument produces good music if the bow and fiddle strings are well rubbed with powdered rosin. Both the fiddle and bow may be fashioned from a corn stalk with a jack knife.

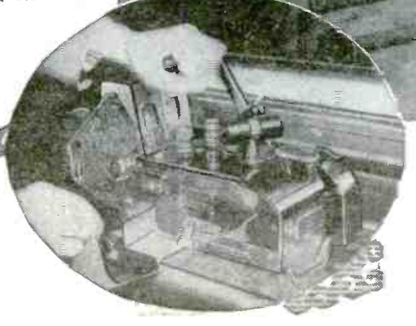


The above photo shows an inflatable life belt which may be put on either over or under the bathing suit. Mr. Simon Brygider, of New York City, the inventor of the new life saving device, is shown demonstrating its uses.





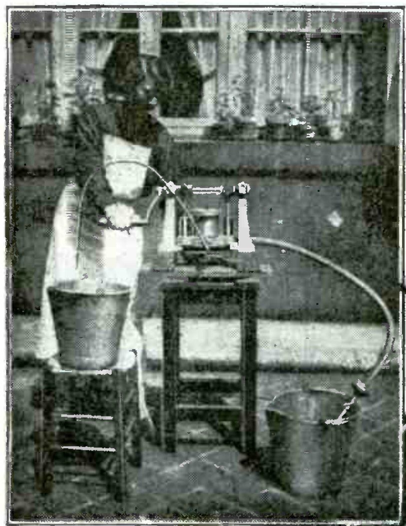
Safe makers are always endeavoring to further protect their products from the attack of criminals. The above photo shows a safe door with graduated cuts and reinforced steel bars, which are to be filled with anti-thermite. It has been found that this compound affords the best protection against the oxygen flame. Safe manufacturers make many tests of devices to provide safety against the chisels and oxy-acetylene torches of the burglars. The making of safes is marked by a constant fight between science and the ingenuity of criminals.



By means of the new printing machine shown above and also at the left, railroads can now print tickets for passengers when they call for them, instead of preprinting and keeping on hand thousands of tickets. The machine works like a typewriter and not only prints the ticket, but also keeps a record. The machine is shown above and at left.

Practical Gifts from the Scientist

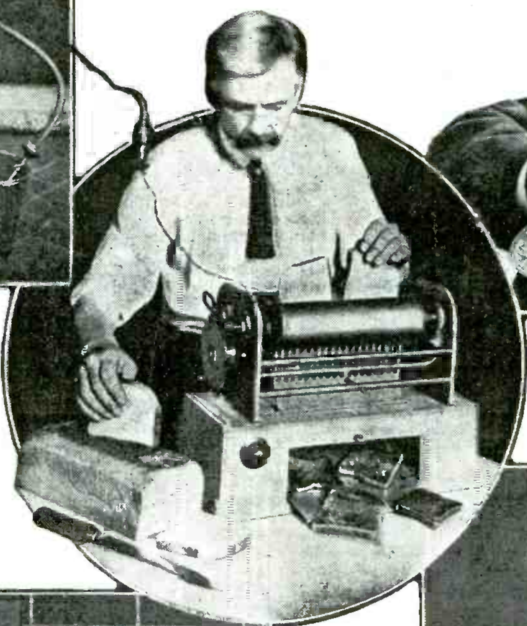
New Churn, Rapid Toaster, Non-Skid Plate, Newspaper Vender, Improved Roller Skate, Rotary Toothbrush and Folding Umbrella



At the left is a photo of a new churn which has two double-stroke pistons connected to the main chamber in which the milk is churned. It is operated either by a lever or a handle attached to a crankshaft for alternate movement. The churn is the invention of M. Kerpinski of Paris.

A rubber tube is connected to the main chamber, at the extreme end of which is a small valve which is regulated by an adjusting screw. The cream is drawn up through a suction tube and is mixed with air. The butter is emitted in small chunks through the large tube.

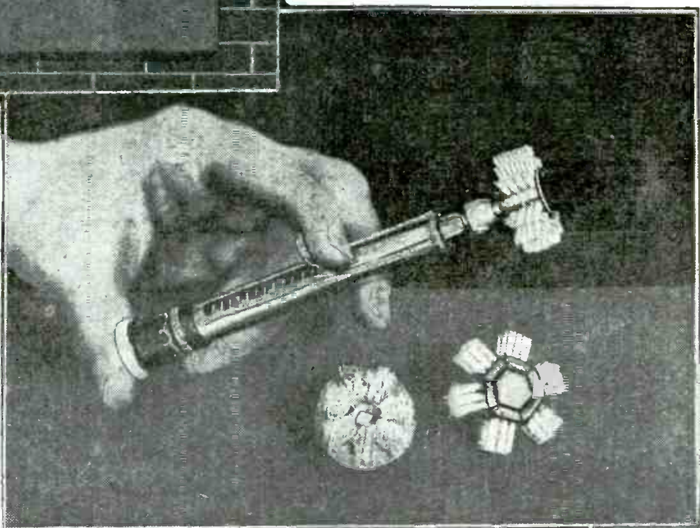
Mr. Thankful Sturdee is shown below with a device which he has devised in order to prevent the slipping of meat from a dish. Discs are fixed to the plate and hold the food in place without slipping.



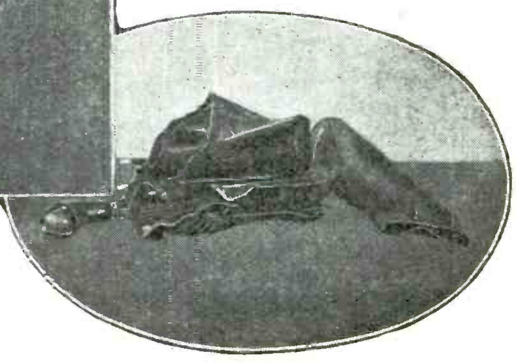
The photo at the left shows a new electric toaster which is capable of toasting fifty slices of bread a minute. It is operated and heated electrically. The photo shows Mr. E. W. Roberts, the inventor, with his machine.

The photo at the left shows a new kind of roller skate which was recently exhibited at Central Hall, Westminster, in London. These skates are claimed to be much safer than the ordinary kind.

Above we have a photograph of what might be termed a silent newsboy, which has recently been introduced by a newspaper in Portland, Oregon. A glass front reveals the headlines and tells the principal news of the day. When a coin is dropped in the slot, a paper is automatically released. Devices of this nature have been proposed for a long time and have even been tried out in several instances but were found to be unsatisfactory in some way or another. However, it is claimed that this new newspaper vender is successful and it is expected that such will be installed throughout the city of Portland within a short time.



The photo at the left shows another interesting device which was recently exhibited at the Institute of Patentees in London. This device is a rotary toothbrush which is operated by a small lever. The brush rotates against the teeth when the lever is pressed. A further advantage is that the brushes may be removed and cleaned, and several different types may be substituted in order to fit the individual needs.



The photo at the right shows the latest in Parisian umbrellas. This one folds up into a small bag, which makes it ideal to take on a voyage, as it can be easily placed in the pocket or the week-end case. The umbrella shown in the photograph is partially folded up. The entire umbrella weighs only a few ounces.

HUMAN NUTRITION

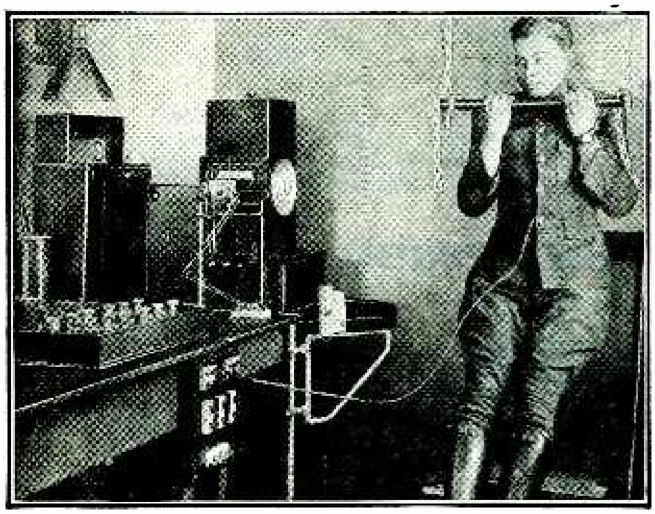
Scientists Study Life's Problems with Delicate Instruments

By WALTER RALEIGH

The above photograph shows the ergometer used at the Nutrition Laboratory in measuring the effects of muscular activity on the carbon dioxide output of the human body and also measuring combustion, both with and without food. Carbon dioxide is formed in the body, which uses oxygen in greater quantities during muscular exertion.

LIGHT is thrown on problems of human nutrition by a series of experiments with fasting steers which Dr. F. G. Benedict, Director, Nutrition Laboratory of the Carnegie Institution of Washington, and Professor E. G. Ritzman of the New Hampshire Agricultural Experiment Station, have jointly been conducting.

By means of an ingenious and elaborate apparatus, developed to measure the physiological processes of the human body but modified to serve the same purpose with cattle, the scientists were able to make very exact studies of the heat or energy transformations which took place during the course of each experiment. Not only were they able to follow, day by day, changes in weight and general condition but they were also able to measure loss of weight through lungs and skin because of insensible perspiration; to determine physical and chemical changes in excreta; to observe and record the effect upon heart-rate, respiration-rate, and internal and external temperature; to compute the total heat produced by the animals during 24-hour periods; and to ascertain what energy-yielding material was being burned by the animals to supply this heat. In addition, accurate daily records were obtained on all these points when modified by changes in quantity and kind of food and by the position of the animals, as when standing or lying down.



In this room at the Nutrition Laboratory at the Carnegie Institute there are instruments which record the muscular energy required in every conceivable form of exercise. Notice the connection between the subject "chinning" and the recording apparatus.

Particular attention was given to the energy transformation (heat production) and its relationship to the general physiological activities of the animal organism while fasting and while on different levels of subsistence ranging from undernutrition to heavy productive feeding. The relative influence of another significant factor, the variability in fill contained in the digestive tract, which has heretofore been a constant cause of uncertainty in determining changes in body tissue because it disguises the true body weight, was also satisfactorily appraised.

FASTING PUTS ORGANISM ON THE DEFENSIVE

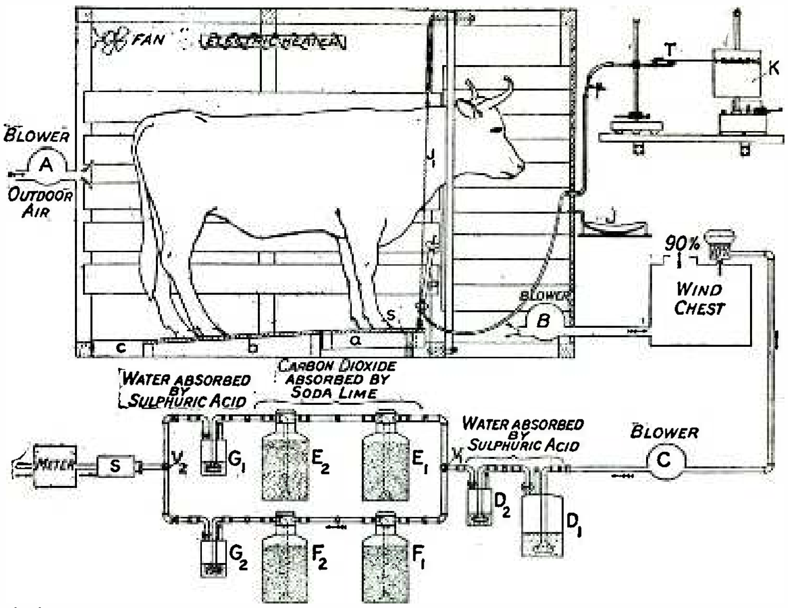
"The complete withdrawal of food from the living organism," say the scientists, "throws the demand for energy to maintain life upon the organism itself, and profound changes may be expected in the adaptation of vital activities to this new situation. Life itself now becomes part of a defensive scheme. Readjustments are made to secure a minimum demand upon existing stores of energy.

"With cold-blooded animals fasting is a regular occurrence in the life cycle. The demand for energy is low, the reserves are usually well filled, hence renewal of the store is necessary only at long intervals. Warm-blooded animals, whose reserves are frequently lower and whose energy needs are greater, withstand fasting much less readily, for not only may their reserves be quickly depleted, but the organized tissues may well be attacked.

"Omnivorous or carnivorous animals during normal feeding have, as a rule, deposits of body fat, but because of the rapidity with

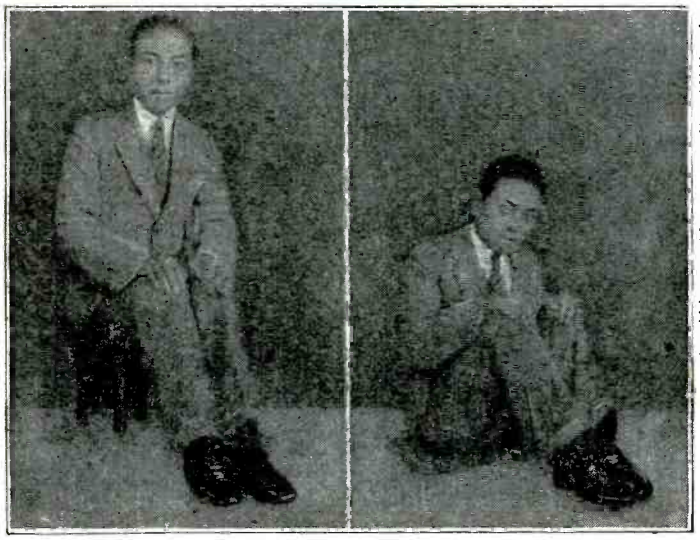
(Continued on page 1154)

At the right we find a graphic diagram of the complicated appliances used to measure the effect of either fasting or feeding on cattle. The numerals relating to this respiration chamber and their inference are given in the caption below the illustration.



Pure outdoor air is introduced into chamber by blower A, is withdrawn by blower B, and forced into wind-chest. Through one of two circular openings in wind-chest 90 per cent of air escapes into room; 10 per cent passes into sampling-can with rubber bathing-cap top. Blower C forces air withdrawn from sampling-can through two sulphuric-acid bottles, D-1 and D-2. Valve V-1 deflects air through either one of two sets of soda-lime bottles, E-1 and E-2 or F-1 or F-2, and sulphuric-acid bottles, G-1 or G-2. Air then passes from sodium-bicarbonate container S through meter. Delicate petroleum manometer J is used to indicate pressure inside chamber. To register muscular activity of animal, floor is in two sections; at front a movable platform, a, supported by two chains attached to springs at top of chamber and by two compression springs resting on the metal floor of chamber, only one of which, s, is shown. Rear of floor is fixed platform, b, slanting to allow flow of urine into container, c. P, pneumograph attached at one end to one of the chains, J-1, supporting movable platform, a, and at the other end to one of the stall uprights. Changes in tension of air in pneumograph transmitted through rubber tubing with safety outlet and pinchcock to tambour T, which actuates a small pointer writing on kymograph drum K.

Possible or Impossible?

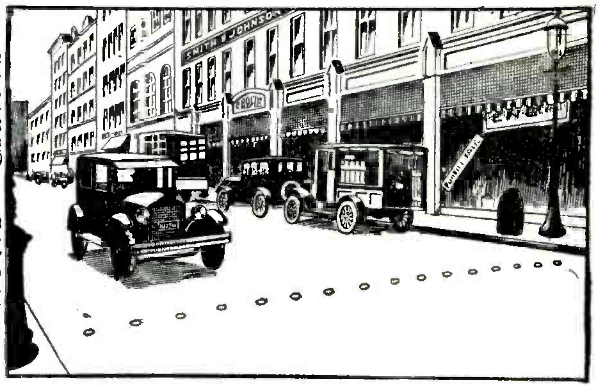


The photos at the left show two positions from which it is impossible to rise. In one case the man is sitting on the floor; in the other on a low stool. ←

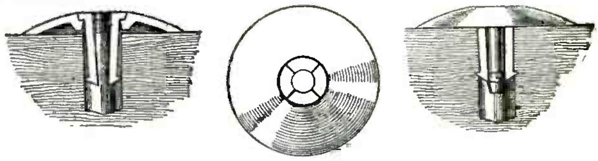
IF one sits on the floor or on a low stool, putting his hands upon his knees, and extending his feet so that he may see his own toes, it is absolutely impossible to arise. It is very interesting to note that it is impossible to get up when in this position, although few would believe this unless it were tried. Of course the subject is not allowed to lift his hands off his knees, or to draw his feet nearer to his body. The subject should be able to see his own toes when sitting in an erect position. Because of his vain efforts to leave the place where he sits, the subject seems to be more or less hypnotized. Try it and see; then fool your friends.—*K. Liu, Rep. No. 27082.*

Traffic Zone Domes

At the right is an illustration showing a single line of zone domes laid on the traffic approach side of a cross walk. →



Below we have three views of the zone dome before driving the plug, and after the plug has been put in position.

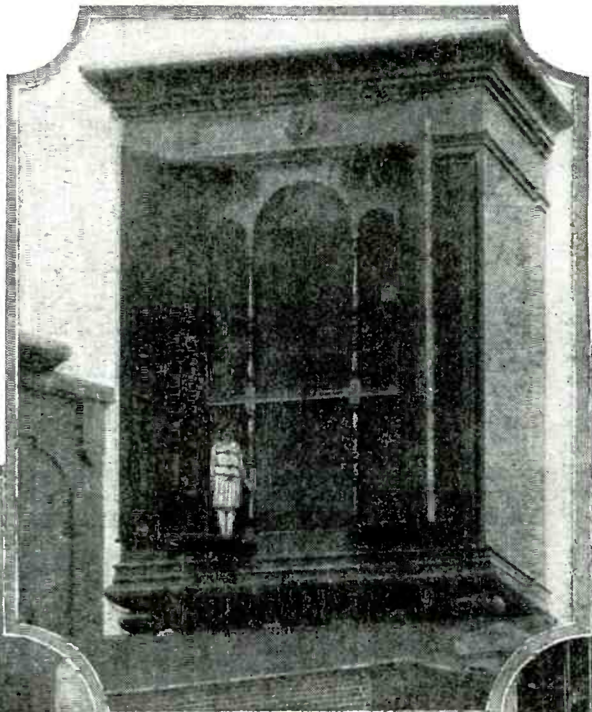


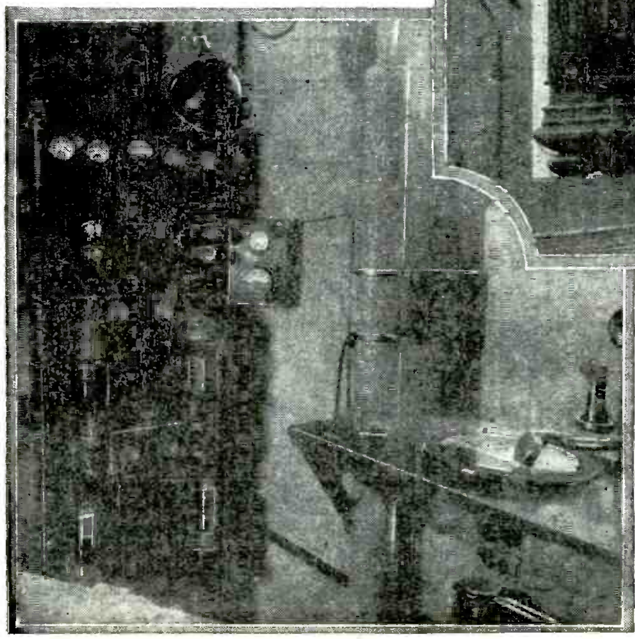
Painted traffic lines must be renewed at least every two weeks in order to be successful. In many of the larger cities, zone domes are now being employed. These are made of stainless steel, and are sunk into the asphalt concrete or wood roadbed, with their tops exposed, clearly marking the lines.

World's Largest Phonograph

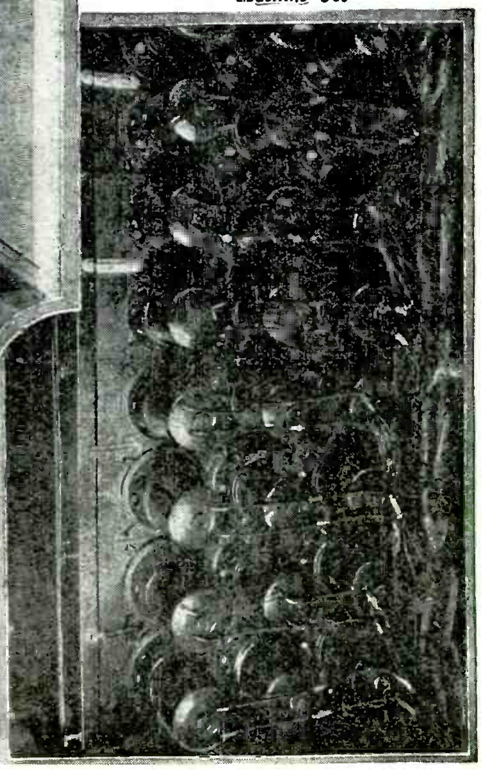
THE largest talking machine in the world has recently been erected by an enterprising talking machine company on the roof of one of its buildings in Camden, N. J. The instrument is a replica of the familiar type of orthophonic machine. It is equipped with doors which can be opened. A large number of electrical driving units are actuated by a standard record through a tremendously powerful amplifier. Placed at one end of the Delaware Bridge it attracts the attention of motorists many blocks away. Owing to the enormous size of the amplifier, it is possible to reproduce sound with extraordinary faithfulness at a great distance. The instrument is operated by remote control, which is placed below the machine in the building upon which it has been erected. It is practically impossible for one to remain inside the cabinet.

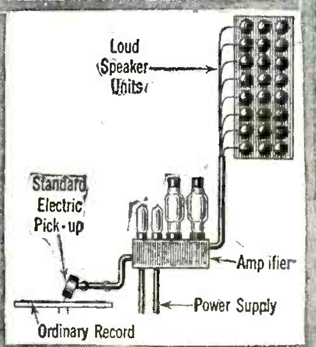
The photo in the center of the page shows the huge phonograph, which stands 31½ feet high, is 20 feet 8 inches wide, and 16 feet deep. It is equipped with doors which can be opened. Below is the amplifier.





Below we have a view of the bank of twenty-four speaker units which are required with this huge instrument. The machine is capable of entertaining people in their homes thirty blocks away. *Photos courtesy Victor Talking Machine Co.*

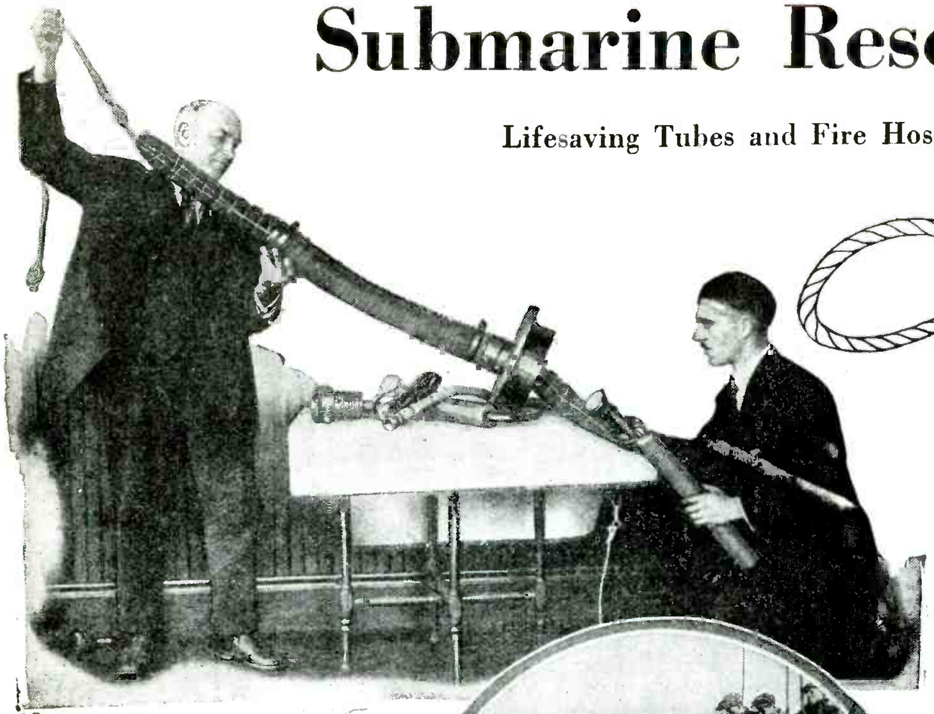


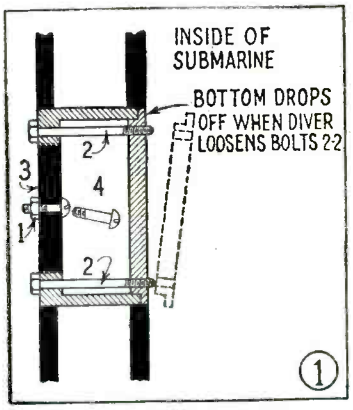


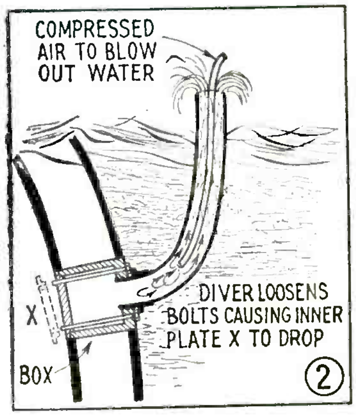
Above—the hook-up.

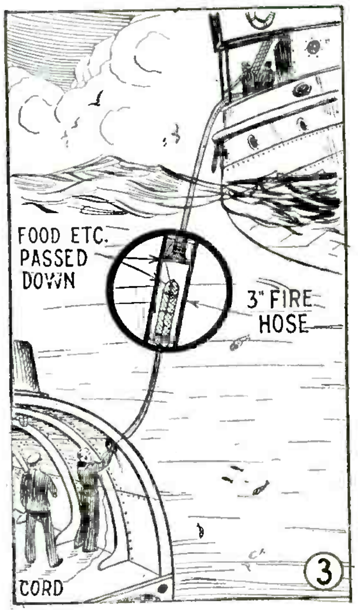
Submarine Rescue Methods

Lifesaving Tubes and Fire Hose Play Important Part



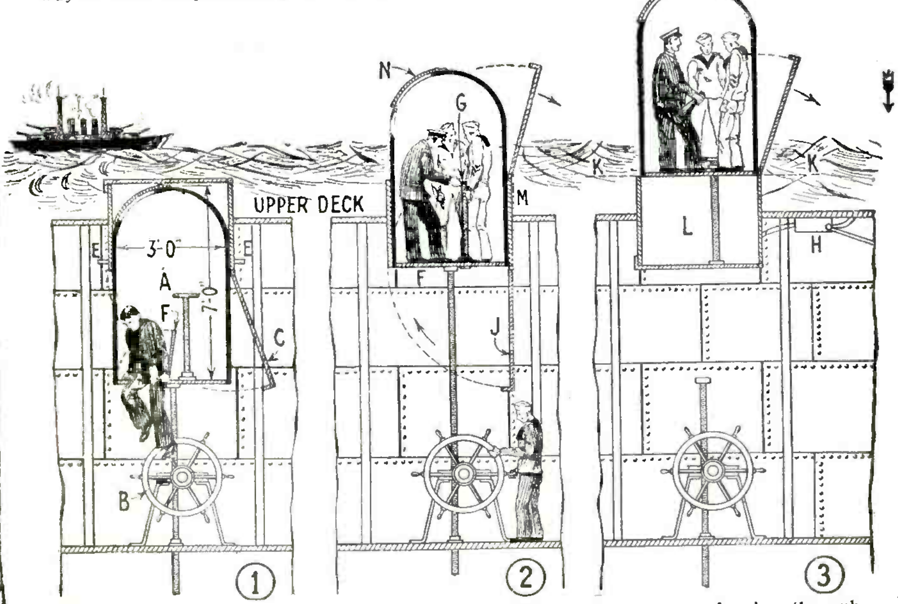






IN this modern age, it is unthinkable for men to die like rats in a sunken submarine, and on this page several methods of submarine rescue are outlined. Directly to the right is a tank used in demonstrating the submarine lifesaving device shown at the top of the page. This is a heavy three-inch hose, through which food, water and the like can be passed down to the entrapped men. A plate fastened on the outside of the boat is removed by the diver and the hose screwed in place. The diver then loosens two bolts from the outside, and causes an inner plate to drop off, as shown in the illustration, after a tube carrying compressed air has been placed in the hose and the water blown out. Thus, food, water and fresh air can be supplied to the submarine crew. This method was invented by Mr. L. M. Cottrell, of Boston.

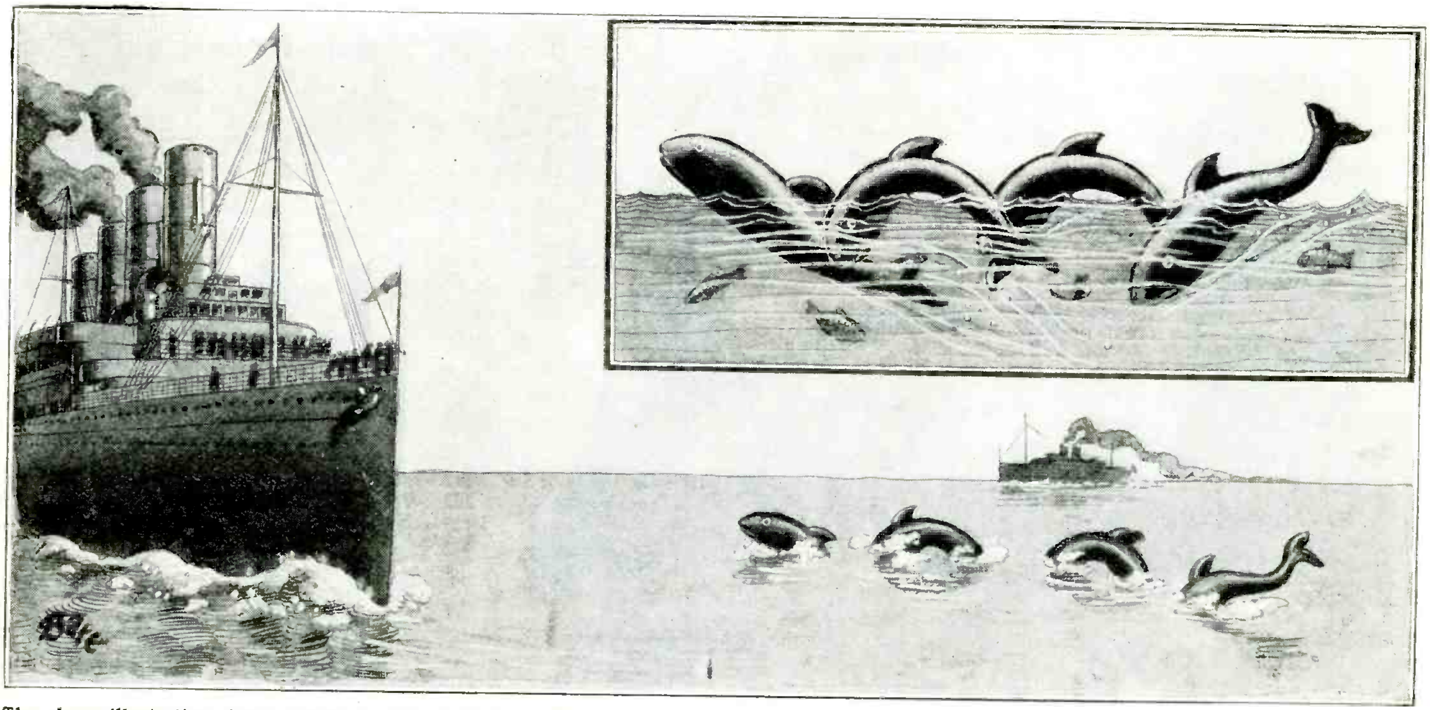
Below we see another device by which the men may actually leave the submarine. This is an invention of Mr. J. G. Pratt. Referring to the illustration, C is an underhatchway covering. B is a hand-operated jack, F is a door, and N is a hatch to admit air and also serve as an exit. Water collecting in compartment L is pumped out by a hand-operated pump. In order to install these tubes, it would merely necessitate cutting another hatchway in each compartment of the submarine.



The above drawing shows three stages in the process of using the submarine lifesaving torpedo. No. 1 shows one of the crew entering the chamber. No. 2 shows how the chamber is raised to the upper deck by a man in the submarine. No. 3 shows the final stage, with the trap door closed. The lifesaving tube, being buoyant, will then rise to the surface. Each compartment of the submarine would be fitted with an extra hatchway, as shown above.

In the above drawing, Fig. 1 shows a sectional view. The outside plate can be removed by diver when bolt is loosened, because pressure is then equalized. Fig. 2 shows water blown out of hose and Fig. 3 shows hose in use.

Sea Serpents---An Optical Illusion

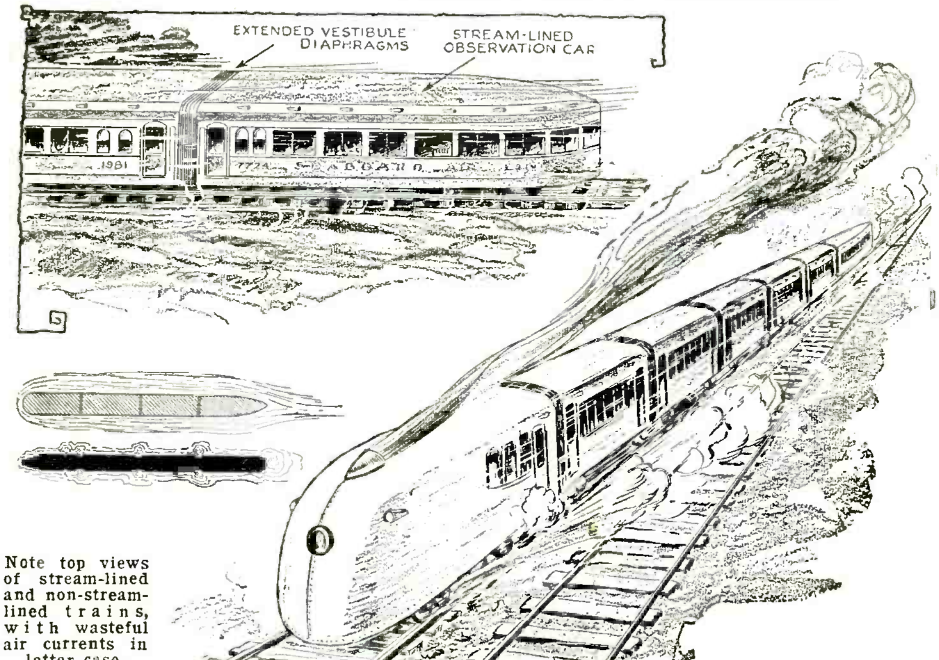


The above illustration shows clearly an optical illusion which seems to be a sea serpent when viewed from the surface of the water at a distance.

The supposed sea serpent was merely the movement of a number of young whales which propelled themselves through the water, as shown above.

For many years *sea serpents* have terrified certain navigators, who have sworn that they have seen these huge denizens of the deep. These serpents, however, were never seen when the ship drew up close, but always at a distance. A logical explanation has now seemed to be reached as to the origin of the sea serpent myth. The movements of a group of small whales, when viewed from a distance, are remarkably like that of a huge shiny black sea serpent. Navigators who proclaimed that they had seen these monsters were tricked by this optical illusion, which is illustrated in the above drawing.

Streamlined Trains More Efficient

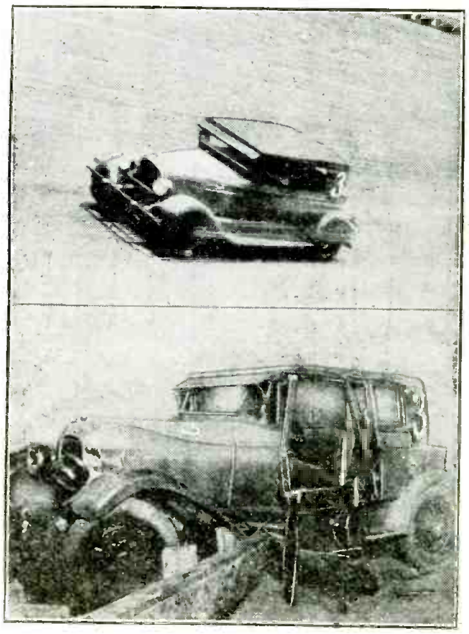


Note top views of stream-lined and non-stream-lined trains, with wasteful air currents in latter case.

WITH the advances made in aerodynamics in the past ten years, there is no reason why any vehicle traveling at high speed on the surface of the earth, should not be properly streamlined, either to increase its speed, or reduce the power required to propel it. Since passenger trains have reached their maximum economical speed, a plan has been advanced to streamline the observation coach at the rear of the train, and also to utilize extending vestibule diaphragms, as shown in the sketch. The air resistance would thus be reduced about forty-six per cent with an equivalent reduction in fuel consumption. This system may be further improved by streamlining the locomotive pulling the train. The effect of streamlining the train and the equivalent reduction in resistance, may be seen by referring to the drawing which shows the top views of a streamline and non-streamline trains.—*F. E. Loudy.*

Curious Accident

After finishing 2,000 miles at a new record for closed cars, this sedan traveling at 65 miles per hour, turned over on a wet track, skidded fifty feet on its roof, righted itself, and crashed through the guard rail of the track. After being out of the test seven hours for body repairs, the car finished the 15,000 mile grind, averaging 62.7 miles per hour. The photos below show the car making about 65 miles per hour, at the beginning of the test, and also, the appearance after the smash occurred. *Photo courtesy Auburn Automobile Co.*

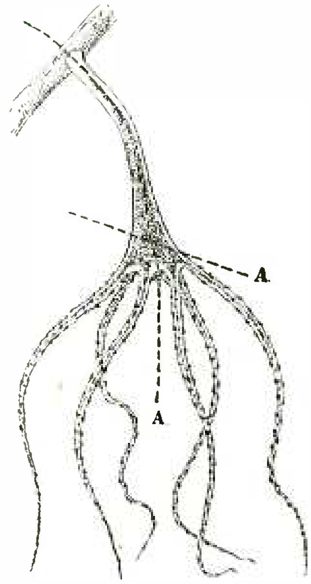


Above we have a photo showing a sedan before and after the crash.

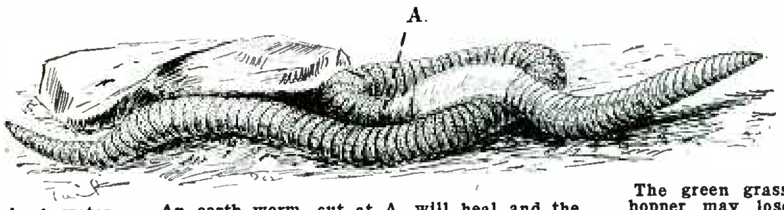
How Animals Grow New Limbs

Greatest Marvel of Nature—New Limbs Actually Regenerated

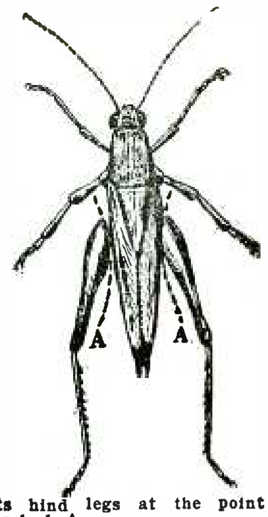
By DR. ERNEST BADE



A fresh water polyp is shown at the left.



An earth worm, cut at A, will heal and the tail will develop a head and vice versa.



The green grass-hopper may lose its hind legs at the point marked A.

A PECULIAR weapon has been given to some animals, a weapon which enables them to regenerate any part which may have been lost in the battle for existence. What difference does it make that a leg or an eye was sacrificed if life still remains? It just means that a place of concealment must be found until the miracle takes place. The wounds heal and the lost members and organs are replaced. It reads like a fairy tale.

But still more wonderful things occur, for each of the dismembered parts may make a new combatant. No weird tale has ever suggested such a thing, no fairy tale ever suggested such a possibility.

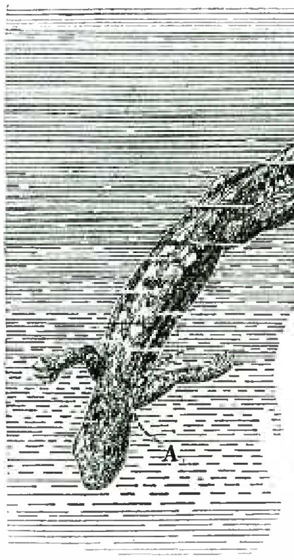
A polyp, lacerated and divided into 40 or more pieces, is able to regenerate a complete animal out of each of the fragments. Even the ordinary worm and the star fish of our coasts, regenerate entire bodies if a fragment is torn off, each piece making a new creature.

HOW SELF-AMPUTATION OCCURS

But the amputation of certain parts of the body is also frequently carried out, more especially are such parts sacrificed if the animal thereby saves its life. Certain grasshoppers like the katy-did and their relatives, chew off their leg at the moment of capture and thus they often escape from other animals.

A more striking example of self-amputation is shown on capturing the smaller agile lizards. These, after chasing through the grasses, are at last caught by the tail. Proud in possession, the tail is gripped tightly. The lizard, anxious to get away, struggles in vain. It throws its body from side to side and twists around and it is gone. The tail is left behind and it wags mockingly. The tail is not broken or torn off. The break occurs in a certain definite place, and in the middle of one of the tail bones which is provided with a membranous partition. In addition this particular bone is modified. It is elongated wide at each end, and extremely narrow in the center. The break is clean, and little or no blood flows. Peculiar as it may seem, the tail will not break at this point by a straight pull, nor will it come off when the creature has been weakened through hunger or cold.

After amputation, the muscles of the tail joint which broke contract and prevent loss



When the newt loses one of its front legs, indicated at A, a new leg will be regenerated.

of blood and the wound is healed over after a few days. Then a new tail begins to sprout and at the end of a few months it will have attained its full size, although slightly shorter than the original one. This tail also differs in other respects. It is boneless, the bones being replaced by a cartilage. Then, it can not break at the same place again, but only at a point above the place where the new tail ends.

The enemy of such a fast and agile creature would naturally grasp its tail as being the first thing it can reach. Obviously, amputating the offending member, offending in so far as it prevents escape, is a simple method for release and freedom.

Then, too, self-amputation may help in carrying out the functions of life. This particular case is illustrated by the termites and the ants. The winged females, after their bridal flight, break off their wings by bending at the roots. At times it may be observed how one female helps another in this task. Such self-amputation is natural. Why keep the wings if no more flights are intended? Living in a burrow, as they do, they would only be a hindrance.

CRABS AND LOBSTERS

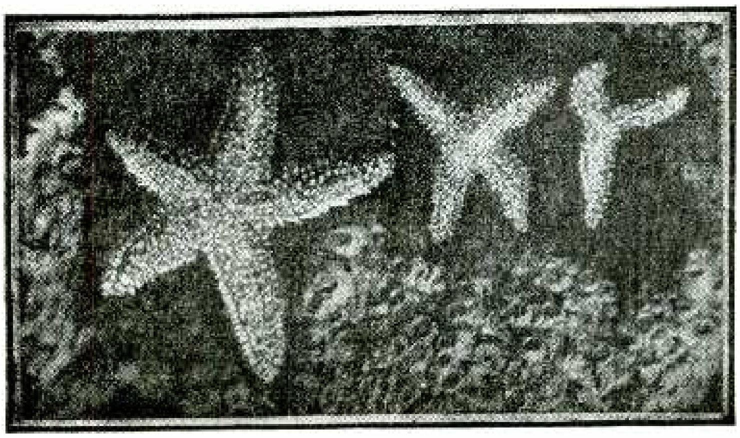
Salamanders are able to regenerate extremities, fish can regenerate their fins, many birds will regenerate a mutilated beak, and at times the frog and some of its relatives are able to regenerate a lost eye.

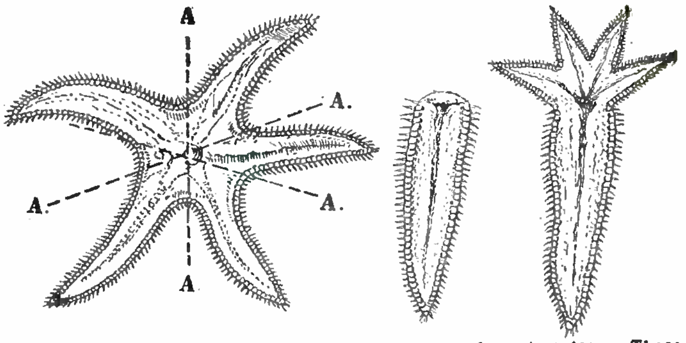
Lost legs on crabs and lobsters have undoubtedly been often observed. These are readily given up by these long-legged stalking animals. If a leg is grasped and held tight, the crab makes certain violent motions, and if it is prevented from carrying them out, the leg breaks off at a definite point. Very little blood flows. But the legs are not permanently lost, for they are also regenerated.

An example of self-amputation can be found with practically all spiders, more especially the long-legged kinds. Hold one of the legs for a few moments and it will break off, while the spider runs away.

Take the walking-stick, a relative of the grasshopper; this creature also gives up its extremities to save its life. How easily the leg may be removed is best illustrated by such an insect. Holding the leg lightly, the insect makes a few movements and is free, leaving the leg behind. But just try to tear the leg

(Continued on page 1140)



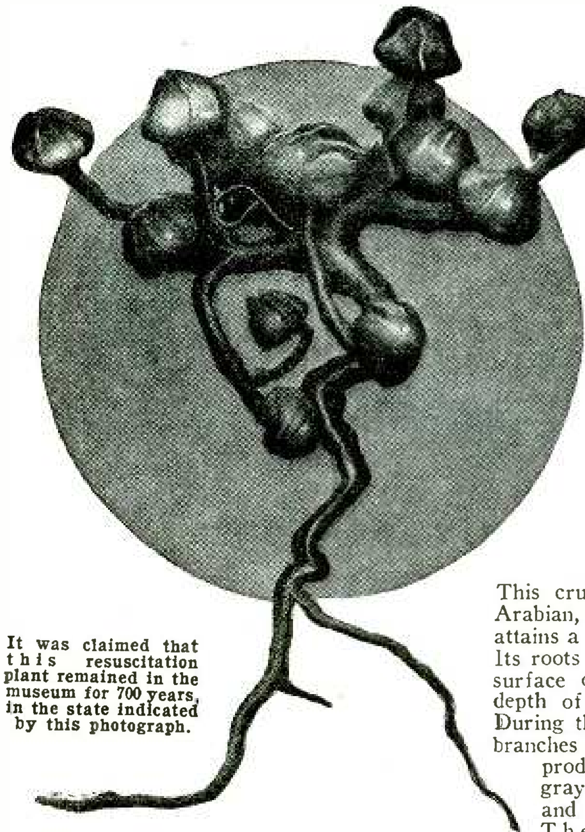


The photo at the left shows how a star fish may be cut or torn. These portions are indicated by the lines A in the above drawing. Each one of the arms produces the missing parts, so that each fragment soon becomes a complete new animal. The photo shows two star fish in various stages of their growth after being torn apart.

Do Resurrection Back to

Some Desert Plants Resuscitate After an Hygroscopic and Swell Like Japanese

By JOSEPH



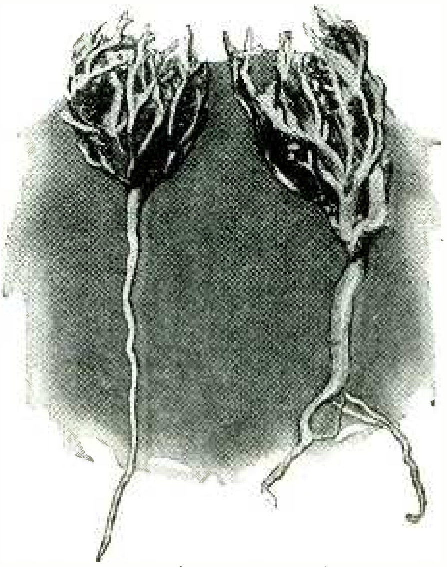
It was claimed that this resuscitation plant remained in the museum for 700 years, in the state indicated by this photograph.

WE all know that plants somehow seem to enjoy a perpetual life. Some plants produce seeds, others produce spores, and still others propagate in entirely different ways. The means of propagation are as varied as the methods. The winds may scatter the seeds or they may be taken from place to place by animals or man. The seeds may be shot out of the pods, or bulblets may be produced around the base of a bulb. With the coming of the spring rains and the warm sun, the seeds again germinate, and if they find fertile soil or soil suited to their growth, they perpetuate the existence of their species forever.

On the other hand, there are some plants (the perennial varieties) in which life depends upon the roots themselves. These roots remain alive beneath the surface of the soil during winter seasons and in the spring the roots that were apparently dead, revive again to produce new stocks in the place of the old ones. On the other hand, there are plants that die out completely and dry up, roots and all. Others shrivel up during the dry seasons and during the short rainy season again take on their life-like colors and continue to grow. This characteristic is particularly true of desert plants, and is made the subject of interest by plant wizards.

This habit is a splendid illustration of the adaptation of certain plants to a rather unique environment, and plants of this nature are called popularly resurrection plants because they apparently have the peculiar property of resuscitation.

There is the Anastatica Hierochuntica, popularly termed the Rose of Jericho, and the Asteriscus, another Rose of Jericho, and sometimes known under the name of Pilgrim Rose. And then the rather prominent Selaginella Lepidophylla, known as the Resurrection Plant.



A view of a dry Anastatica, popularly termed a Rose of Jericho. Note corresponding photo showing how it opens up when placed in water.

LEGENDARY HISTORY

OF the three, the Asteriscus is the most interesting because of its legendary history. This cruciferous plant is a native of the Arabian, Syrian and Egyptian deserts. It attains a height of approximately six inches. Its roots begin at the base very close to the surface of the soil and reach down to a depth of two inches. During the spring the branches of this plant produce some grayish leaves and red flowers. The latter become completely white after a few weeks. The flowers then bear fruits in the form of pods containing dozens of tiny seeds. This Resurrection Plant is sold in the Oriental shops under the name of Rose of Jericho (although there seems to be some question as to which plant is really the true Rose of Jericho).

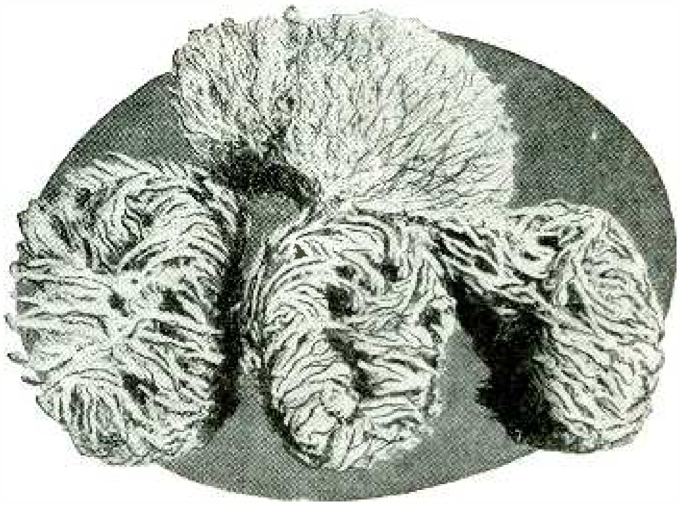
After this plant flowers, the leaves fall off, leaving only the delicate branches. The branches shrivel up into a grayish ball. In this form it is uprooted later in the season by the strong winds. Should it happen to be blown into water, the branches again expand, the pods open and let out the seeds. Natives of the countries where these plants grow, gather the plants as they are blown to the river banks or sea shores, and sell them to the commission merchants, who transport them to other European markets or export them to foreign countries.

A brisk trade is carried on with these unusual plants in almost every European city. The demand for them is created by the European housewife, and they are used for many purposes as home decorations, dressing-shop windows and for the production of our other artistic settings. The plants are purchased in the dried state, after which point the real phenomenon of what many call resuscitation occurs.

Having thus remained dormant probably for months since they were picked up in the desert countries, they are now ready for an entirely new environment. Instead of their bleak desert home, they may now grace a boudoir table in a French chateau or decorate the setting in some aristocratic mansion in London, Paris or Vienna.

SO-CALLED RESUSCITATION

THE operation of this so-called resuscitation is very simple. In order to bring back these plants in a unique splendor, the plant is placed in a vase of water, and within a few hours it will be seen to swell as if by magic. The shriveled-up leaves begin to open, the seed pods open and slowly the plant takes on a new color. This is the end of this particular stage of phenomenon. As long as the plant is kept in the humid state, its branches remain quite fresh. The seeds may begin to grow, provided that they have survived the handling and shipment and are not too old. It might be mentioned here that some seeds have an extraordinary longevity and seeds hundreds of years old have been known to be propagated.



This is a photograph of the Selaginella. Shriveled up and dry, it opens as in the photograph at the right.

Should the plant again be removed from the water, it will shrivel up and assume its former ball-like state. It can thus be taken out of the water and replaced almost as often as desired. The lay reader generally assumes when this plant opens up, that the resuscitation is real, and that the plant has actually come back to life after an indefinite dry period. This is not the case. As has previously been stated, the plant when it grows has leaves which are never seen on the exported product.

LIKE CHINESE PAPER FLOWERS

THE effect may be likened to those Chinese paper flowers which mystically open up to become quite beautiful when they are placed in water. The paper flowers do not again shrivel up and assume their former shape, but the physical principle of the

Plants Come Life?

Apparent State of Death, Others Are Merely Paper Flowers When Put in Water

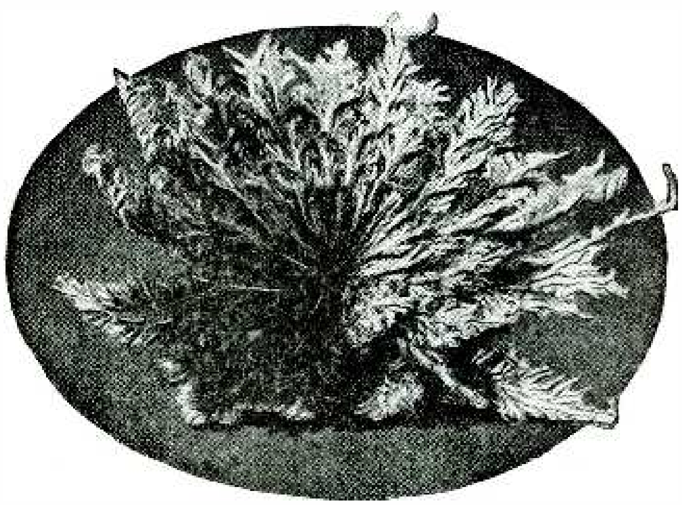
H. KRAUS

swelling is identical. This plant is purely hygroscopic, and because of its property of absorbing water it swells out.

One frequently reads statements to the effect that some of these plants were kept in a dry state for fifteen years and after this long sleep, they were placed into water, survived and even remained fresh for several years more. When one realizes that the plant is merely a series of dry twigs, one can see that this story is not quite within the realm of possibility.

PLANT LIVES AFTER 700 YEARS?

THEN there is another story sponsored by Dr. Ritter, a famous German botanist, but the story should be taken with perhaps more than the proverbial grain of salt. Dr. Ritter claimed that in his search for further information regarding the immortality of this plant, he came across a specimen in the Berlin Museum. After considerable research he discovered that the specimen was brought back by the crusaders 700 years ago, and it finally found its way into a showcase of the Museum of Natural History. To prove the theory of resuscitation (which, as heretofore explained, the phenomenon is not), he removed this particular plant and placed it in a jar of water, and to his astonishment, it began to revive. The statements to the effect that it resumed its former freshness and actually bloomed, are discounted by every botanist who has had occasion to read his story. There is not the slightest doubt that the plant might have swelled up, but there is indeed a grave question as to its resuscitation.



Selaginella when fully opened takes on this fine fern or moss-like appearance. This plant may come back to life.

There is an interesting legend connected with this plant, which dates back to the days of the Bible. It is said that when Joseph and Mary ran away from the Holy Land into Egypt, in order to save the infant Christ from the great massacre as related in the New Testament, they stopped by a tree for a rest. The mother Mary placed the infant Christ on the ground and when she moved, her hand touched some of these plants, therefore God blessed the plant ever since and gave it immortal life. To this day, the legend still is related by the natives of the Holy Land, and it is known by them as Kaff Maryam, which in Arab means, "the palm of Mary's hand."

The Holy plant is also venerated by the Bedouins, who consult it before going on a trip, or when they want to make a certain decision of importance. The involuntary actions of the plant are considered by these fanatics as miracles; for instance, if the branches shrivel up it is a bad omen, and means that the trip might end in disaster. On the other hand, if the branches happen to open, it is then a sign that good luck is in store for them. During grave sickness or malady, the plant is often consulted as to the result of the sickness whether to end in death or complete cure. This is the only way they have of knowing what will happen to the patient. After a brief ceremony, the plant is placed in the water; if resuscitation takes place immediately, it is a sign that the patient will recover; if, on the contrary, the branches refuse to open quickly, it means that the patient is ready to meet the Prophet in Paradise.

The plant in full bloom after a rest claimed to have been more than five centuries.

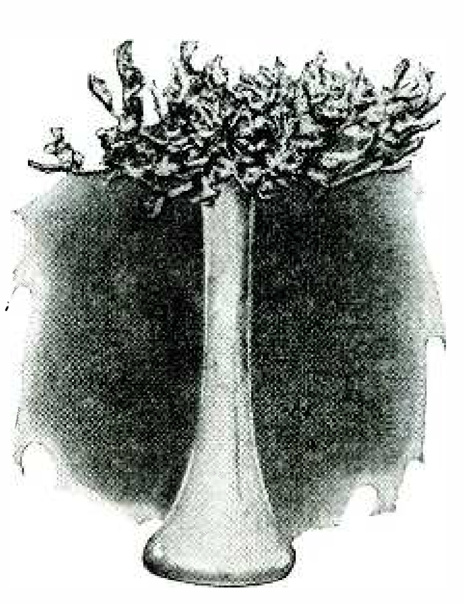
The Selaginella (a bird's nest moss) is a native of Mexico and western Texas. It is quite well known to American scientists and amateur botanists. This plant, when placed in water, may become green, and even grow. Thus, in this case, we have a plant that when put into water, can actually be resuscitated, but is this plant any different from a rose transported to a distant place or from any of the other perennials that are shipped in a nearly dry state? It is true that the Selaginella can probably withstand a dry atmosphere to a greater extent than many of our other hardy and half-hardy perennials, but by no stretch of the imagination can any authority conceive of the possibility of a plant coming back to life years after it was kept encased in a museum for approximately seven to eight hundred years.

Science now finds it quite possible to take cuttings and place them in bottles for use in subsequent years, but it must be remembered that these cuttings are being preserved against the ravages of the atmosphere. Experiments with seeds, on the other hand, have indicated that nature preserves some seeds with a remarkable protective covering. So be not surprised if someone tells you that seeds have been known to live for hundreds of years.

AUTHORITY FOR FACTS

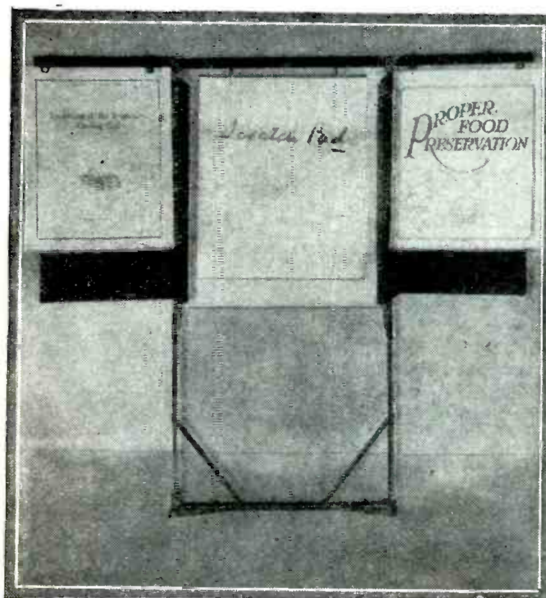
THE photographs on this page were furnished by Count A. N. Mirzaoff, together with an article collected from purported authorities. In an effort to determine whether these "authorities" were mythical, and whether there was any truth in the statements presented, we took the matter up with several acknowledged botanical experts at the New York Botanical Gardens. Inasmuch as there can be no question as to the accuracy of their statements, we unearthed the real facts concerning resurrection plants. The consensus of expert opinion is that these plants are no more mystical than many others, and in fact, less so than some of them. Many of the supposed startling phenomena are pandered to the uninitiated through veiled advertisements. Still the advertisers themselves may be absolutely sincere and not even know the true status of resurrection plants.

In accordance with its policy, this publication will continue to tear the veil of mystery from all sorts of quackery. This is another step in that direction.

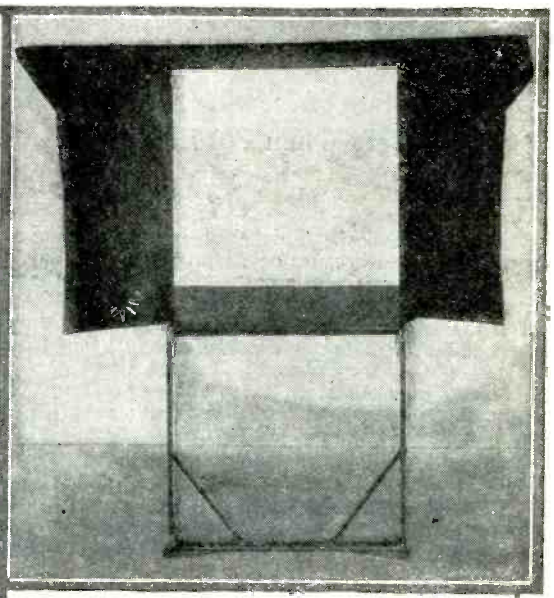


This is the way the Rose of Jericho looks after it has been placed in water for about three minutes.

Novel Folding Easel



Above we have a photograph showing the folding easel in use. Three separate charts or pads may be supported at the same time with this new device.

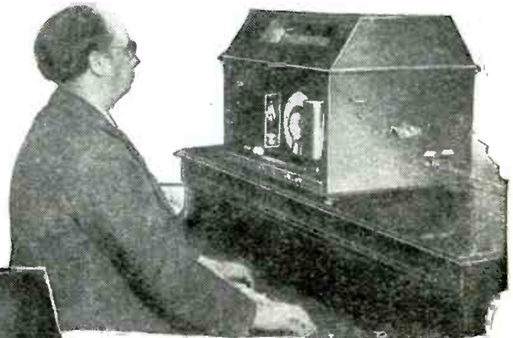


The easel may also be turned into a small movie screen, as shown. The black wings make possible the use of slide films in a lighted room.

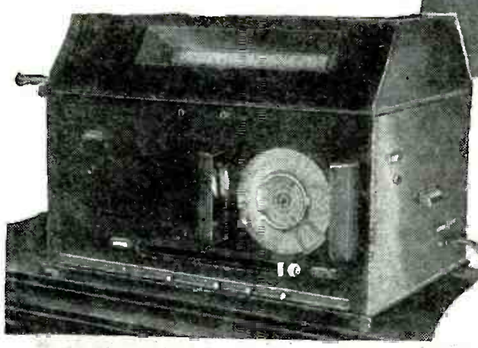
FINDING many disadvantages in the customary style of wooden easels, Le Roy Smelkner of Dayton, Ohio, has created an easel which may be folded up into a small space. The completed arrangement weighs only about ten pounds, and when opened provides space for three charts or pads. Black wings on either side and above turn the face of the easel into a small movie screen, and may also be extended, so that larger pictures can be thrown upon it. The black wings make it possible to use slides in a well lighted room. Several of the attached parts, such as the legs, may be removed, and the easel may then be hung on the wall for movie use alone. This device is now being used by some of the larger corporations in training salesmen.—*J. Nesbit.*

A Musical Chronometer

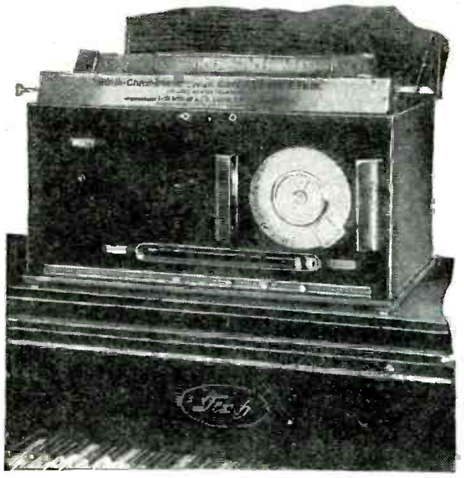
IT is generally thought that rhythm in music is something fixed and rigid, something teachable by a simple metronome, a thing free from any variation due to the performer's personality. This view, however, is false, and it has only been realized of late that the rhythm of any work of music largely depends on personal factors, and is really a characteristic expression of the personality. Mr. Carl Robert Blum, of Berlin, has for the last few years been giving much thought to this and other problems of similar kind. He has invented an apparatus which enables any musician to study all the details of any piece of music, and to improve his sense of rhythm and power of expression. The machine comprises an attachment by means of which a moving music tape is carried past an adjustable mark. Other devices on this apparatus comprise a tachometer for reading, and a rheostat for regulating the speed, a gauge enabling the rhythm to be adjusted, and any change of rhythm to be read on special scales. The music tape can be replaced by a record of several voices, or even an entire score. The musical chronometer can be installed at any place desired, and can be coupled to any clockwork or machine. It may also be attached to the shaft of the moving picture projector, which will operate the music tape in synchronism with the projector. The music tape is prepared with the aid of a special synchronizing tape, which during the recording of a film is covered with marks, and after the cutting of the negative is in turn cut, and a record made thereon. Thus a rhythmogram on music tape comprises all the characteristics required for the conducting and rendering of a piece of music. The rate of reproduction may be readily accelerated or slowed down without any fear of discord resulting.—*Dr. Alfred Gradenwitz.*

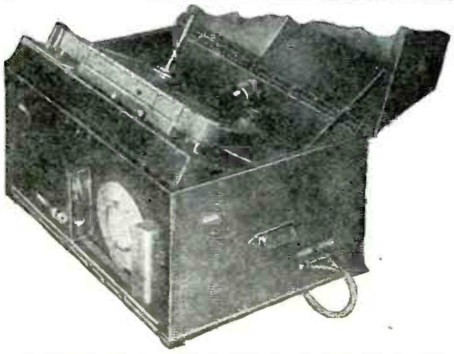


Above we have a view of the instrument in use. This apparatus enables any musician or musical student to study all the details of any piece of music, and thus improve her or his sense of rhythm and power of expression.

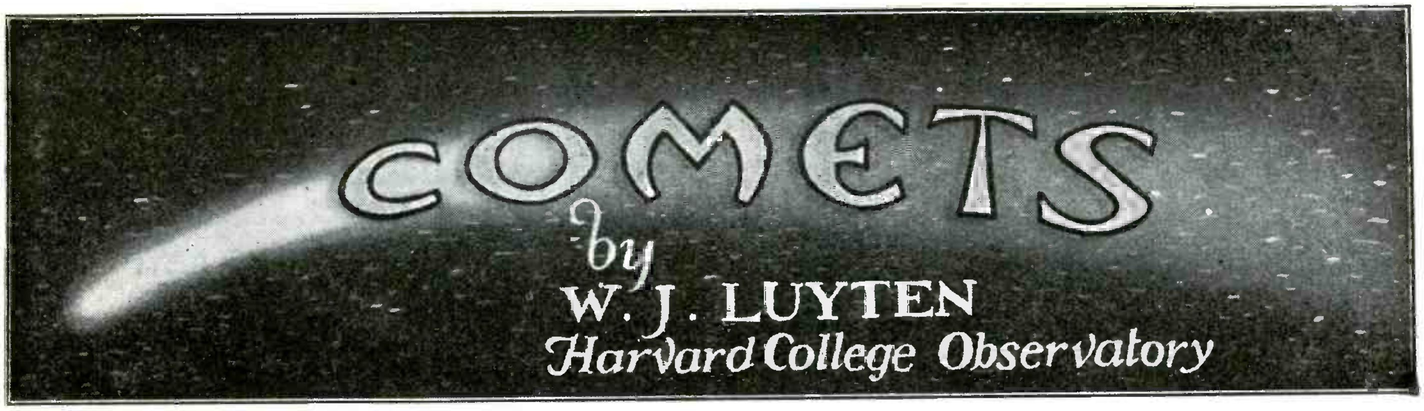


At the left is a view of the apparatus showing the moving music tape which can be replaced by a record of several voices, or even an entire score. A portion of the tape is visible at all times through a rectangular window.





A front view and a three-quarter view of the new musical aid are shown above.



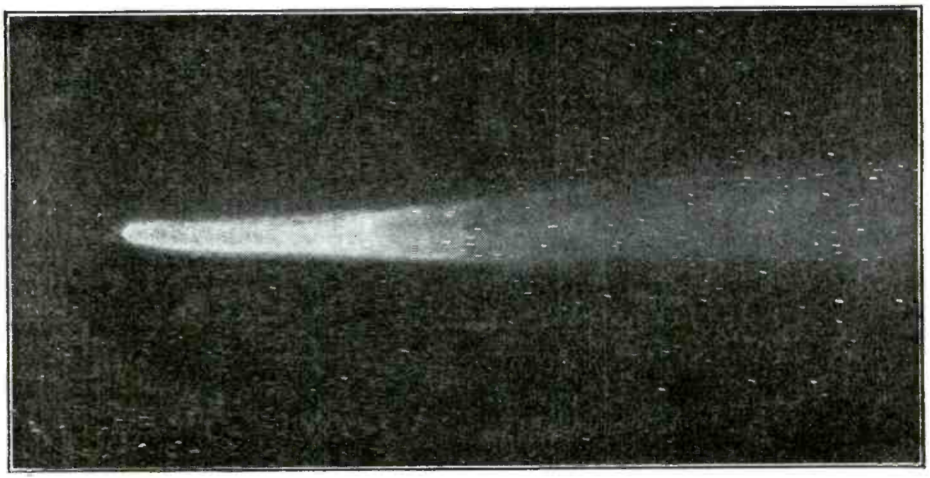
MAN has always been particularly fond of shifting the responsibility for misfortunes befalling the human race onto other parts of the universe. And comets, as most unusual and weird phenomena of extremely rare occurrence, received a generous share of the accusations. Indeed, of all the spectacles which Nature provides for us, the sudden display of a great comet is easily among the most imposing. Though perhaps a total eclipse of the sun is of more grandeur and more terrifying, it is of comparatively short duration, and apt to be quickly forgotten. The sight of a great comet, blazing forth in the blackness of the nocturnal sky, on the other hand, is something not easily forgotten or lightly ignored. Hence, the numerous allusions to comets throughout literature, sometimes descriptions of painstaking minuteness, sometimes in language of grotesque extravagance. Especially the ancient Chinese records reveal some past masters in this noble art.

COMETS AS OMENS

THE name comet dates back to the Greeks, and is derived from *cometes,* "the hairy one," a most obvious description. Although some ancient philosophers already held views upon the nature and constitution of comets, which approach very closely our present ideas upon these subjects, the general populace regarded them with great awe, and took them to be forebodings of imminent disaster. Homer, e.g., ascribed to them the power to produce famine, pestilence and wars. The Romans on the other hand, who were a practical people and more successful as warriors, politicians and bricklayers, did not pay much attention to comets. The historian Suetonius tells us that when the emperor Vespasian, already feeling low, and with his end near, heard his courtiers discuss the comet which had just appeared in the sky, he said: "This hairy star does not concern me, it menaces rather the King of the Parthians, for he is hairy and I am bald." In general, comets were very useful because their appearance could be turned to explain anything one wanted. The great comet which "hung over the city like a sword" forecast the destruction of Jerusalem in 65 A.D., while the same comet had, at its previous appearance been used both, as the "Star of Bethlehem" and as the celestial messenger who came to claim the life of Agrippa in Rome in 11 B.C. Some old Norman chronicles derived the divine right of William the Conqueror to invade England, from the fact that a comet with three tails appeared in the sky, in 1066, and such a star only appeared "when a Kingdom wanted a King."

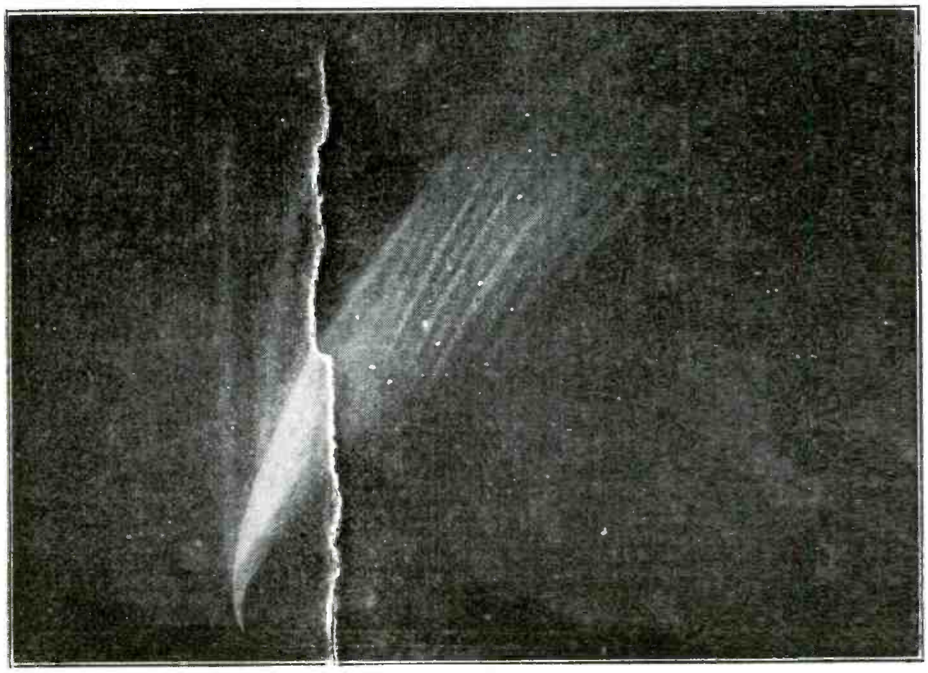
HALLEY'S COMET

THE most famous comet of all times is, without doubt, Halley's, which has been a noteworthy visitor to our skies for tens



Above is a photograph of Halley's comet taken at the Mills Observatory, May 7th, 1910, at 5 A. M. Since the telescope must be trained exactly on the moving comet at all times, the stars move across the photographic plate and appear as small lines on the photo.

Below we have a photograph of Donati's comet of 1858, which had a huge tail more than 55 million miles long. Compare this to the photograph of Halley's comet, which is shown at the right.



of centuries. When it appeared in 1682, and was observed at the Royal Observatory in Greenwich, the observations were given to Edmund Halley to calculate the path of the comet around the sun. Having performed his calculation, Halley was struck with the resemblance between the path of this comet and that of the great comets of 1531, and of 1607. He boldly concluded that these must all be appearances of the same comet which revolved around the sun in a period of 75 years, and accordingly he predicted its return for the year 1758. It is difficult for us nowadays, when we can compute a comet's orbit in a few hours, to realize fully what this meant. It was the first prediction, and consequently the first rigorous test to which Newton's theory of gravitation had been put. Halley died in 1742, leaving posterity to decide whether he had been right or wrong. At first people paid little attention to his prediction, but as the year 1758 drew near, two French astronomers, Clairaut and Lalande set to

(*Continued on page* 1129)

The Metal EMPEROR

by A. Merritt
Author of "THE MOON POOL", "THE FACE IN THE ABYSS" etc.

(Seventh Installment)

CHAPTER XX

THE CORRIDOR EJECTS US

I THINK that for a moment we both went a little mad. I know we started running once more, side by side, gripping, like frightened children, each other's hands. Then Drake stopped.

"By all the hell of this place," he said, "I'll run no more! After all—we're men! If they kill us, they kill us. But by the God who made me, I'll run from them no more. I'll die standing!"

His courage steadied me. Defiantly, we marched on. Up from below us, down from the roof, out from the walls of our way the hosts of eyes gleamed and twinkled on us.

"Who could have believed it?" Drake muttered, half to himself. "A living nest of them; a prodigious living nest."

A nest? I caught at the word. What did it suggest? That was it—the nest of the army ants, the city of the army ants, that William Beebe had studied in the South American jungles, and once described to me. After all, was this more wonderful, more unbelievable than that—the city of ants which was formed by their living bodies precisely as this was of the bodies of the Cubes?

How had Beebe phrased it—"the home, the nest, the hearth, the nursery, the bridal suite, the kitchen, the bed and board of the army ants." Built of and occupied by those blind and deaf and savage little insects, which by the guidance of smell alone carried on the most intricate operations, the most complex activities. Nothing in this place was stranger than that, I reflected—if once one could rid the mind of the paralyzing influence of the shapes of the Metal Folk. Whence came the stimuli that moved them, the stimuli to which they reacted? Well then—whence and how came the orders to which the ants responded; that bade them open this corridor in their nest, close that, form this chamber, fill that one? Was one more mysterious than the other?

Breaking into my thought came consciousness that I was moving with increasing speed. Simultaneously with this recognition, I was lifted from the floor of the corridor and levitated with considerable rapidity forward. Looking down I saw the floor level several feet below me.

"Closing up behind us," Drake muttered. "They're putting us—out."

It was, indeed, as though the passageway had wearied of our deliberate progress and had decided to—give us a lift. Rearward, it was shutting. I noted with interest how accurately this motion kept pace with our own speed, and how fluidly the walls seemed to run together. Our movement became accelerated. It was as though we floated buoyantly, weightless, upon some swift stream. The sensation was curiously pleasant, languorous—what was the word Ruth had used?—elemental—and free. The supporting force seemed to flow equally from walls and floor to reach down to us from the roof. It was even, and effortless. In advance of us the living corridor was opening even as behind us it was closing.

All around us the little points twinkled. Deeper and deeper dropped my mind into the depths of that alien tranquility. Faster and faster we floated—onward.

Abruptly, ahead of us shone a blaze of—daylight. We passed into it. The force holding us withdrew its grip. I felt the solidity beneath my feet. I stood and leaned back against a smooth wall.

The corridor had ended and—had shut us out from itself.

"Bounced!" exclaimed Drake.

We were upon a ledge jutting from the barrier. Before us lay spread the most amazing, the most extraordinarily fantastic scene upon which, I think, the vision of man has rested since the advent of time.

It was a crater. A mile on high and ten thousand feet across ran the circular lip of its vast rim. Above it was a circle of white and glaring sky in whose center flamed the sun. Instantly, before my vision could grasp a tithe of that panorama, I knew that this place was the very heart of the Metal City.

Around the crater lip were poised thousands of concave disks, vernal green, enormous. They were like a border of gigantic, upthrust shields, and within each, emblazoned like a shield's device, was a blinding flower of flame—the reflected, dilated face of the sun. Below this glistening diadem hung, pendent, clusters of other disks, swarmed like the globular hiving of Hercules' captured suns. And in each of these also hung prisoned the image of the day star.

A hundred feet below us was the crater floor.

Up from it thrust a mountainous forest of the pallidly radiant cones, bristling, prodigious. Tier upon tier, thicket upon thicket, phalanx upon phalanx they climbed. Up and up, pyramidically, they flung their spiked hosts.

They drew together two thousand feet above, clustering close about the foot of a single huge spire which thrust itself skyward for half a mile above them. The crest of this spire was truncated. From its shorn tip radiated scores of long and slender spokes, holding in place a thousand feet wide wheel of wan green disks whose concave surfaces, unlike those smooth ones girding the crater, were curiously faceted.

Synopsis

Dr. Louis Thornton is traveling through Tibet with his Chinese servant-cook, Chiu Ming, and two ponies that carried the impedimenta. They come upon a white man who introduces himself as Richard Keene Drake. Drake's father had been very friendly with Thornton. The three decide to carry on and come upon Martin Ventnor, a geologist, and Ruth, his daughter. The latter are guarding themselves against hundreds of soldiers who belong to an age at least twenty centuries back. While escaping they are attacked and would have been exterminated, were it not for the timely intervention of Norhala, a tall, beautiful, metallic-haired woman, whose control over lightning and over heavy metallic blocks was phenomenal. These blocks, at her command, would make a bridge for her to walk on or form themselves into battling monsters to protect her or obey her every whim. Chiu Ming is killed in the battle, the survivors leaving with Norhala. Ruth and Norhala get on one of the blocks. The others stand upon a second composed of four smaller ones joined together by their own peculiar super-normal power. The platforms speed through space at a terrific rate, arriving eventually in the court of the Metal Emperor. Angered by the influence of Norhala over Ruth, Ventnor raises his rifle and fires at the red ruby-like object he believes to be the brain of the metal monster. He is struck down by a lance of green flame and rendered unconscious. The metal monster gives Norhala the entire company to serve as her toys. She takes them to her home, where she informs Yuruk, her ape-like eunuch attendant, they are not to be harmed. Ventnor talks, then lapses into unconsciousness again. Ruth, after telling about the strange power that holds her enslaved, goes to sleep. Drake and Thornton discourse on the metal intelligences, and come to the conclusion that they are guided by some sort of group consciousness, and that they move by super-rapid molecular "steps!" Yuruk, because of jealousy, informs Drake of the way back to the city, which Ventnor, in a semi-conscious state, told them was their only hope. Yuruk claims that though the inhabitants of the city were hostile, it is much safer to escape. Leaving Ruth with Ventnor, Thornton and Drake decided to skip away from Norhala. They informed Ruth that Yuruk has learned the meaning of the pistol. After rather spectacular adventures, they come upon the Metal City, where geometrical and intangible forms are seemingly endowed with super-intelligence. The city saw and was alive. Norhala appears unexpectedly and is just as quickly blotted out from sight.

They drew together two thousand feet above, clustering close about the foot of a single huge spire, which thrust itself skyward for half a mile above them. The crest of this was truncated. From its shorn tip radiated scores of long and slender spokes, holding in place a thousand feet wide wheel of wan green disks whose concave surface, unlike those smooth ones girding the crater, were curiously faceted.

This amazing structure rested upon a myriad-footed base of crystal, even as had that other cornute fantasy beside which we had met the great Disc. It was in size to that as Goliath to David; no—as Leviathan to a minnow. From it streamed the same baffling suggestion of invincible force transmuted into matter, energy coalesced into the tangible, power concentrate in the vestments of substance.

Half-way between crater lip and floor began the Hordes of Metal.

In animate cheveau-du-frise of thousand-foot girders they thrust themselves out from the curving walls — walls, I now knew, as alive as they. From these beams they swung into ropes and clusters — spheres and cubes studded thickly with the pyramids. Group after group they dropped, pendulous. Coppices of slender columns of thistle globes sprang up to meet the festooned joists. Between the girders they draped themselves in stellated garlands, grouped themselves in innumerable, kaleidoscopic patterns. They clicked into place around the ledge in which we crouched. In fantastic arrases they swayed in front of us, hiding and revealing through their quicksilver interweavings the mount of the cones.

Steadily those flowing in below added to their multitudes, gliding up cable and pillar, building out still further the living girders, stringing themselves upon living festoons and living garlands, weaving in among them, changing their shapes, rewriting their symbols.

They swung and threaded swiftly, in shifting arabesque and *cocquillage,* in Gothic traceries, in lace-like Renaissance fantasies, arches and brocatteled astragals, unutterably bizarre, unutterably beautiful — crystalline, geometric always.

Their movement ceased—so abruptly that the stoppage of all the ordered turmoil had in it a quality of appalling silence.

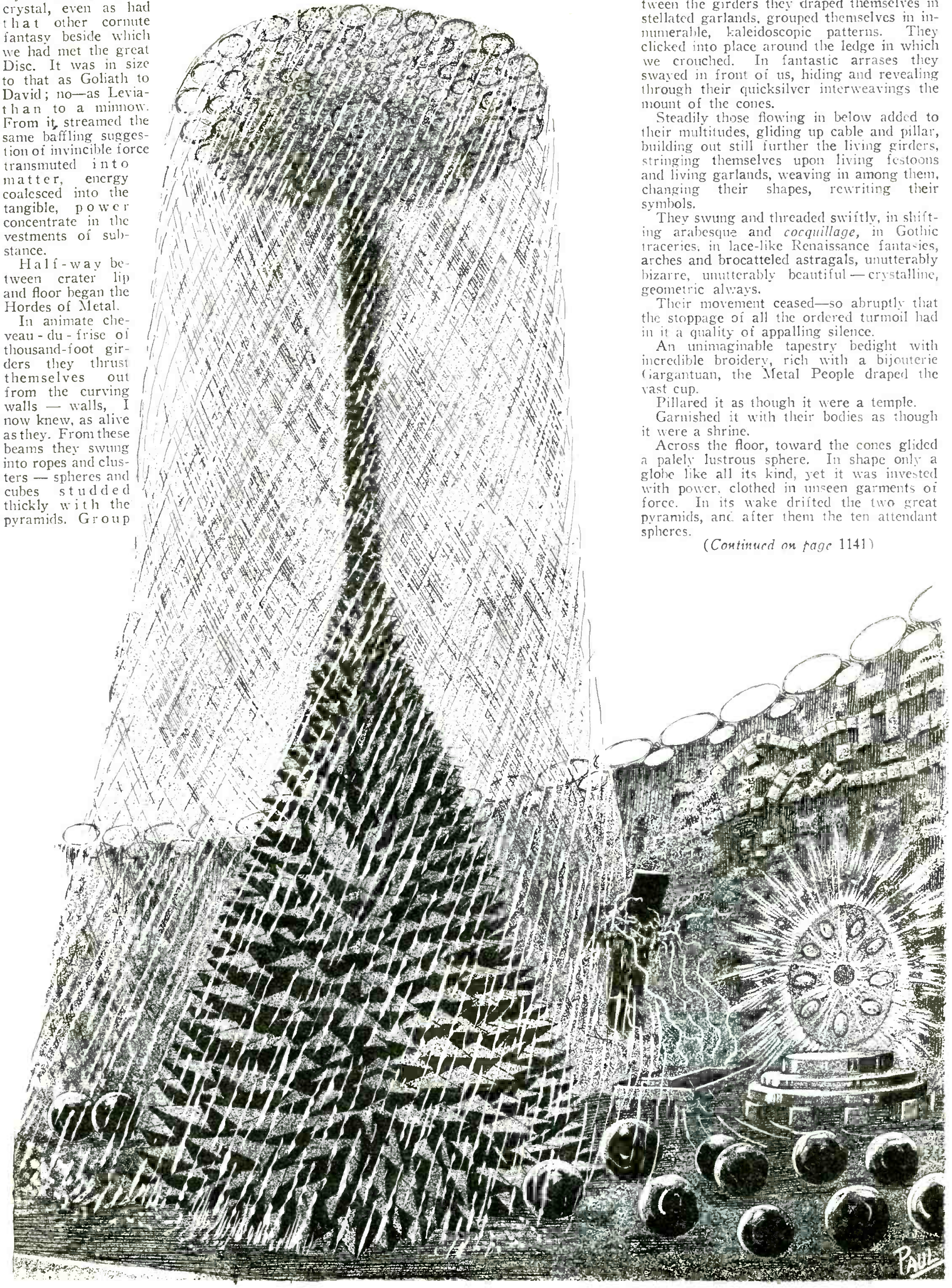
An unimaginable tapestry bedight with incredible broidery, rich with a bijouterie Gargantuan, the Metal People draped the vast cup.

Pillared it as though it were a temple.

Garnished it with their bodies as though it were a shrine.

Across the floor, toward the cones glided a palely lustrous sphere. In shape only a globe like all its kind, yet it was invested with power, clothed in unseen garments of force. In its wake drifted the two great pyramids, and after them the ten attendant spheres.

(*Continued on page* 1141)



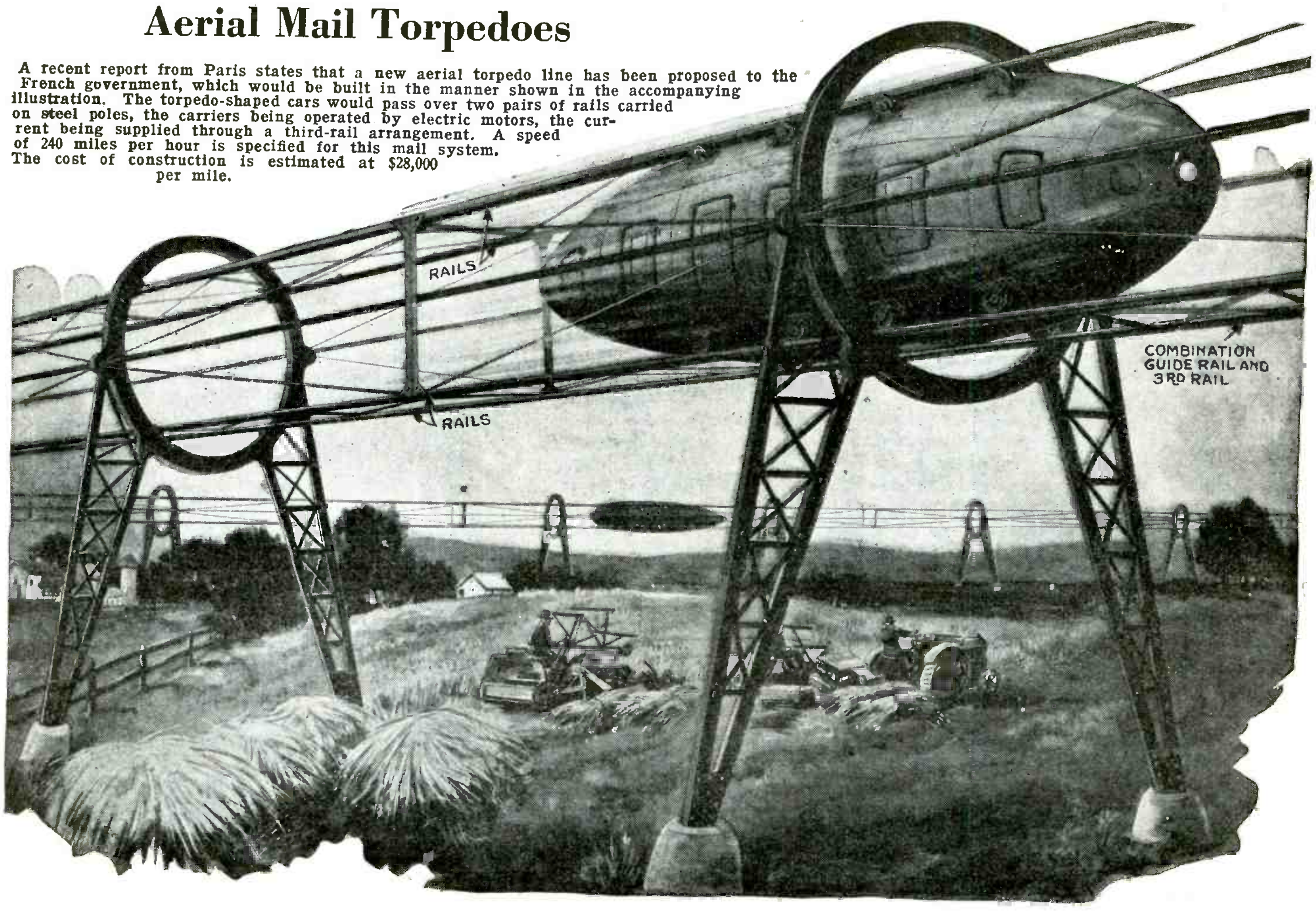
Can You Answer These Scientific Questions?

SCIENCE and INVENTION Magazine readers, especially our thousands of friends in schools and colleges everywhere, have frequently testified in their letters to the editors that they obtain invaluable help from the columns of this magazine, in clearing up technical questions which arise daily. It is a recognized fact that everyone today, including those of both sexes, are expected to have a fairly good general knowledge of the latest scientific developments and discoveries. It is quite impossible to obtain this knowledge of the latest conquests in science from text-books, as they are usually revised but once a year, and in many cases not as often as that. You will find the questions below a good challenge to your knowledge of modern science, and we advise you to form your own answer, before you turn to the page referred to in each case.

1. How is rubber made from such plants as the Guayule shrub and the cacti? (See page 1074.)
2. What is the average elevation possible in degrees for the 16-inch guns on a modern battleship? (See page 1075.)
3. What advantages, if any, are obtained by designing special trans-oceanic airplanes suitable for flying at an altitude of 40,000 feet, instead of the usual lower altitudes of 10,000 to 15,000 feet? (See page 1076.)
4. Is it possible to freeze the soil under the tower of Pisa, and construct a new foundation under the tower in its present position? What other scheme would you suggest? (See page 1078.)
5. What advantage is gained in designing high voltage electric cables with hollow centers through which oil is forced? (See page 1080.)
6. Do you think it will ever be possible to make sustained flights in man-propelled airplane without any engine at all? (Form your answer before reading page 1082.)
7. In regard to human nutrition, what is the effect of the complete (temporary) withdrawal of food from the living organism? (See page 1087.)
8. Do you think it would help very much to streamline the observation car on a railroad train as well as the locomotive; if so, what per cent in reduction of fuel would be obtained approximately? (See page 1090.)
9. Do animals actually grow new limbs when they lose one through accident or otherwise? (See page 1091.)
10. What is a comet, and name three particular features of these remarkable astronomical displays? (See page 1095.)
11. What is the name of the animal substance used in building the gas cells for the large dirigibles, such as the Los Angeles? (See page 1099.)
12. An electric fan helps to keep you cool in the summertime; will it also help to keep ice cream cool and prevent it from melting so rapidly? (See page 1102.)

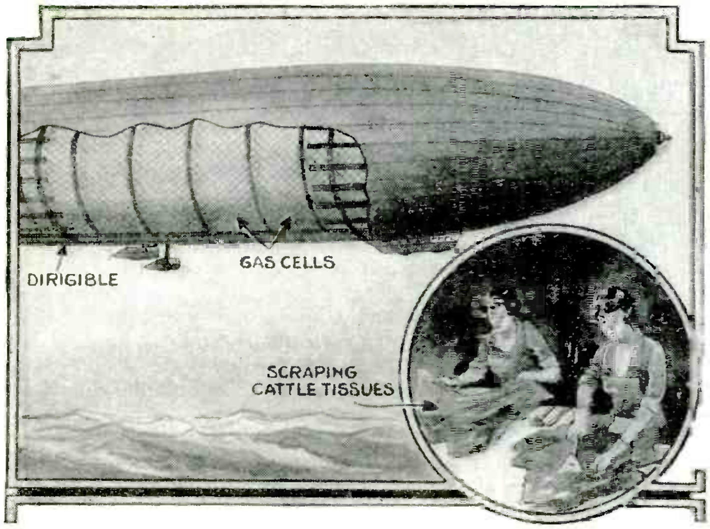
Aerial Mail Torpedoes

A recent report from Paris states that a new aerial torpedo line has been proposed to the French government, which would be built in the manner shown in the accompanying illustration. The torpedo-shaped cars would pass over two pairs of rails carried on steel poles, the carriers being operated by electric motors, the current being supplied through a third-rail arrangement. A speed of 240 miles per hour is specified for this mail system. The cost of construction is estimated at $28,000 per mile.

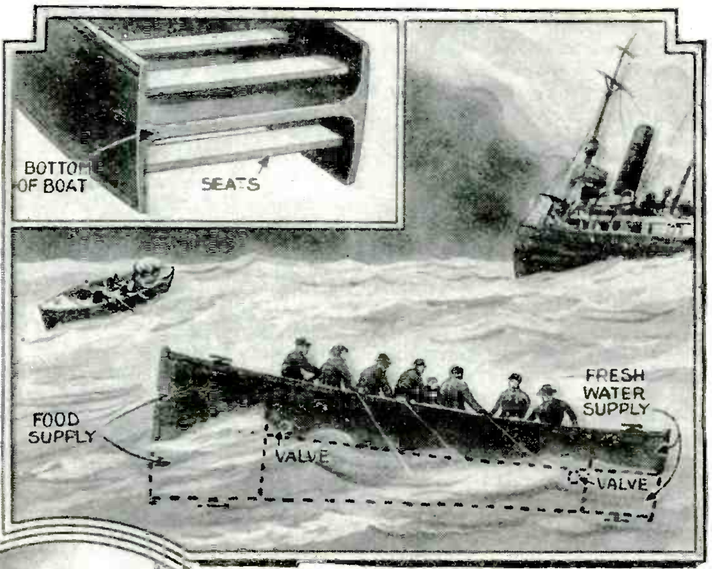


The Month's Scientific News Illustrated

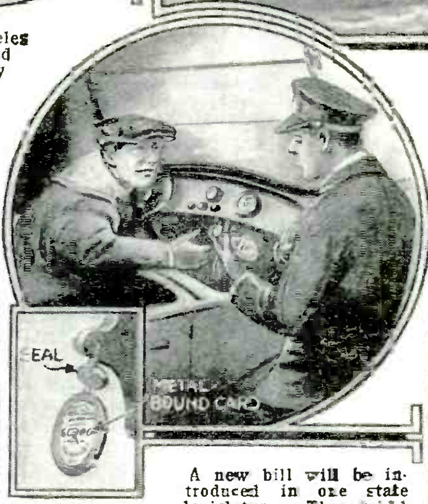
By GEORGE WALL



Tissues taken from a million cattle will keep the Los Angeles afloat in the air. Nearly a hundred girls are now employed in searching out perfect cattle inner tissues for the Navy dirigible. Science has not as yet found a substitute for "goldbeater's skin," which is nothing but the casing of the lower intestine of cattle. It will take tissues from 1,000,000 steers to make the cells and envelope for the Los Angeles.

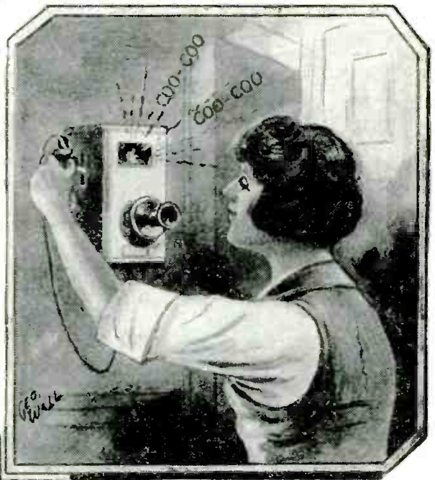


A new unsinkable boat was recently demonstrated in London. Besides being unsinkable the boat is reversible, self-emptying and cannot be capsized. It is built like two broad punts, placed bottom to bottom. Tanks of fresh water and food are placed at each end. In the bottom of each boat are two valves which let out the water.



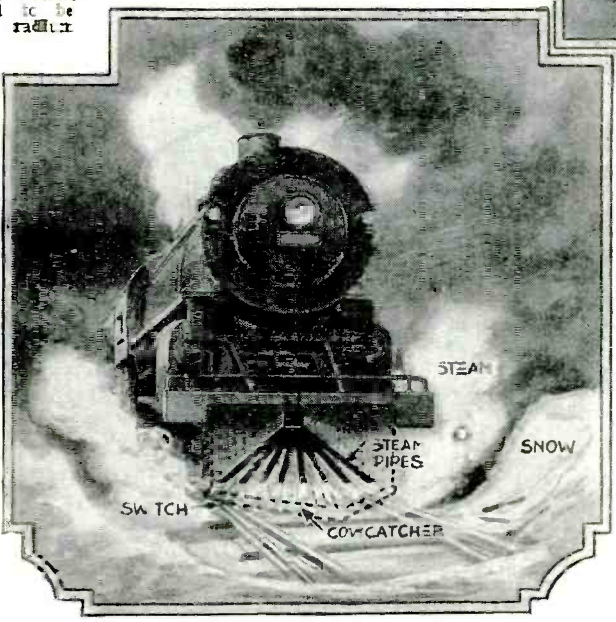
A new bill will be introduced in one state legislature. This bill calls for the adoption of a device to seal automobiles against theft. The device consists of a metal bound card giving identification of car and owner, which is sealed to the machine with a clip. If the seal is broken, the buyer will know that the car has been stolen. James Eeeshen of Oklahoma is the inventor of this patented seal.

A woman recently brought suit against a radium company, and testified that her hair and skin glowed like a watch dial after she had been employed for a few months in the plant. Hers is the first of five damage suits brought against the radium company by female employees. In court, the claimant appeared to be crippled and said her condition was due to radium poisoning.



Instead of the harsh clang of an electric bell, the sweet notes of the nightingale may soon be used as a telephone signal in France. Two engineers have invented an apparatus which will reproduce, either the nightingale's note or any other which may be desired. The inventors are convinced that many householders will gratefully welcome this milder and more musical form of telephone summons. M. Vallée and M. Aupère, are the inventors of this unique telephone alarm.

John W. Leon, a student in Columbia University, has invented and perfected a self-lighting cigarette. A paper tab treated with an inflammable substance is attached to one end of the cigarette, and when torn off produces a flame. It is claimed that the novel lighter is odorless and tasteless, and will not injure the smoking qualities in any way. In order to light the cigarette, it is only necessary to pull off the paper tab.



Special snow-fighting locomotives have been adopted by several eastern railroad yards, in order to clear the switches of snow. The engines are equipped with nine pipes arranged in a "V," just behind the cow catcher. Live steam is forced through these pipes and strikes the snow and ice directly beneath, melting it directly. One large railroad has twenty-five of its locomotives equipped in this manner, in order to safe-guard against winter delays.

Above—A locomotive equipped with the new snow remover.

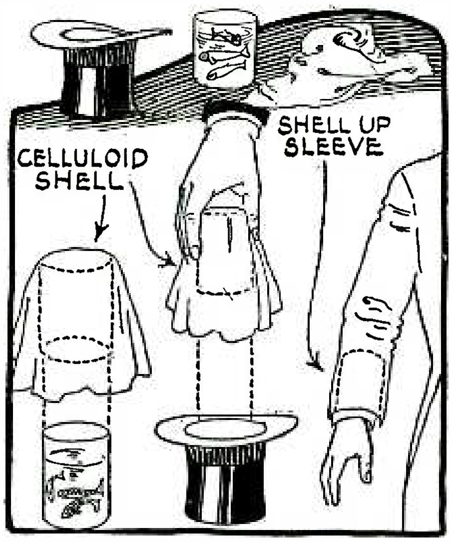
MAGIC By "DUNNINGER"

NO. 61 OF A SERIES

FLYING GOLD FISH

THE magician holds up a glass container, three-quarters full of water in which several gold fish are seen to be swimming. A cloth is then passed for examination and the aquarium is covered with it. The jar under cover of the cloth is placed into a hat, after which the magician explains his intention of vanishing the aquarium from his fingertips. He apparently removes the container together with the cloth, and a moment later tosses the cloth into the audience. Fish, water and jar have disappeared. Thereafter the liquid-filled aquarium is removed from the hat.

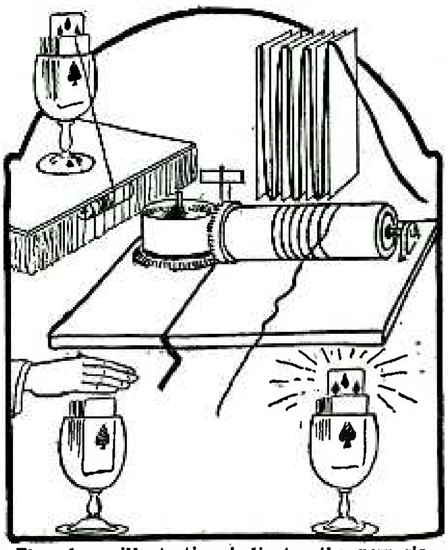
Explanation. The aquarium is surrounded with an outer shell made of thin transparent celluloid. Both articles are placed into the hat apparently to illustrate that it is into the hat that the aquarium will travel. Actually the aquarium is left in the hat and the transparent shell removed beneath the cover of the cloth whereupon the magician, inserting his hand under the cloth, slides the celluloid over the arm and under his coat sleeve. The cloth now being empty can be tossed toward the audience and the aquarium removed from the hat and likewise passed for examination.



The above illustration illustrates the method of causing an aquarium full of gold fish to vanish from the hands and reappear in a hat. Note celluloid shell in sleeve.

NEW RISING CARDS

RISING cards have for years been considered to be one of the most spectacular and mystifying of conjuring effects. Magi-



The above illustration indicates the new rising card effect which does not require an assistant. A music box mechanism is employed in the effect.

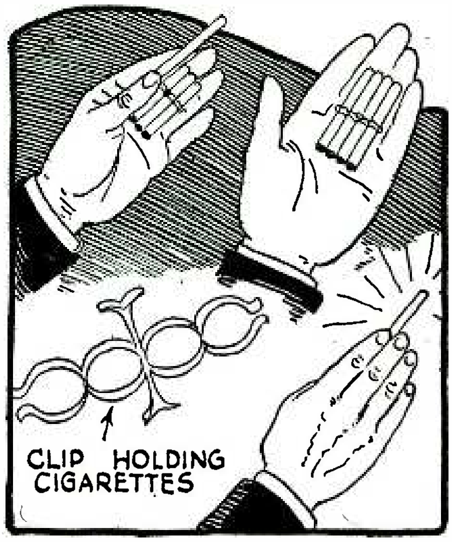
cians have discarded the trick, due to the fact that in nearly every case, cumbersome unreliable methods had to be resorted to in producing the effect. The present system is a vast improvement over the others, because it is a non-assistant trick which will continue to operate, regardless of the magician's position on the platform.

Explanation. The cards for this trick are threaded in the usual way and three cards are forced as usual and returned to the pack. Now, standing several feet away from the deck, the magician commands the cards to rise up one by one, which they do. It will be found that in order to produce the slow rise, so much desired by magicians, one of the best instrumentalities which can possibly be employed is the small mechanism found in European music boxes. This mechanism is already equipped with a governor and a stop. The magician needs merely to remove the reeds and the small metal pins on the revolving drum and substitute a thread for the pins. He can now turn on the motor and walk away from the table. The motor is small and concealed beneath the table-top, as the illustration indicates.

FLYING CIGARETTES

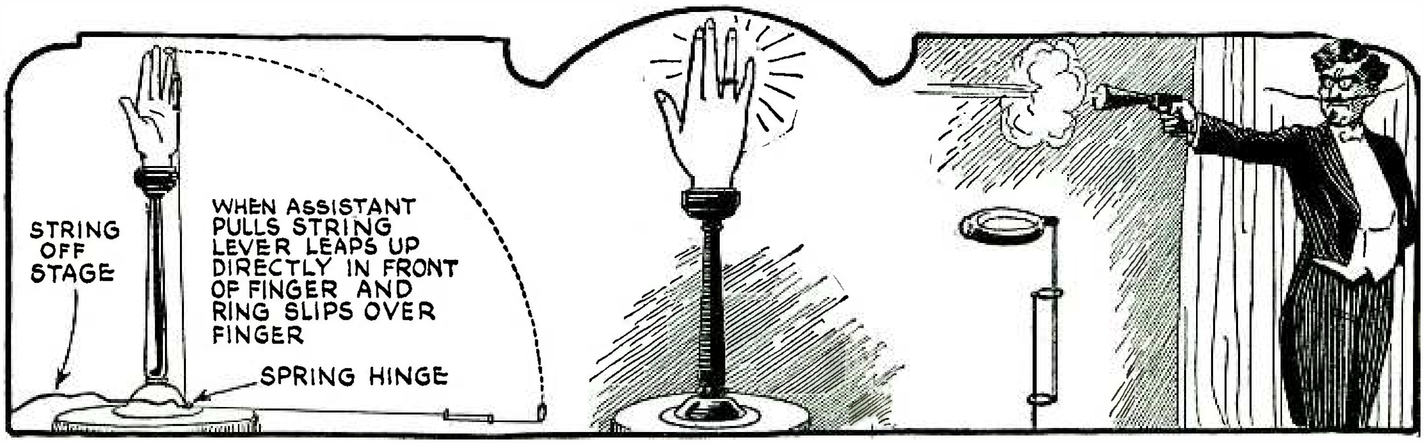
IN this effect the magician after apparently showing both hands empty, reaches into space and produces a cigarette at his finger-tips. Placing this one upon the table, he again extracts another from the air in a similar manner. He repeats this action until four cigarettes have been produced, and then again shows both hands completely empty. Similarly he can reverse the procedure and vanish the cigarettes.

Explanation. The secret consists in a small piece of apparatus made of quite thin metal, and shaped as indicated in the diagram. To each side a clip is soldered which serves as an aid in palming the small spread clip, making it possible to hold the cigarettes in either hand, switching them rapidly from one to the other so that both hands are apparently shown empty. After one cigarette has made its appearance, the hands are again shown empty, and then a second is produced. The thumb pushes the cigarettes from their positions in the holder. The metal itself should be painted flesh color so as not to be too prominent in the glare of electric lights.

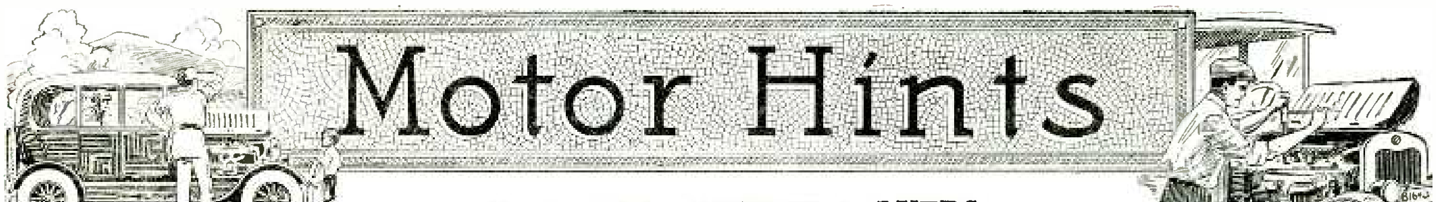


A cigarette-holding clip provided with two grips, which enables the magician to make cigarettes appear mysteriously at the finger-tips, is here illustrated.

THE MYSTIC HAND OF DANTÉ



A glass hand of the feminine type is exhibited, examined and returned. It is placed in an upright position on a stand made to receive it. A lady's finger-ring is then loaded into the magician's ever ready pistol and the shot fired directly at the artificial hand where the ring appears. The magician removes the hand and presents it to the lady, who takes her ring from the glass finger. The effect is produced by affixing the borrowed ring to a lever of thin wire, arranged in back of the magician's stand. The assistant does this, or the magician may do so while looking for another piece of apparatus. When the spring is released, the ring flies upward above the finger where, because the rod is made in two sections, the top one slides down, leaving the ring on the finger itself. Note rod detail and method of attaching ring.

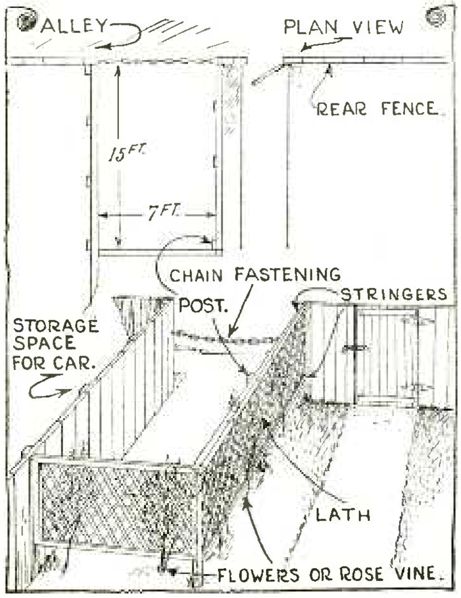


Motor Hints

Conducted by GEORGE A. LUERS

PENDING THE BUILDING OF A PERMANENT GARAGE

A garage is usually restricted by local laws requiring this to be fireproof, fitted with a grease trap and sewer connection for roof drainage. To avoid the delay, the owner can temporarily and conveniently house his car in a niche in the rear of the house as illustrated by the attached sketch. Such provision can usually be constructed by the owner in one or two days' time from light materials, costing only the smallest fraction of a garage cost. An opening in the rear fence about seven feet wide is cut. One post is planted about fifteen feet from the fence. Stringers are placed to support a light lattice work. Vines or rambler roses are planted adjacent to the lattice. Across the front, a piece of chain, secured at one end by a heavy staple and at the other an eyebolt for a padlock, is made as a barrier against theft of the car.



To avoid delay pending the construction of a permanent fireproof garage, a temporary shelter can be constructed as shown in the above illustration. A lattice work is erected, and flowers or vines are planted near it. The lattice work covered by flowers adds to the attractiveness of the rear yard.

The light lattice construction, covered by flowers, adds to the attractiveness of the rear yard.

If this must serve through a winter, a light wooden roof may be placed over the enclosure.

AIR TEST FOR COMPRESSION LOSSES THROUGH CYLINDERS OF ENGINE

To definitely test and ascertain the location of compression losses, the small test device shown in the attached sketch, will prove a useful and practical device for the driver.

Using a spark plug shell and a valve from an inner tube, these parts are combined as a unit, by unscrewing the packing nut in the spark plug and inserting the valve between pieces of leather as washers in the manner shown in the sketch.

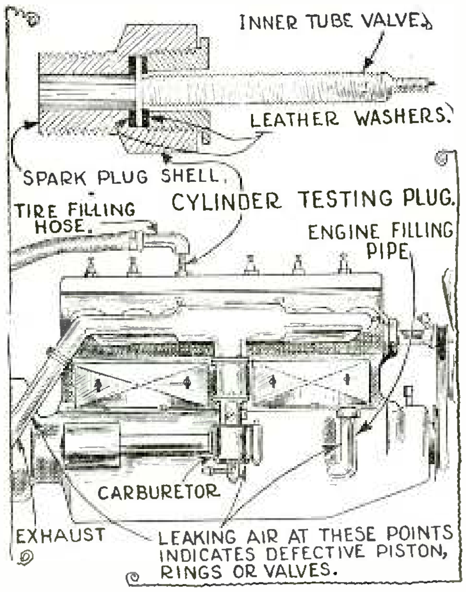
Screw this into a cylinder and apply air pressure from a tire filling hose.

If air leaks by the piston and rings, it will be heard through the engine filling pipe or breather.

If air leaks by the intake valve, the escape through the carburetor will indicate defective seating of the valve or need of grinding.

If the hiss of escaping air is through the muffler the exhaust valve is leaking.

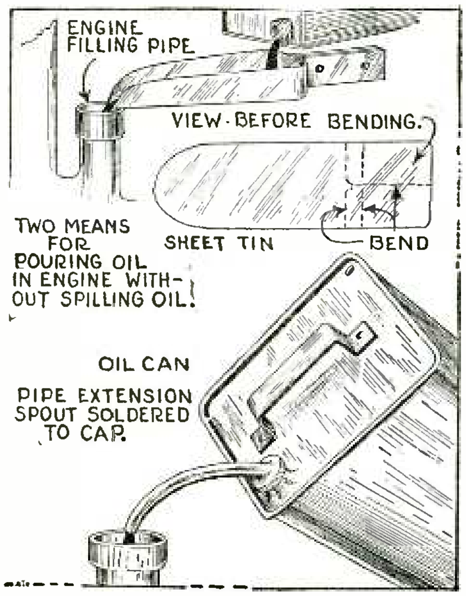
Repair of either of the possible sources is quickly accomplished, once the actual source of trouble is identified and located by this simple means.



A cylinder testing plug for determining compression losses, is made and used as shown above.

WHY WASTE OIL WHEN FILLING CRANKCASE?

To avoid the loss of oil, by offside pouring on the filler spout of the engine, and avoid the unsightliness and danger of an oil-soaked engine and drip-pan, the motorist can easily adopt either of the means shown in the attached sketch.



Two suggestions for avoiding the spilling of crankcase oil are shown here.

DO YOU KNOW—the filling of the grease gun or grease cup can be expeditiously done with hot grease. Heat the can of grease on the stove or in pail of boiling water.

Make a trough funnel from a piece of tin, bending to the shape as shown or solder a small pipe to the filler cap of the oil container.

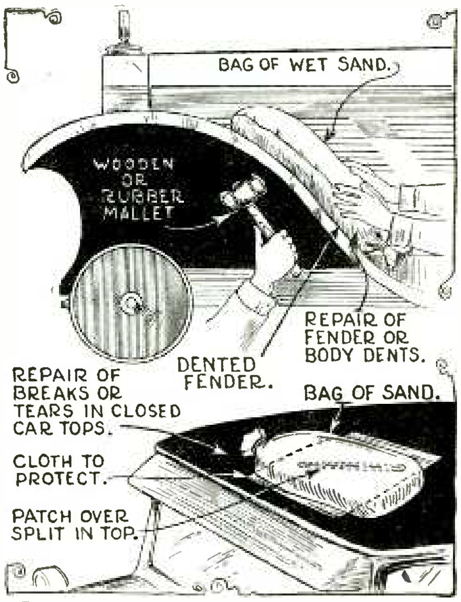
The bent tin funnel is the easiest one to make up, but the extension pouring nozzle is the most convenient to use.

The motorist will appreciate the advantages of these methods as are illustrated by the sketch.

WHERE SANDBAG IS USEFUL IN REPAIRS

One of the most useful supports to back up a dented fender or a body dent, while driving this back with a wooden, rawhide or rubber mallet, is a bag of sand. If the bag is tightly packed and water-soaked it is far better than a lead block and does no damage at all to the paint on the car.

Another exceptional service of a bag of sand is that of using this to patch breaks in the curved tops of closed cars. After cementing the strip of fabric over the break, place a piece of cloth over the patch and press down firmly with a fairly heavy bag of sand. This should remain over night or at least until the patch is cemented solidly.



A bag of wet sand is very useful when straightening a dented fender or a body dent. A bag of sand is also of service when repairing a tear in the car top.

TIME AND TROUBLE SAVERS ALL DRIVERS SHOULD KNOW

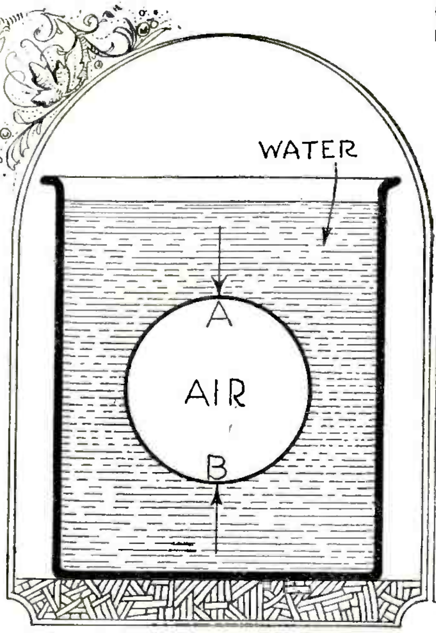
The informed driver, is the one who seldom fails to arrive at his destination on time or has to call for road service.

A number of minor but important details of operation all drivers should know, are listed below and these should serve as a guide to forestall trouble and unnecessary delay on the road when an emergency arises.

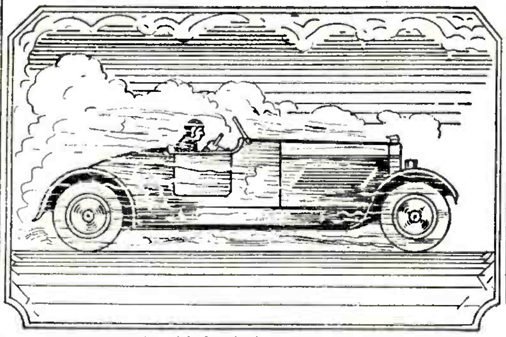
(*Continued on page* 1124)

Scientific Problems and Puzzles

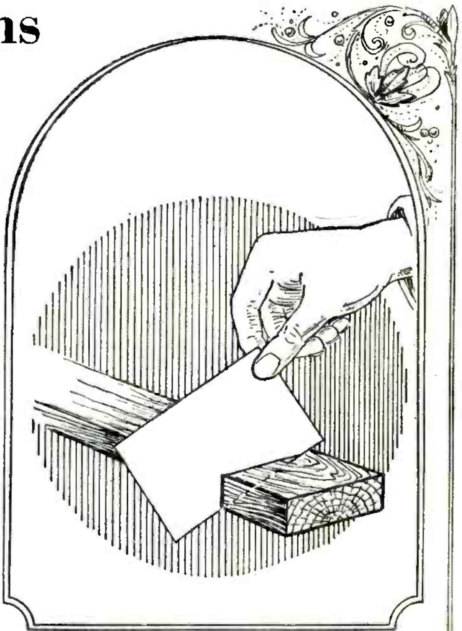
By ERNEST K. CHAPIN, M.A.



A flexible balloon is made, of such specific gravity, as to remain stationary when submerged, but the pressure of the water is greater at the bottom of the balloon. How is this possible?

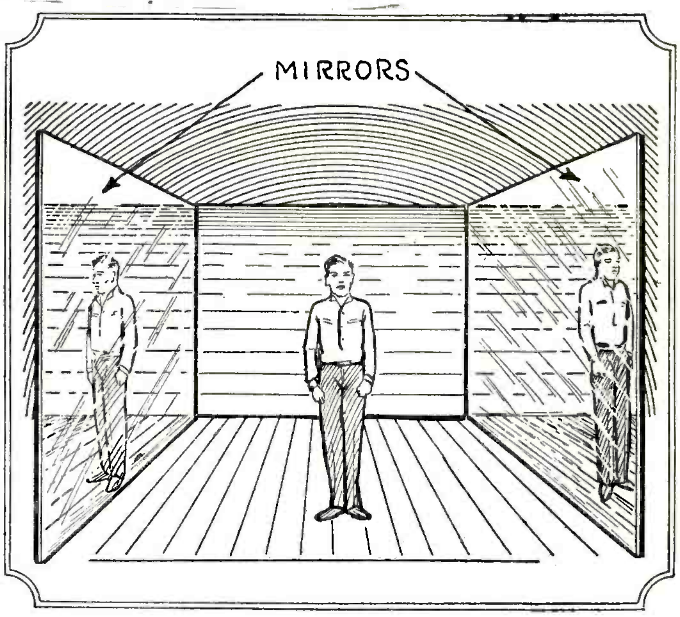


Many people think that a car does not press as heavily on the roadbed when travelling rapidly, as it does when moving slowly or standing still. Is there any justification for this notion?

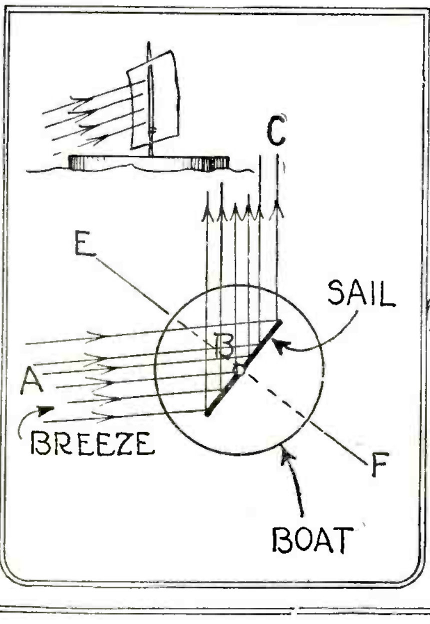


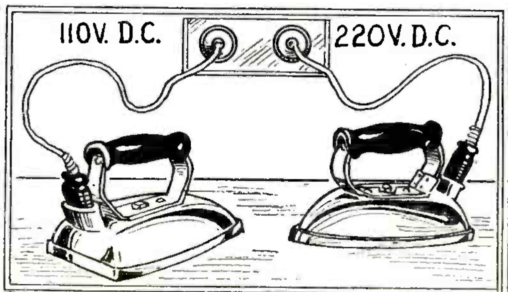
Is it possible to make a sheet of ordinary writing paper cut through a board, and if so, how?

Is there any truth in the statement, which is often made, that a silk thread can be used to draw a battleship through still water?



Two plain mirrors are hung vertically on opposite walls. A person standing in the center of the room would see an image of himself in both mirrors. Suppose that he walks toward one of the mirrors, will the images appear to get closer or farther apart?

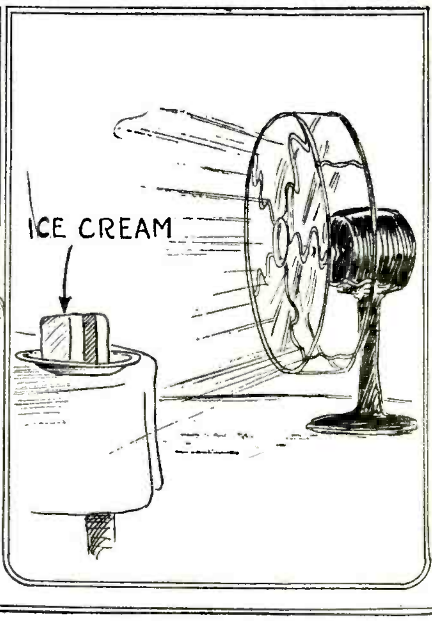




An electric iron on 110 volts D.C. circuit draws exactly the same power that another one does on 220 volts D.C. Compare the resistance of these two heating appliances?

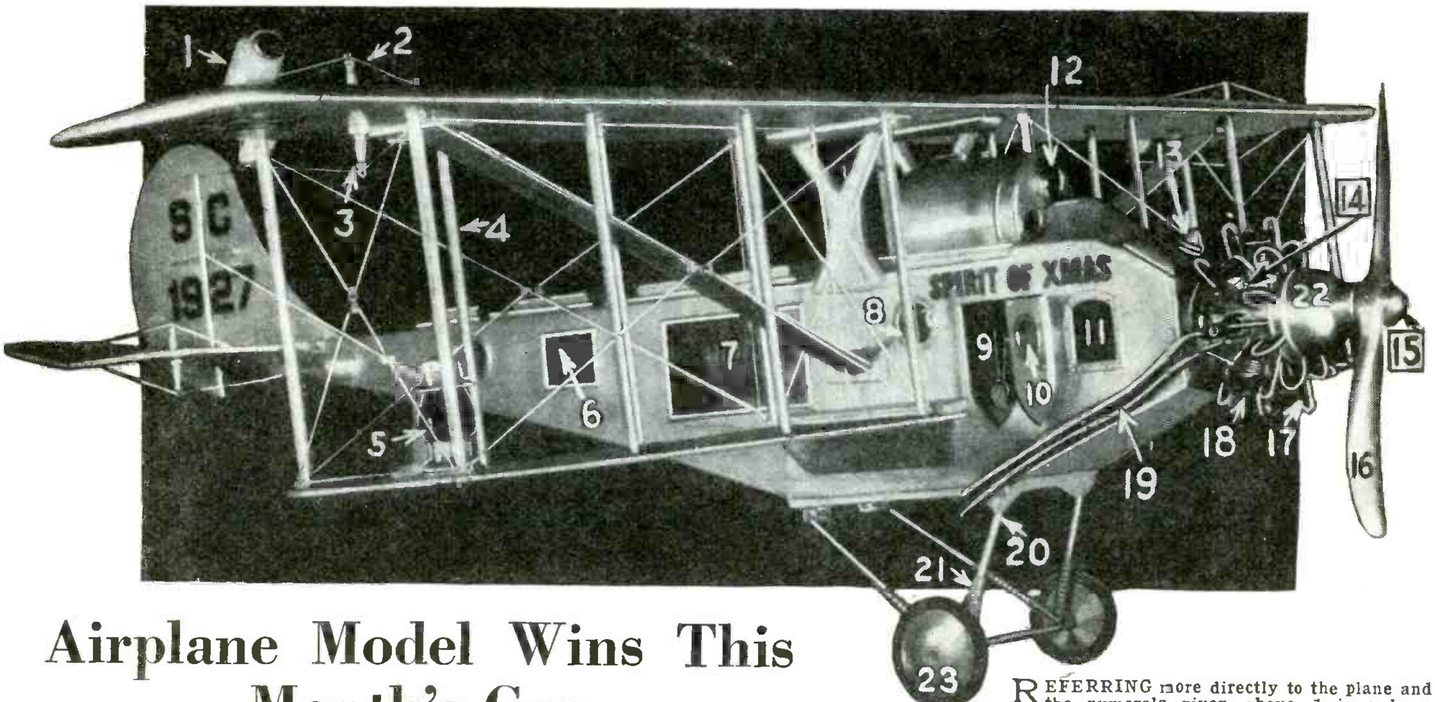
Make a small boat out of wood or cork, as shown. If a breeze strikes the sail obliquely, will the boat move in the direction of the breeze, or in some other direction?

An electric fan helps to keep one cool in the summer time, will it also help to keep ice cream cool and therefore prevent it from melting so rapidly?



(*Answers to these puzzles appear on page 1128*)

Model Department

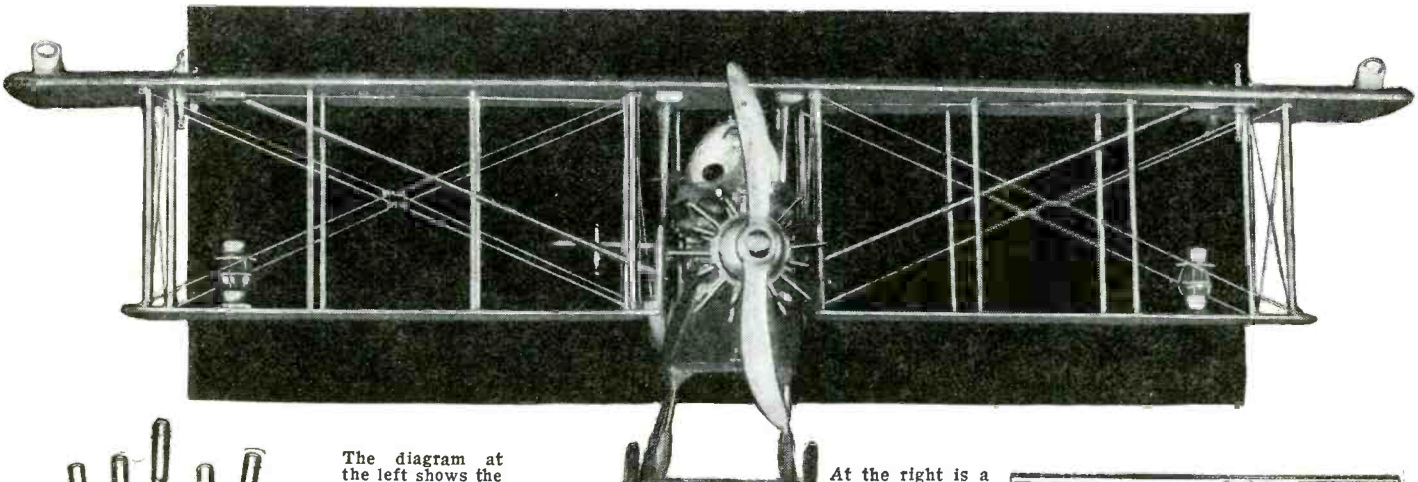


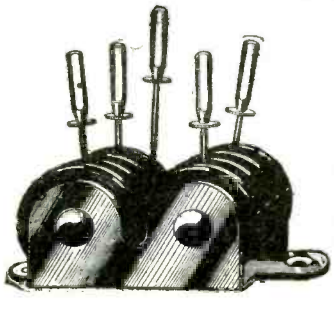
Airplane Model Wins This Month's Cup

Coveted Prize Awarded to William C. Klassen, of New York City, for a Plane Uniquely Equipped with Five-and-Ten-Cent Store Odds and Ends

MODEL with its garnishments is styled after the Curtiss training plane J N 4 D-2, and is built on a scale of one inch to the foot. It took Mr. Klassen, the Mâitre D'Hôtel of the Great Northern Hotel in New York, approximately six months to build it. A fan motor drives the propeller of this five-foot plane with a six and a half-foot wing spread. The equipment is unusually unique, particularly in view of the fact that ordinary materials obtainable anywhere were used.

REFERRING more directly to the plane and the numerals given above, 1 is a lamp housing whittled from a piece of broomstick, the bull's-eye being a red brooch obtainable in five-and-ten-cent stores; 2 are pieces of doll's clothesline pins fitted at the end with screw-eyes, 3. The wing struts, 4, are taken from a wooden plate drainer. Wing lights, 5, are small candy jars, and 6 and 7 are picture frames of different sizes set directly into the body, affording a view of the interior. Porthole, 8, is a magnifying glass, and 9, the controls, made from ten-cent screw drivers and a knife sharpener. 10 is an eye glass; 11, a picture frame; 12, a searchlight; 13, the top of a salt shaker; 14, the cylinders, are pipe nipples; 15 is the end of a broomstick, and 16 was whittled from a broom handle; 17 is cut from a potato masher, and the cylinder tops, 18, are rubber bumpers used under toilet seats; 19 are rubber tubes; 20 are cut from coat hangers; 21 are bird-cage springs; 22 is a cocktail shaker top, and 23, baby carriage wheels.

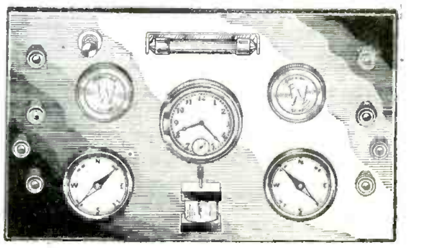




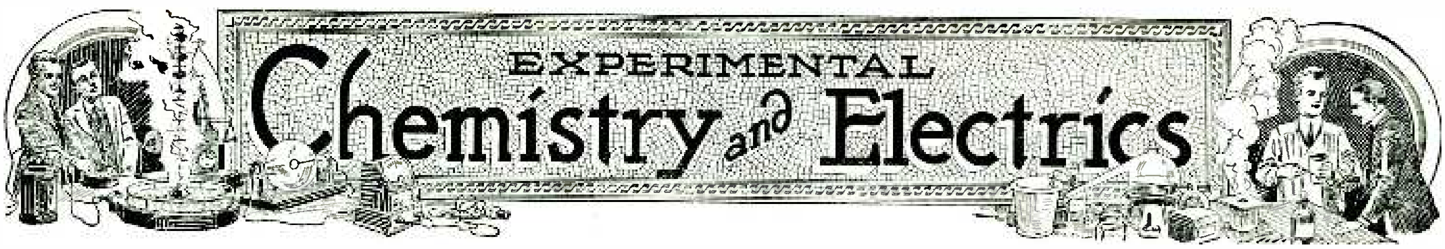
The diagram at the left shows the control details as indicated by 9 in the photo at the top of this page. This is a knife sharpener, into which ten-cent eye-glass screw-drivers have been inserted. The effect is extremely realistic.

Above is a front view of the plane. Note the graceful lines. The wings and body are made of wood, sandpapered and then painted with aluminum paint. Rubber exhaust pipes are bronzed, giving a metallic appearance.

At the right is a view of the control board in the plane. It is made of a grid leak, a miniature watch, two miniature compasses, several binding posts, a switch, and two tops of shaving tubes mounted on bakelite.



(*Rules for entries in Model Department on page 1156*)



Window Closing Device

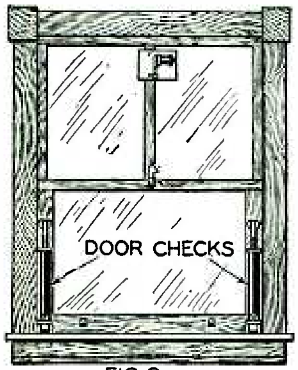


FIG. 2

Fig 1 shows very clearly the arrangement of a catch to hold a window sash open. It will be seen that the oscillating hook-catch is pivoted to the center of the upper part of the frame and when a current passes through the electro-magnet, the hook is pushed to the left so as to release the sash. The sash is slightly overweighted so that it descends.

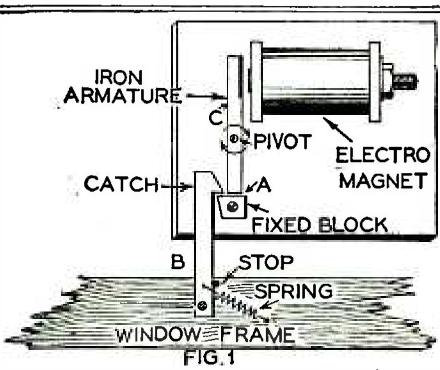


FIG. 1

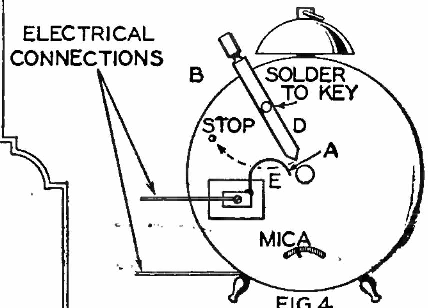


FIG. 4.

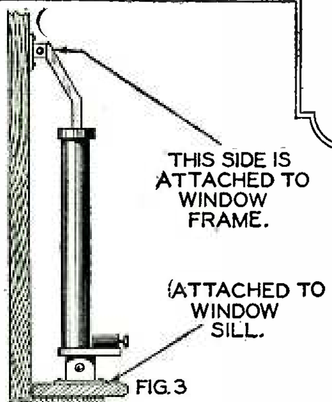


FIG. 3

Fig. 2 shows the general arrangement of the device; the hook-catch with its spring drawing it to the right appears on the top of the frame of the lower sash, which is shown closed in the picture.

Fig. 3 shows in some detail the door checks also seen in Fig 2, which prevent the window from slamming when it shuts.

Fig. 4 shows very clearly the simple clock connection, and Fig 5 the general layout. Anyone with a passion for open air sleeping can have the window open until five or six in the morning and then have it closed by the clock to prevent the sleeper from having to rise in the wintry air.

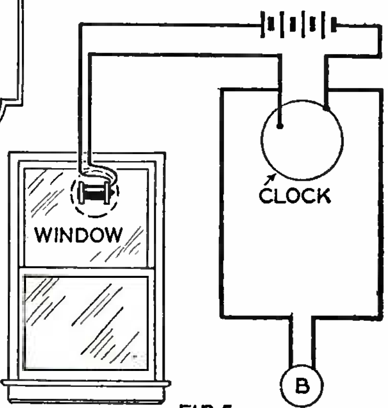


FIG. 5

Since the value of fresh air to our well being is well known the majority of people prefer to have the windows in their bedrooms open all night. A great number of people, however, find it very uncomfortable to dress in the morning in a cold room and they prefer, therefore, to sleep with closed windows at the sacrifice of fresh air. If the window could be made to close itself a few hours before the person has to get up, one could enjoy fresh air during the night and at the same time avoid the discomfort of a cold room in the morning. The device described in the following article will do the desired operation, that is, it will close the window at any time desired by an electrically operated release.

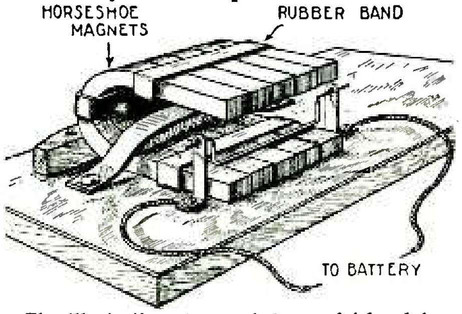
The essential things are two door checks, a circuit closer made from an alarm clock, and a catch that will hold the window up all night and let it go down at a set time.

TOY ELECTRIC ENGINE

By W. LANCASTER

The electric motor shown and described here is of almost unbelievable simplicity. The jumping about of the wire shaft and crank is what opens and closes the circuit so as to produce the rotation.

The field magnets, which are permanent horseshoe magnets and can be easily obtained from the junk pile of a laboratory, are strapped down to a baseboard as indicated. The vertical brackets for carrying the crankshaft have holes in the ends which must be large enough to permit the wire to jump about in them. When a current passes through the wire, it is polarized in one or the other sense so as to be attracted by one set of poles of the permanent magnet and repelled by the other. When in its motion, it ceases to be in contact with the standards or even with one of them, it is no longer polarized as it may be expressed. The standards are connected to a battery as indicated. When started into motion, the crankshaft will rotate with a considerable degree of regularity.



The illustration shows what may fairly claim to be the simplest electric motor. The requisite changes of polarity in the bent wire armature and brought about by its motions in the over-sized openings in the two standards.

REMOVING BOLTS AND NUTS FROM THE DRIP PAN

A handy and inexpensive tool to have along on a trip is the magnet. The simple horseshoe magnet will answer the purpose. It can be used for recovering bolts and nuts that have dropped into the drip pan, for valve keys that slip behind the valves.

Contributed by E. E. Matheson

STRIPPING RUBBER INSULATION FROM WIRES

By ROBERT L. LEWIS

The following is an easy method to remove insulation from single strand wires larger than No. 14 guage.

The wire, from which the insulation is to be removed, is laid upon some solid object, say an anvil, or the face of a flat-iron, and hit with a hammer. One blow will usually crack the insulation, baring the wire, so that the insulation falls off, leaving a clean bare wire. Great lengths of wire may be easily stripped if needed. This applies especially to larger size wire which is very difficult to strip in any other way.

Water and Its Impurities

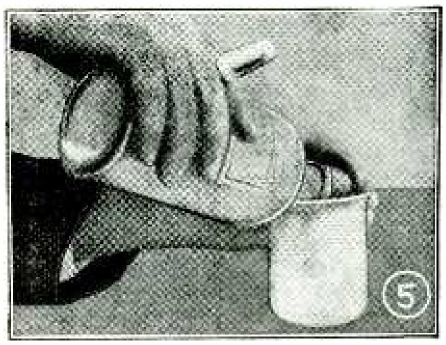
By DR. ERNEST BADE

(*Continued from page* 1008, *March number.*)

ALTHOUGH these tests are only a skeleton guide for the more important constituents which may be found in various kinds of waters, such as wells, rivers and lakes, still they are important, for if certain elements are present, such as phosphates and chlorides in large amounts, it is probable that the water is contaminated with sewage. The water is poor when large amounts of chloride of sodium and calcium sulphate are present. Then, when large quantities of ammonia are present, the water is unfit for drinking, or at least is in a very suspicious condition.

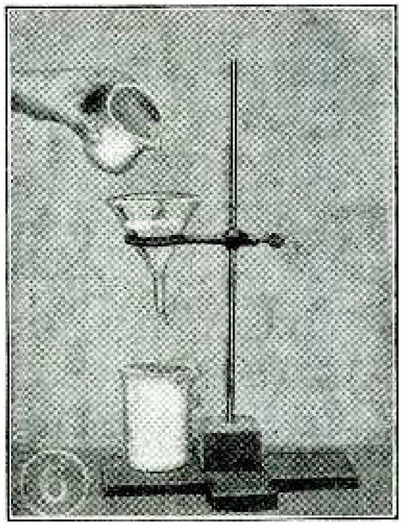
The slightest amount of nitrous acid makes the water dangerous to drink, but other such salts as sodium carbonate, magnesium sulphate, etc., are not injurious, but healthy. Here we have the mineral wells made famous by the different baths all over the world.

Collect a quart of the water, stopper the bottle containing it, and let it stand one or two days. Decant into a large beaker and



The first step in testing for aluminum and phosphoric acid is to evaporate to dryness, and dissolve in dilute nitric acid.

evaporate one quart to about one-half a pint. Collect the precipitate in the original bottle, estimate its quantity and examine under a microscope. This shows if the precipitate consists primarily of settled mineral matter or if it consists of living or dead animals and plants. One or two drops of the sediment is sufficient for this particular test. The remainder of the sediment is poured into an evaporating dish and the water is poured off, and the residue is heated. If this turns brown or black, evidence is afforded of the presence of too much organic matter. The remaining water from the residue is divided into four parts, of a few drops each, in test tubes. To one test tube a drop of methyl orange indicator is added; if the

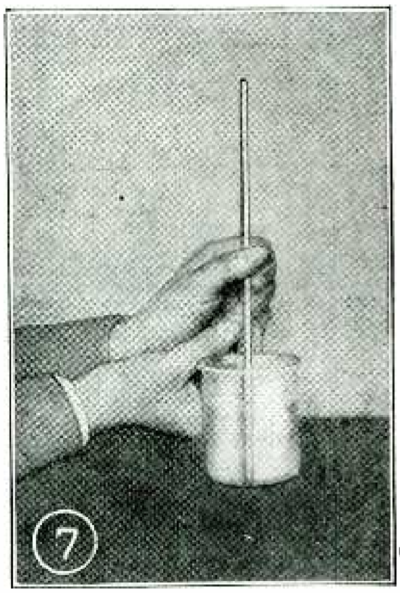


Here filtering is shown necessary if the solution is not clear; it is to be divided into two parts, so as to test for aluminum and the phosphates.

color is changed to red, the water is acid. If no change occurs, add a drop of phenolphthalein to another test tube of the water under consideration. If the color changes to red, the water is basic. Litmus may be taken for both tests, but it is not so sensitive.

The remaining two portions in the test tube are tested for ammonia and nitrous acid. Both tests are very sensitive and should be made, especially if no reaction is had with the indicators. A crystal of diphenylamine is dissolved in a few cc. of strong sulphuric acid. This is then poured into one of the remaining test tubes. Heat gently if no blue color is developed. The absence of a blue color indicates that no nitrous acid is present.

The last test tube is used to test for ammonia by means of Nesslers' reagent, which is prepared as follows: 7 grams of potassium iodide are dissolved in 20 cc. of water and 3.2 grams of bichloride of mercury are dissolved in 60 cc. of water. Then the last solution is poured into the first very slowly and with stirring until the precipitate first formed remains undissolved. Then 10 cc. of water are used to dissolve 50 gr. of potassium hydroxide, and this is added. The mixture is filtered, tightly stoppered, and kept away from the light. Light decomposes the solution. A brownish or reddish coloration indicates ammonia. A brown precipitate is formed when large quantities of ammonia or salts of ammonia are present.



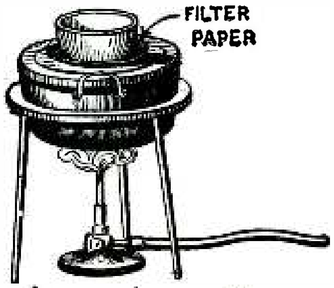
This shows a good way of increasing the delicacy of the test for magnesium. The double phosphate is precipitated better if the sides of the beaker are rubbed with a glass rod.

Three parts of ammonia can be detected in ten million parts water. Ammonia should never be present in drinking water.

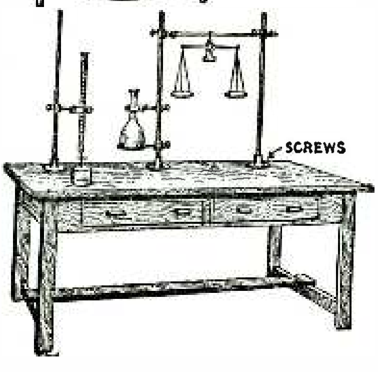
CHEMICAL NOTES

QUANTITATIVE EVAPORATION WRINKLE

A piece of filter paper, placed under dishes being evaporated on the usual form of copper water bath, will prevent troublesome deposits forming on the bottoms of the dishes.—*A. Jule.*



The upper drawing shows a water bath used for evaporating in a dish which it is desirable not to discolor. A piece of filter paper is placed beneath the dish, so that it does not come in contact with the copper of the water bath.



The lower cut shows apparatus supports on a laboratory table made up of pipe fittings. A quarter-inch pipe is a convenient size, and if the table has a wooden top, the screwing down of the flanges is easier than if it has the slate top, now so much used. The illustration is a suggestion, because all sorts of convenient supports can be made on these lines.

SUBSTITUTE FOR RINGSTAND

A convenient and cheap substitute for the usual ring stand may be made from small size gas pipes and fittings as shown in the accompanying sketch. These are screwed to the laboratory work table at convenient intervals, and in connection with ordinary iron clamps furnish an adaptable and very firm means for supporting the various pieces of laboratory equipment.—*A. Jule.*

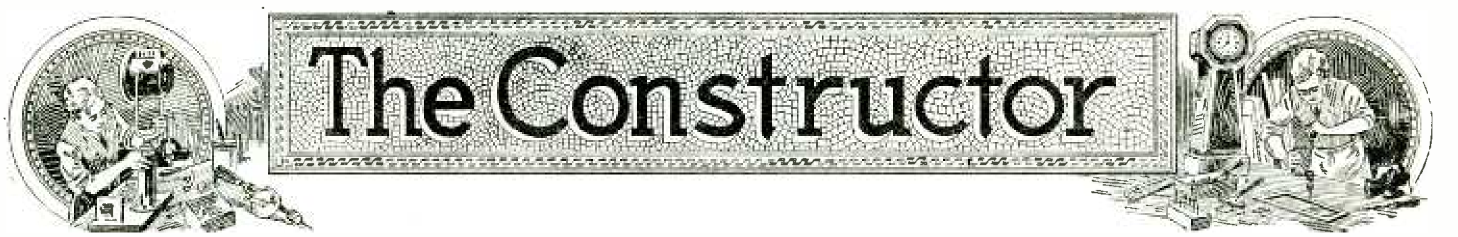
IMPROVED SHELF FOR DRYING OVEN

Having occasion to dry considerable quantities of glassware in an electric oven recently, it was soon noticed that troublesome iron stains formed when the wet glass was placed in contact with the ordinary metal trays. These stains were not only unsightly and difficult to remove but in several quantitative evaporations the consequent increase in weight affected the accuracy of the determinations.

This difficulty was entirely overcome by substituting shelves cut from an ordinary piece of plate glass. These plates heat more slowly than the metal shelves but in case the time element is a factor, small squares of glass, such as old photograph plates, with film stripped off, may be placed directly on the metal shelves. This arrangement is equally satisfactory.—*A. Jule.*

A SOLID FROM TWO LIQUIDS

Prepare separately, saturated solutions of sulphate of magnesia (Epsom salts) and carbonate of potash. On mixing them the result will be nearly solid.



A Home-Made Reflecting Telescope

Efficient Instrument Built at Home Provides Much Entertainment

By WILLIAM H. CHRISTIE

PART ONE

THE construction of a good reflecting telescope should present no difficulties that cannot be overcome by a patient worker, and the finished instrument will provide its constructor with many evenings of profitable pleasure.

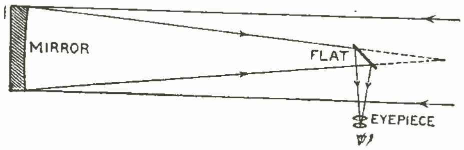


Fig. 1.

Above we have the optical arrangement of a reflecting telescope of the Newtonian type. The focal length of the mirror depends upon the curvature of the glass surface.

The type of instrument that will be described in these columns is the "Newtonian" reflector, the optical arrangement of which is shown diagrammatically in Fig. 1. The distance from the mirror to the focus, called the focal length of the mirror, depends upon the curvature of the glass surface; reflecting telescopes are made with focal lengths varying from less than three times to greater than one hundred times the diameter of the mirror, depending upon the nature of the work for which they are made. For small instruments, six inches or less in diameter, a ratio of 10 to 1 will be found convenient, but on increasing the aperture this ratio should be reduced in order to keep the tube within reasonable length. A ratio of 5 to 1 is very satisfactory for a twelve inch mirror.

The magnifying power of the telescope depends upon two factors, the focal length of the mirror and the equivalent focal length of the eyepiece, and may be determined by dividing the former quantity by the latter. The light grasping power of the instrument and the resolving power are functions of the diameter of the mirror, the former varying as the square of the aperture and the latter varying directly as that quantity. The larger the mirror, the brighter objects appear and the finer the detail that can be seen.

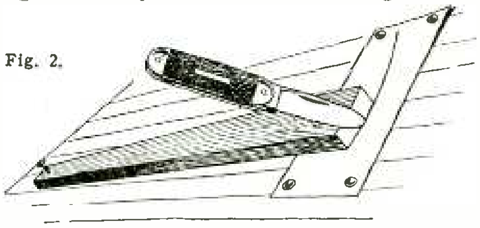
The average amateur telescope builder will have to be satisfied with a mirror nine inches, or less, in diameter because of the difficulty in handling the heavy glass disks necessary for the larger ones. The eyepieces had best be purchased from some reliable maker of astronomical instruments. These eyepieces cost in the neighborhood of $5 to $6 for average powers, lower powers costing somewhat more. If you only wish to start with one eyepiece, choose one that will give you a power of about 75 or 100; as a second choice purchase a low power, giving a magnification of fifty or less. After this you may get one that will give you a power of 250 or 300, much above this it is not advisable to go, as atmospheric conditions seldom warrant the use of higher powers. If you only purchase one eyepiece and make that a high power one, it will only lead to disappointment.

THE MIRROR

To begin with grind, polish and figure a four-inch disk, even though you intend to construct a larger one and the smaller may never be mounted. The experience gained will prove invaluable and, having successfully figured a four-inch, you may confidently start on a larger one with some assurance of success. Remember that the difficulties increase rapidly with the diameter, and that a six-inch is at least twice as difficult to make as a four-inch.

Suppose that you have decided to follow the writer's advice, and make the four-inch first. Purchase two four-inch glass disks, which may be cut from a piece of thick plate glass, at least ½ inch thick, after making sure that there are no air bubbles *near* the surface; small bubbles in the interior will not affect the mirror. Have the disks ground truly circular with the edges bevelled a little at an angle of 45°. This may be done for oneself, if you possess a lathe, by cementing the disks to a block of wood and mounting the same in the lathe; the edges may now be ground with an old emery or carborundum "stone," running the lathe slowly and keeping the stone wet.

Fig. 2.



The above illustration shows how the template is cut from a piece of cardboard with a sharp knife. A piece of wood is nailed to the floor as shown, so that an arc may be cut in the cardboard.

Decide upon the focal length of your mirror and then make a template in the following manner. Mark from the squared end of a stiff lath a distance equal to twice the focal length of the mirror and at this point bore a hole for a nail and tack the lath to the floor. Tack a piece of good cardboard under the free end of the lath, then, with a sharp knife pressed against the end, make a sweeping cut in the card; Fig. 2. Do not try to trim the template with a pair of shears, but cut as directed if you want the finished mirror to be anywhere near the required focal length.

PREPARING TO POLISH MIRROR

Select a place as free from dust as possible for the work on the mirror, also one that is not subject to sudden changes in temperature. If the work is to be done in the basement, clean the working space thoroughly, then tack large sheets of clean paper to the joists above to prevent dust, or particles of gritty matter, from falling on the mirror or among the abrasives. The floor may be oiled to reduce the 'dust menace—for a menace it is to the mirror polisher!

If precautions are not taken the mirror may be scratched during the final stages, which may necessitate going over most of the work again!

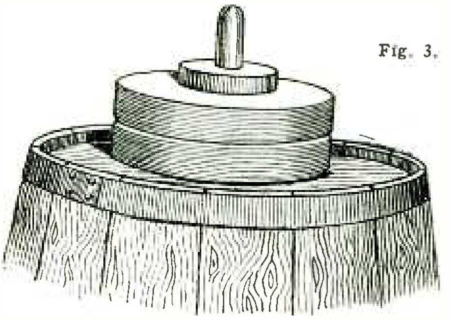
Set up a solid stand of convenient height, such as a good barrel filled with something to ballast it, arranging it where you can walk around it freely. Whatever you use be sure that it is solid, for a poor work bench may cause you all kinds of trouble.

The materials required for working the glass are cheap and easily obtained. Purchase three grades of carborundum, i.e. Nos. 80, 120 and 280. These should be bought in unopened cans as there may be the chance of the finer grades being contaminated with the coarser if they are bought from broken packages. From an optician, or jeweler, obtain a few ounces of rouge,—they will usually oblige one with a little. A lump of pitch and some beeswax will complete the list.

WASHING THE ABRASIVE

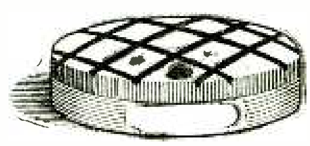
If you wish to purchase but a little abrasive, wash the finer grade in the following manner for safety. Stir it into about a gallon of water and allow it to settle for fifteen minutes in a clean, unchipped enamel pail, or other suitable container. With a clean length of rubber hose siphon off the water and the suspended particles into another vessel, taking care that none of the coarser settled particles are drawn off in doing so. Allow the material siphoned off to settle for sixty minutes and then siphon off again, allowing the material drawn off this time to settle until clear. The three grades of material obtained this way should be placed in clean covered containers such as fruit jars. If you have bought your carborundum in unbroken cans this process should not be necessary as these grades have been treated so that you have 1, 15 and 60 minute carborundum.

Fig. 3.



The mirror and grinding tool mounted on a stand may be seen above.

The rouge had best be treated in a somewhat similar manner, unless it is of the finest quality. Mix it with about a quart of water, allow it to settle for one minute.



At the right we have an illustration showing the polishing lap. The lap is coated with a mixture of pitch and beeswax. Fig. 4.

then siphon off. Add another quart of water to the remainder, mix, allow it to settle for another minute, then siphon off again, repeating this process several times. The remaining material may now be thrown away, that siphoned off is allowed to settle until clear, when the excess water may be removed.

Cement the least perfect of the two glass disks to the bench with pitch, or hold it in place with cleats. Cement a small circular wooden block, into which a short handle has been inserted, to the other disk, which will eventually be the finished mirror, as shown in Fig. 3. Warm the disks slowly in water to which hot water is gradually added and dry them thoroughly before applying the pitch to them. When heating the pitch keep your eye on it for if it boils over there will be a nasty mess to clean up, not to mention the danger of fire; it need only be hot enough to flow readily.

THE FIRST GRINDING STEP

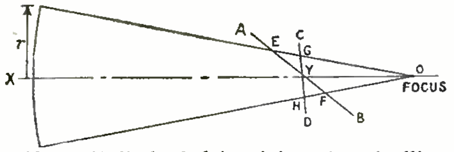
Put a small quantity of the coarsest abrasive and water between the two glass disks and, keeping it well moistened, commence grinding. Hold the upper disk with the fingers pressed lightly upon the wooden block and glass and sweep it to and fro across the lower, center over center, with smooth even strokes, one third the diameter of the mirror in length; at the same time move slowly around the stand, turning the disk under the fingers in doing so. These motions will slowly grind out the center of the mirror.

Renew the grinding material at intervals until the template very nearly fits the mirror surface. Carefully clean off all traces of the abrasive just used, by swilling the mirror and grinding tool off with water. Scrub the bench thoroughly so that no trace of the coarse material remains, then continue with the next grade until the template fits the glass surface. Wash everything clean once more, then continue with the finer grade. It will speed up the grinding process considerably if you make sure that every trace of the previous grade is ground out before continuing with the net. After using the finest abrasive the glass should present a uniform, almost polished, appearance, free from any pits and scratches. We are now ready for the polishing process.

MAKING THE POLISHING LAP

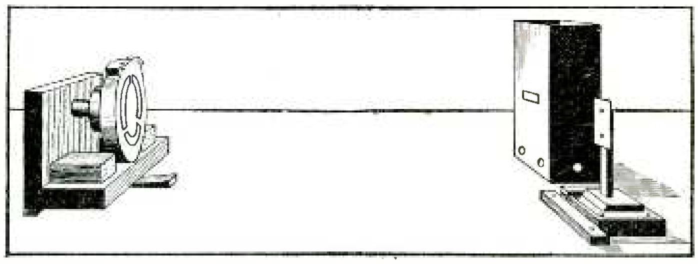
The polishing lap may be made by coating the disk that we have been using for a grinding tool with a mixture of pitch and beeswax. See Fig. 4. This mixture is made by stirring the beeswax into the melted pitch until a drop of it, when cooled in water, will indent fairly easy under pressure of the thumb-nail. Warm up both glass disks as directed before, dry the one to be coated and wrap a band of waxed paper around it to form a shallow tray into which the mixture is poured. When cool enough, remove the paper band, coat the surface of the pitch with rouge and water, then gently press the mirror surface upon the polishing lap. If the pitch is too hard to conform to the shape of the mirror, warm it slightly in water until it will do so, taking care that it is everywhere in contact with the glass. Now score the pitch into one inch squares, cutting the grooves about one-eighth inch wide, then reshape the lap as before and retrim the grooves, which may have become partially filled up in the process.

Mount the polishing tool on the bench and wet the surface with the rouge and water. Commence polishing, making the same motions with the mirror as you did in grinding, taking care that the strokes



Above—Method of determining size of elliptical flat. Fig. 7.

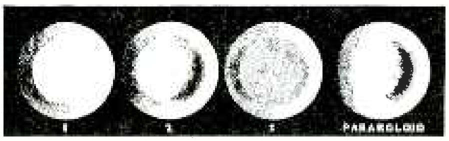
At the right, Fig. 5, a short focus mirror set up for testing with the diaphragm in place. This test shows whether the mirror is as spherical as it should be and will reveal errors of 1/100,000 of an inch, and to an experienced worker errors of the order of one-millionth of an inch will be noticeable. An oil lamp, acetylene gas or an electric arc can be used in making this test.



are even. Keep plenty of rouge between the two surfaces, wetting when necessary, otherwise the two surfaces may stick together. As soon as you feel the mirror "dragging," apply more rouge.

TESTING MIRROR

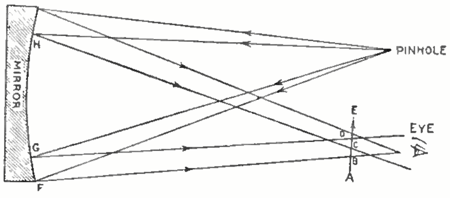
When the mirror shows a high polish, free from scratches, we are ready to test it. A simple test, due to the French physicist Foucault, will tell us if our mirror is spherical,



Above we have a number of examples of shadow patterns. Fig. 6-A.

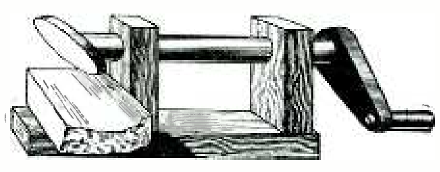
as it should be, or not. This test will readily reveal errors of 1/100,000 inch and, to an experienced worker, errors of the order of one-millionth of an inch!

Obtain as bright a source of light as you can, *other than an incandescent electric light.* An oil lamp, acetylene, gas, electric arc or a Prest-o-lite source will serve. Punch a tiny



The above illustration shows the cause of shadow patterns. Fig. 6.

round hole in a thin sheet of metal with a fine needle and mount this over a hole cut in a screen placed around the light source. The knife-edge may consist of a safety-razor blade mounted on a stand which has its front edge bevelled to serve as a straight-edge.



The method of grinding the elliptical flat mirror is shown above. Fig. 7-A.

Set up the mirror, as shown in Fig. 5, and place the light source about the center of curvature. Darken the room and, with the eye about two feet from the mirror, locate the image (reflection) of the pinhole in it. Move the eye slowly away from the mirror, keeping the image of the pin-hole central, until the mirror appears to be flooded with light. If necessary move the light source to one side or the other. Now take the knife-edge and slide it slowly across the beam of light coming to the eye, a shadow will be seen to sweep across the mirror as you do so. If this shadow moves in the same direction as the knife-edge, move the blade back a little; if in the opposite direction, forward a little, until the surface of the mirror darkens more or less uniformly as the knife-edge cuts the beam. Adjust the source, mirror and knife-edge until the point just found is level with the pin-hole and as close to it as convenient. A little wedge under the mirror stand will allow the tilt of the mirror, and hence the height of the focus, to be adjusted. It is important that the light source and the image formed at the knife-edge be close together and the same distance from the mirror. As the light-source is moved towards the mirror the image formed will move farther away, and vice-versa. The beginner may have difficulty in locating the point described, at first, but after a little practice it will be picked up at once.

When the mirror darkens more or less uniformly the knife-edge is in the focus of the mirror and we are ready to begin our tests. This darkening will only be perfectly uniform when the mirror is truly spherical, otherwise various shadow-patterns will be seen as the knife-edge cuts the beam. As an example of the causes of these shadow patterns look at Fig. 6. Here we have a mirror, the edge of which is turned back so that the light coming to the eye from the outer zone comes to a focus outside of that coming from the center. Suppose that the knife-edge moves along the line AE; then, as it cuts the beam at B, cutting off the light coming from F, the mirror will appear as in 1, Fig. 6a. At C the knife-edge begins to obstruct the light coming from G and then the mirror will appear as in 2, Fig. 6a. At D all the light from the central zone is cut off and only the light from H, onwards, reaches the eye, the mirror will then appear somewhat like the third example. To interpret these shadow patterns you must regard the mirror as a more or less flat surface, illuminated very obliquely from the direction opposite to that in which the knife-edge moves, the shadows being cast by the higher parts.

POLISHING OUT FLAWS IN MIRROR

The next step consists of removing any irregularities by carefully polishing them out. A complete discussion of the methods of procedure in order to bring the mirror to a spherical form from the various shapes it may have assumed, would take up too much space to be given here. The best way for you to continue is to sketch the form of the shadow-patterns in a notebook, polish for a few minutes, then examine the surface again, making notes as to the kind of strokes used and the effect of them on the mirror's figure. If the edge is turned back or the mirror is too deep in the center, use shorter strokes; if the edge is turned up or the center is too high, longer strokes should do the trick. Remember that you are working to *millionths* of an inch, so polish only for a short time before testing once more. Allow the mirror to stand for a while before testing after polishing because the heat developed in the polishing process is sufficient to distort its figure; for the same reason care should be taken that the mirror is not subjected to any sudden change of temperature; accurate work is impossible under these conditions.

When the mirror is spherical the center must be deepened slightly in order to give it the correct shape for a telescope mirror; as yet it is useless for that purpose. The figure that we must now give it is known as a paraboloid of revolution. To give it this figure the strokes on the polishing lap may be lengthened, or the size of the lap may be reduced by cutting a narrow ring from the

(Continued on page 1132)

Color Cement Craft for the Home

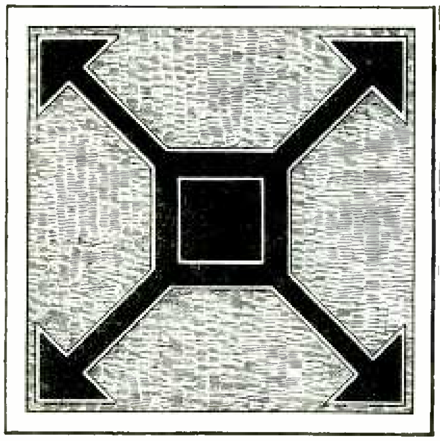
By GEORGE RICE

The Art of Magnesite Cement Craft and How to Make Plaster-of-Paris Molds

MAGNESITE cement is a cement by itself. It does not contain any Portland cement, but it belongs to the cement class and is being utilized by cement handicraft artisans for facing material on tile, flagstones, and various objects on which a fine, tough, glossy white or colored coating is desired. Marble and enamel imitation finishes are easily procured with it. It is magnesium oxide or magnesia and when mixed with a solution of magnesium chloride it sets to a very hard pure white solid. It is a white powder which can be purchased almost anywhere in the form of magnesite cement or just plain magnesite. To prepare the powdered magnesite for use, weigh out three pounds and mix it with two pounds of silica and one pound of white talc and mix well in a dry state and if a color is desired the coloring materials in a dry condition can be added and all mixed together.

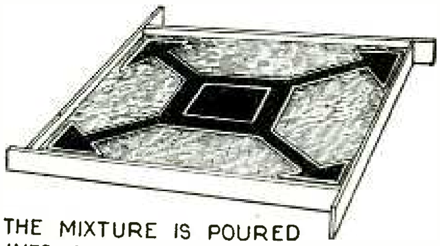
A stone or cement mortar is useful for making the mixture, although any utensil of a similar pattern will do. Next the binding ingredient is added to the mixture, consisting of one-quarter of a pound of chloride of magnesium which can be bought at the druggists or any store dealing in chemicals. This substance looks like alum. It is dissolved in water and added to the dry mixture already made. It is best to have a Beaumé hydrometer at hand, also sold by most druggists, to test the strength of the solution which should be about 20 in density.

The hydrometer will register at zero in the clear water and as the density of the water is increased as you add the chemical the recording will go up. Cease adding the chemical as soon as the instrument records 20. This liquid mixture is then poured into the previously made dry mixture and all worked together until a consistency about like melted tar results. This completes the mixture, although usually it should be strained through any common flour sieve for the purpose of eliminating lumps and foreign matter.



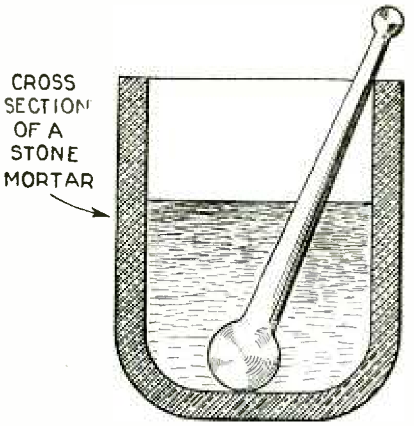
A MAGNESITE CEMENT TILE

One of the finished magnesite cement tiles is shown above. Marble and imitation enamel finishes are easily produced with this cement.



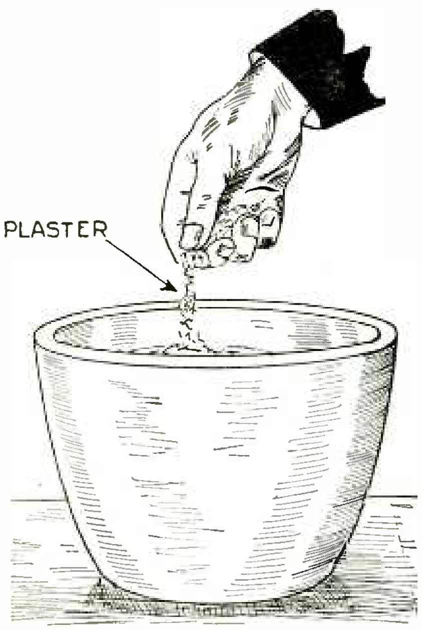
THE MIXTURE IS POURED INTO A MOLD TO MAKE A TILE

The cement mixture is poured into a rectangular or square form in order to make a tile.



A STONE MORTAR IS USED TO GRIND THE MAGNESITE MIXTURE INTO PROPER FORM

A stone mortar is used to grind the magnesite mixture into a smooth consistency.



THE PLASTER IS SIFTED THROUGH THE FINGERS AND STIRRED

Plaster-of-Paris is useful in making molds and models for the cement. The plaster should be sifted through the fingers and stirred with water until about the consistency of lard.

POURING THE MIXTURE TO MAKE A TILE

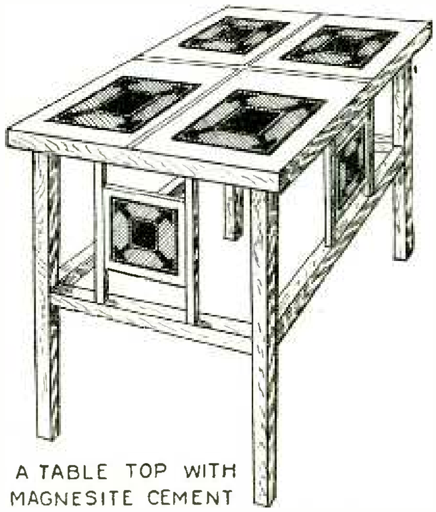
Sometimes the entire tile or other object is made of this magnesite compound, while again only the surfacing of the object is coated with it. Contracting builders use magnesite compositions of this sort as facings for entire bathrooms, including the floor, wall and ceiling. The contractor usually refers to it as magnesite enamel. Halls and stairs have been artistically decorated with magnesite enamel in all of the colors of the rainbow and in an endless array of patterns and designs.

Recently we saw a children's nursery in which the walls and ceiling were ornamented with colorful animal life set in relief in white magnesite enamel. The owner of the house said that his playful children soon defaced wall paper figures, but that the hard, fireproof, toolproof and children-proof magnesite enamel could not be marred by the roughest of play.

If a complete object is to be cast with the mixture which has been made, the retaining bars for a mold are set up and held in place with putty or clay and the mixture is poured in the same as cement is poured. Decorative effects are also made the same as when ornamenting a cement cast. The incised, carved, modeled or other prepared model with its designed surface up is placed in the mold and the magnesite mixture is poured in.

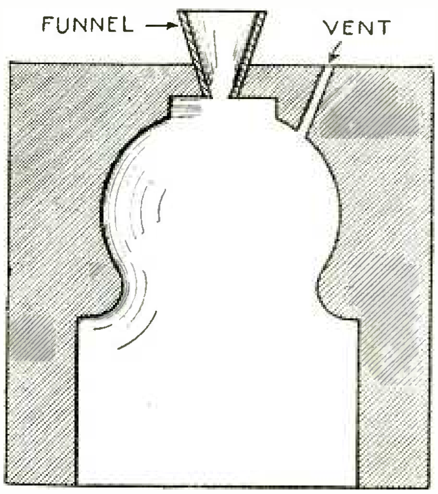
The finishing operation on magnesite

(*Continued on page* 1134)



A TABLE TOP WITH MAGNESITE CEMENT INSERTS

A table, artistically finished with magnesite cement inserts. is shown above.



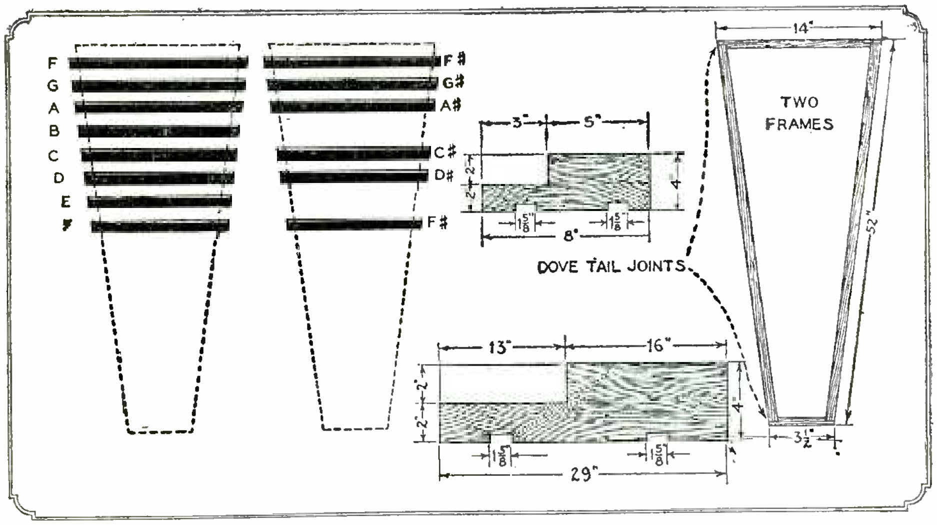
THIS IS ONE HALF OF THE MOLD READY FOR CASTING ANY NUMBER OF VASES DESIRED.

Above is a plaster mold used for casting vases. The mixture is poured in the top by means of a funnel, and a vent is arranged as shown. Tile, pottery, vases, book supports, door stops and various architectural designs may be cast for use in the home and garden.

Building an Inexpensive Xylophone

Musical Instrument Constructed at a Cost of Only $6.50 Covers a Range of Three and One-Half Octaves

By VERNON W. PALEN



The above diagram shows how the Xylophone is assembled. Note that the sharp and flat bars are strung in groups of twos and threes and are raised on the frame slightly above the naturals. This makes for ease in handling the notes.

SOMETIME ago I became interested in the Xylophone and desired to possess and play one of these instruments.

Not having the funds necessary to purchase such an outfit, I obtained the measurements of a commercial instrument and began constructing a home-made model.

The material cost me in the neighborhood of $6.50, and when this amount is compared with that required for the instruments on the market, it is readily seen that the saving is appreciable.

There is this difference between the more expensive commercial instruments and the one to be described: Some commercial instruments have greater volume, due to the addition of resonators. The resonators are merely metal tubes, closed at one end, and of various lengths, suspended beneath the bars. Cost and difficulty of constructing these resonators influenced me to leave them out, and I later learned that their omission did not appreciably decrease the usefulness of the instrument.

USE OAK OR HARD WOOD

Oak or other equally hard wood may be used in constructing the Xylophone, and I found it convenient to purchase the lumber, dressed to size, from a planing mill.

15/16 by 1⅝-inch stock go to make up the bars, bar frames, and braces of the main stand, while ¾ by 4-inch stock is used for the endpieces of the stand. One of these endpieces is 8 inches and the other 29 inches long, as will be seen from the accompanying sketches.

The two trapezoid bar frames with sides 52 inches long, and two endpieces 14 inches and 3½ inches long, respectively, are first made. The joints are dovetailed, or half-lapped, glued, and screwed. Xylophone felt, obtained from any large music store, is glued to the upper edges of the bar frames. This felt supports the bars and chokes out all sounds other than the musical note of the bar itself.

The appended table gives the lengths for all bars necessary for a 3½-octave instrument.

HOW TO TUNE BARS

Although cut to the exact lengths specified, due to difference in wood density, the bars will, in most cases, be out of tune. It is only necessary to hollow out the under side of a bar to lower its pitch, while cutting off the end raises its pitch. A little experimenting will soon teach the constructor just how much to remove in either case. To sound the note in tuning, the bar should be struck with the mallet while it is lying in approximately the correct position on the bar frame.

Tuning may proceed in either of two ways. The middle "C" bar may be tuned to the corresponding note on the piano and the remaining bars tuned from it, or each bar may be tuned individually to correspond with the piano note. A good "tuning" ear is very essential to either method.

After tuning, the bars are drilled, about 2 inches from each end, for a heavy cord, and then sandpapered to a fine finish, stained and varnished.

RUBBER TUBES SEPARATE BARS

The natural bars are strung on one pair of cords with a ¼-inch piece of rubber tubing separating adjacent bars; while the sharp and flat bars are strung in groups of two and three with ⅝-inch lengths of tubing between bars and 2-inch lengths between groups. Screw eyes on the ends of the frames allow the cords to be tightly fastened, thus holding the bars in position.

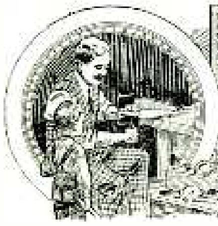
Using the 4-inch stock and two lengths of the 1⅝-inch stock aforementioned, a stand is made to raise the sharps and flats above the naturals. The endpieces of the stand are stepped, and the braces set into grooves cut in the underside.

If it is impossible for the constructor to obtain Xylophone felt, a soft ¼-inch rope can be used on the frames instead.

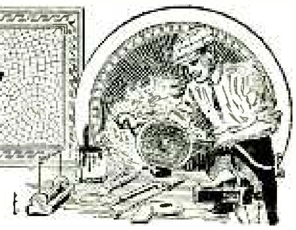
Many details can be worked out with materials which the builder may have at hand. In a pinch felt strips from an old hat may be used on which to mount the bars. Sponge rubber may be used if that is all that the builders should have available. If the xylophone is to be finished up as a parlor ornament, it may be provided with a velvet apron or curtain hanging down from the front and both ends.

TABLE OF LENGTHS OF WOODEN BARS IN INCHES

F	18⅛	G	13⅜	A	9½
F sharp	17¾	G sharp	13⅛	A sharp	9¼
G	17⅝	A	13	B	9
G sharp	17¼	A sharp	12¾	C	8½
A	17	B	12½	C sharp	8¼
A sharp	16¾	C	12	D	8
B	16⅜	C sharp	11¾	D sharp	7⅞
C	15⅞	D	11½	E	7½
C sharp	15½	D sharp	11⅛	F	7⅛
D	15¼	E	11	F sharp	7
D sharp	15	F	10½	G	6⅞
E	14⅝	F sharp	10¼	G sharp	6⅝
F	14	G	10	A	6⅜
F sharp	13¾	G sharp	9¾	A sharp	6⅛
C	5½	B	5⅞		



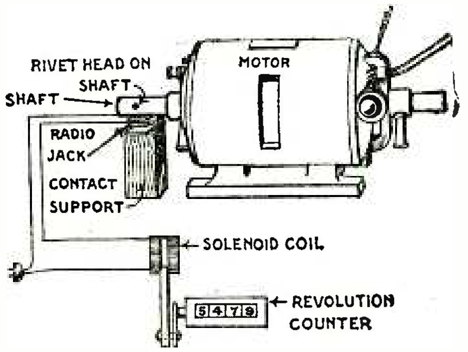
How to make it



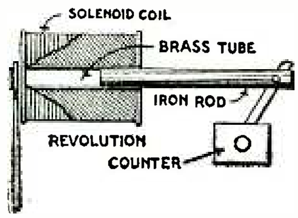
ARTICLES OF INTEREST TO EVERYONE

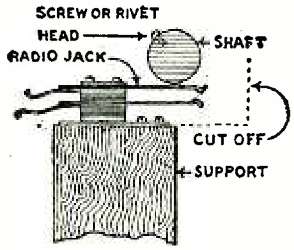
REMOTE CONTROL REVOLUTION COUNTER

REMOTE control for a revolution counter can be arranged with an ordinary counter in the manner shown here. A solenoid coil is made of two hard rubber or wooden disks, with a ¼" brass tube 2" long as a center. The space is filled with No. 22 D.C.C. wire. An iron rod is made to fit into the brass tube so that it slides in and out easily. This rod is connected with the counter rod of the revolution counter with a small screw at one end. On the shaft of the machine, a hole is drilled and a rivet hammered in, so that only the round head projects. A radio jack of the single circuit type is made fast on a support directly under this shaft so that the rivet head will press the two contacts together at every revolution of the shaft. As contact is made through the jack, a current is passed through the solenoid coil which pulls the iron core into the coil. This pulls the counter lever and the spring in the counter lever will pull it back when the contact is open. The coil can be used with 110 volts A.C. (reduced by a bell ringing transformer) or can be used on dry batteries. With this device, it is possible to have the revolution counter placed quite a distance away from the machinery which is being tested for the number of revolutions per minute.—*H. R. Wallin.*



The above illustration gives the details of the remote control device for a revolution counter. The device can be made to run either on dry batteries or directly from the light lines. When an accurate check on the R.P.M. of machinery is required, the counter can be placed in another part of the room or in a distant room if desired.

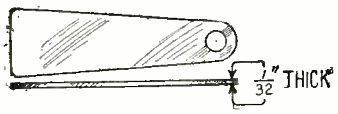




IMITATION WALL TILE

Either new or old plastered walls can be finished like brick or wall tile in the simple manner shown in the sketch above. The wall is grooved about an eighth of an inch deep with an old file or other sharp tool. A straight board is used as a guide. Bricks 3" x 6" are about the right size. After grooving, the wall is treated with a coat of size and then finished with enamel.—Harold Jackson.

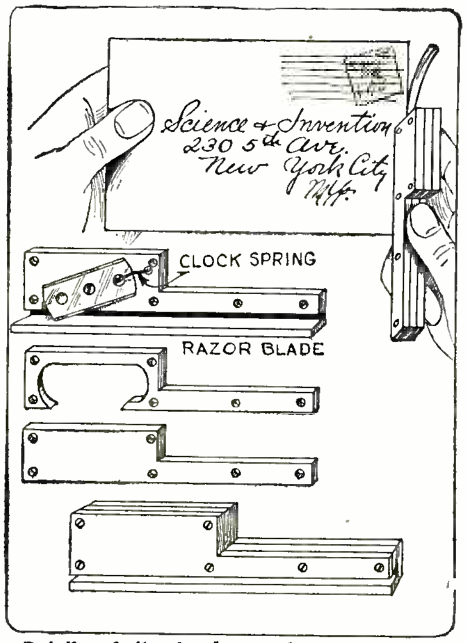
SPARK PLUG ADJUSTER



A gauge for adjusting the distance between the sparking points of a spark plug may be made from a piece of a hack-saw blade, which is about 1/32" in thickness. A grindstone or emery wheel is used to shape the blade as shown. A hole at one end allows the adjuster to be slipped over a key ring, where it will be handy at all times. The gauge is slipped between the two sparking points which may be bent apart or closer to each other, until they are separated the required distance.—Virgil G. Rose.

ENVELOPE OPENER

A very handy envelope opener can be made as shown in the drawing below. The device consists of some pieces of wood, a razor blade, an old clock spring and some wood screws. The clock spring provides the required tension for the razor blade. The operation of the opener is shown in the sketch. The envelope is slipped into the groove on one side of the cutter. The middle wooden strip is cut out as shown to allow for the movement of the razor blade which is attached to the clock spring. The cutter is simple to make and will prove very useful, especially when a large amount of mail has to be opened. The finished device measures about 5" in length.—*P. C. Van Petegem.*

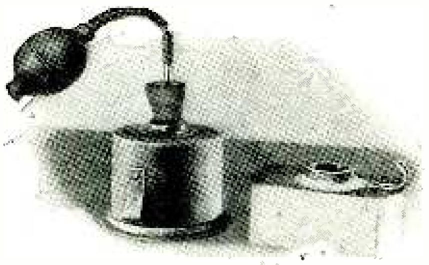


Details of the handy envelope opener are shown in the above illustration.

GIFT CARDS

Home made gift cards can be made quite easily. A small quantity of pastel crayon dust is spread upon the surface of a card and is rubbed with the finger until the surface is "full." Surplus dust is blown off. Shaded and mottled effects are easily obtained. When finished, the cards should be protected with a prepared fixatif. A good fixatif may be made from equal parts of spar varnish and denatured alcohol.—Harold Jackson.

TANK TESTER



An efficient tester for small tanks and the like can be made as shown. The tank is submerged in water, and the rubber bulb pressed. Any leak will then instantly appear as tiny bubbles will be noticeable. This method is better than simply submerging the tank in water, as it tests the tops also.—Wm. J. Douglass.

Readers Forum

SCIENCE AND INVENTION desires to hear from its readers. It solicits comments of general scientific interest, and will appreciate opinions on science subjects. The arguments pro and con will be aired on this page. This magazine also relishes criticisms, and will present them, whether caustic or not. So if you have anything to say, this is the place to say it. Please limit your letters to 500 words or less, and address your letters to Editor—The Readers Forum, c/o Science and Invention Magazine, 230 Fifth Avenue, New York City.

IS TOP OF WHEEL FASTER?

Editor, SCIENCE AND INVENTION:

I would appreciate your opinion and explanation of the following:

Does the top of a wheel that is turning on a base, travel at the same speed as the bottom? If a picture is taken of an automobile that is running at high speed, the spokes near the top of the wheel cannot be seen, while those at the bottom are partly visible. If the car wheel had cogs on it near the edge of the rim and a speedometer mounted on them, it would register the same speed at any point. If this is so, how could it be possible for any portion of the wheel not to turn at the same speed?

PAUL N. RODENBERGER,
Bowling Green, Ind.

(Yes, the top of a wheel, of a wagon, let us say, rotates faster than the bottom with relation to the ground. If you should happen to draw a wheel on a piece of paper, placing the hub naturally at the center, and just imagine that that wheel is moving along, you will find that the bottom of the wheel is stationary with respect to the ground. The hub is moving forward, and the top of the wheel moves just twice as fast as the hub. Therefore, the upper part of the wheel will travel just twice as fast as the center. Any given point on the circumference of the wheel has this double speed the instant that it is vertically above the point of contact with the ground.

If this same wheel had cogs on it near the edge of the rim, and a speedometer was mounted on these cogs, the speedometer would register the same speed, but you must remember that this speedometer is registering the revolutions of the wheel.

We are considering the proposition from a relative standpoint, and relatively the revolutions must be discounted.

Let us cite another example. If you were poling a scow, you might justly ask the question, "Am I moving?" Everyone would say, you are. Relatively you are in the same position. The boat is being moved under you, but your relation with the earth remains identically the same.—EDITOR.)

PANACEA FOR ALL ILLS

Editor, SCIENCE AND INVENTION:

I have read SCIENCE AND INVENTION for over twelve years and I remember when, as the Electrical Experimenter, the magazine endeavored to show that many hokums were being played on an indulgent public. Having just finished reading your editorial in the December number, it brings back to my mind a motion picture I viewed about five or six years ago; I wonder if you have seen it. The name, I believe, was "One A Minute," and featured Johnny Hines or Reginald Denny. The picture deals with a young man who inherits a defunct drug store in a small town. His aunt or grandmother who lives there tells him how her husband had spent the money seeking a "Panacea" or a cure for all ills. The young man gets to thinking about this and finally concocts a mixture which, among many other things, he finds on the shelves of the store. It contains Fuller's Earth, Pepsin, and very bitter chemicals. He then informs the old lady who is deaf and has been waiting for her husband to find the "Panacea" that he has the cure for all ills. The news gets around the town and while his store is being stormed by the villagers, the grandmother pleads for the Panacea. The young man is not sure his haphazard mixture will work, but finally gives in. No sooner does the old lady take the medicine than the impossible happens. She is no longer sick, but feels very spry, and in addition, very clearly hears a train whistling for a crossing about a mile away.

The people are all excited over this wonderful demonstration. The news goes nation wide. A large concern seeks to buy his formula, but he won't sell. Finally the president of a large chain of drug stores arrives with his daughter. He calls the young man a fraud and tells him he has had the medicine analyzed and found it made up of four simple medicines, none of which are much good. The young man tells him he does not know of the fifth ingredient.

The young man falls in love with the daughter and they desire to get married, but the father who suffers from Dyspepsia, will not allow this. The father, seeing the cures made by the "Panacea," begins to believe in it. The young man seeing his chance, persuades him to try it, with the result that he is cured and offers the young fellow a million dollars for the fifth ingredient of his formula, and gives permission to marry his daughter. Receiving the check, the young man informs his father-in-law that the fifth ingredient is FAITH. This drives the old man wild, but finally everything calms down and the story closes with the young man as a partner and married and the Panacea for all ills selling enormously.

I thought this might interest you because of your remark on faith cures.

LOUIS J. GUENZEL,
New York City.

(The idea of faith in a certain drug concoction or in a medical treating apparatus is extremely important and is the one factor that most concerns selling Panaceas depend upon. Testimonial letters, as easily obtained as they are, serve to increase this faith. That is the reason why most concerns make use of testimonial letters to the extent they do. We are pleased to pass this little story along to our readers, but regret it is too real.—EDITOR.)

DR. HOLLINGSHEAD'S ODIC RAY

Editor, SCIENCE AND INVENTION:

I have been reading some of your exposures of frauds and while this is not a medical fraud, it looked to me to be far too good to be true. There has been a man in town (pop. 1000) for the last few days trying to raise subscriptions to finance a certain Dr. Hollingshead, Inventor of the Odic Ray or Death Ray, the marvelous properties of which will be listed later.

This man was not selling stock, the company had not yet been formed. He was just taking subscriptions for which one received a receipt. The main company was to be formed in about sixty days and those who subscribed now would be given ten shares of stock for every dollar invested.

This Dr. Hollingshead is supposed to rank fifth among the scientists in this country.

Some of the properties of this wonderful ray are as follows:

The machine can be manufactured for less than $350.

This ray will penetrate eleven feet of lead and take a picture.

When used as an X-ray, the observer needs no machine or fluoroscope to observe the subject, he can just look at the object and see right through it.

The theory he expounded which caused the heating of the iron was as follows:

He went into lengthy discussion on the atomic and electronic structure of matter and stated that the atom was constructed of positive and negative parts which were constantly revolving. When heated by fire, the positive part was speeded up and when immersed in acid, the negative part was speeded up, both causing heat; but as only one was speeded up at a time, the other slowed it down, with a resultant cooling of the object, but when treated with this ray, both parts were speeded up with nothing to slow down, so the object stayed hot. Simple, isn't it?—**(More than simple.—EDITOR.)**

He admitted that these things went against all laws of physics, but said that Dr. Milliken admitted he was wrong when confronted with Hollingshead's electronic theory.

No, I didn't buy any stock!

H. S. C.
Lyons, Neb.

(It is indeed a pity that a man with as wonderful an invention as Dr. Hollingshead's must resort to a town with a population of 1,000 people to try to finance his dream of a death ray, when right here in New York he would be able to operate it in the midst of the largest population in the world.

If his machine were so wonderful, we are quite confident that Henry Ford would immediately purchase as many rights to this invention as he possibly could, and he would not quibble over a few million. Judging by the description you forwarded, the man is really giving away something for nothing. Our own opinion is, that it is worth just that and no more. We hope others thought first and bought no stock.—EDITOR.)

THE FOURTH DIMENSION?

Editor, SCIENCE AND INVENTION:

Having spent some seven or eight years trying to solve some of the problems confronting our scientists and philosophers, such as: time, space, gravity, inertia, etc., we have arrived at some original conclusions that may be of general interest.

We have early realized that all tangible objects have the three dimensions of length, breadth, and thickness. Therefore, we decided that there must be a fourth dimension, one that controls the characteristics of a three dimensional object.

Having considered Einstein's fourth dimension of "time-space," we have rejected it, for both time and space are subordinate to the true fourth dimension, being subjective to relative association through perception with—"purposeful objects."

The true fourth dimension, when we consider length, breadth, and thickness, as the first three, is—Definite Purpose. But categorically it is the first. The other three being: mental perception, conception of characteristics, and duration.

Every purposeful object has a duration, which is relatively absolute, i. e., absolute as a dimension but relative as a factor.

F. S. B.
THE BLUE DIAMONDS,
Elmhurst, L. I.

(We do not concede that definite purpose is, or can be, a fourth dimension. There are many things which we do, which have no definite purpose whatever. We put the right shoe on first in the morning; what is the definite purpose, when the left could be put on as easily? That, of course, is a minor item, you may say. What then is the definite purpose of our lives? We are born, we live, we die. For what definite purpose? But a few of us will become outstanding lights in this great world of ours. All others will compare favorably with the majority and their names will vanish from the face of this earth and their accomplishments will be conspicuous by their total absence. And supposing even these truly great men like Pasteur, Eugen Steinach, Shakespeare, Nietzsche, Goethe, Shiller, H. G. Wells, Freud, Aristotle, Plato, Galen, Poe, Washington, Lincoln, Lloyd George, Upton Sinclair (include Lindbergh if you like, and go on indefinitely) never existed—what difference would it make? What definite purpose was there for their existence? Supposing the entire world were bereft of all of its human inhabitants? Agnostics see no purpose in the existence of man and no definite purpose for the existence of much of the life on this planet.

No—definite purpose is certainly not a fourth dimension.

Using the term "duration" and stating that it is relatively absolute, instead of the word "time," is just another way, we believe, of confusing the issue. How can a thing be relatively absolute when we do not know what absolute is? Does it refer to—"for all time," or "for no time?" If for all time, how long is all? Duration, relative to this earth's motion around the sun gives us something definite, something concrete upon which we can base our arguments.—EDITOR.)

GRAPHOLOGY

Editor, SCIENCE AND INVENTION:

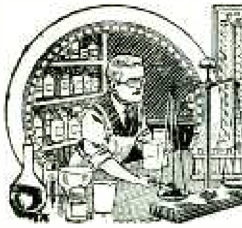
We feel that we could not get along without your splendid magazine for you certainly get at the bottom of things.

We desire to ask your opinion of Graphology, the art of judging character from the handwriting.

RHENE E. BLAKESLEY,
Anacortes Business College,
Anacortes, Wash.

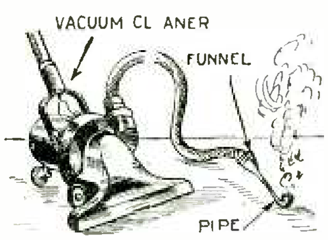
(We do not believe in graphology; we do not believe that it is possible to analyze a person's life or character from his handwriting, nor do we

(Continued on page 1140)



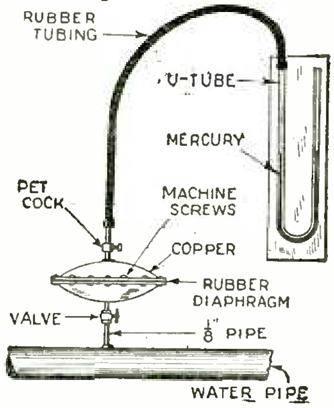
Wrinkles
RECIPES & FORMULAS
Edited by S. Gernsback

KINK FOR PIPE SMOKERS



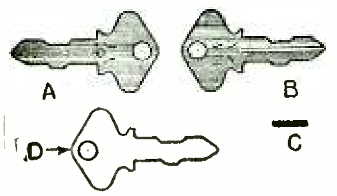
A new pipe may be broken-in by connecting it to the vacuum cleaner. A cone of heavy paper is made and the pipe stem fitted into this as shown. The dust bag is removed and the flexible hose connected in the usual way.—C. A. Adams.

MEASURING LIQUID PRESSURES



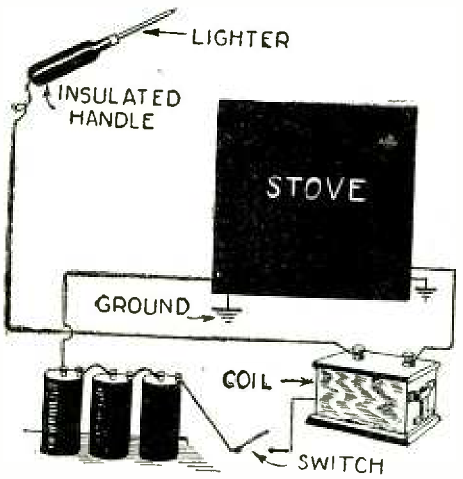
When using "U" tubes filled with mercury for measuring the pressure of liquids, it is sometimes necessary to prevent the liquid from coming into the tube and thus causing inaccurate readings. The device shown in the illustration will overcome this difficulty.—Victor D. Clark.

CAR KEY RECORD



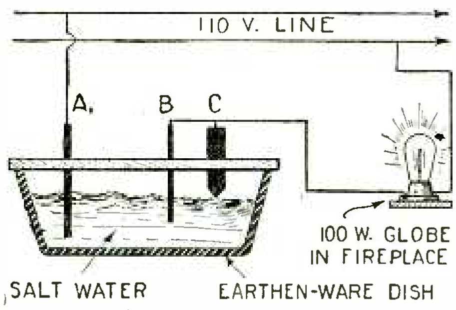
A car key record can be made by placing a piece of paper over the key and rubbing over the entire surface with a lead pencil. Both sides of the key should be treated in this manner.—Dewey C. Wilson.

GAS STOVE LIGHTER



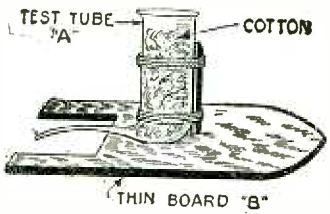
An electric match for the gas stove can be easily made from an old spark coil, a storage battery, or several dry cells, a switch and an insulated handle, as shown in the above illustration.—Glen F. Stillwell.

AN ARTIFICIAL FIREPLACE



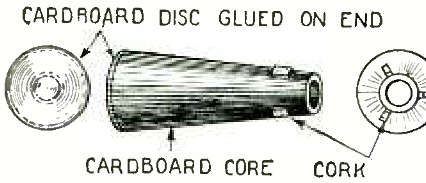
An artificial fireplace fitted with the arrangement shown above will seem most realistic in appearance. The device keeps up an intermittent flashing resembling the flickering of the flames. Rod A is immersed into the water, B is a thin rod or a heavy piece of wire. Rod C is very heavy and has a pointed tip. To operate the device, merely keep the water in motion.—Paul Wirth.

TOY BOAT



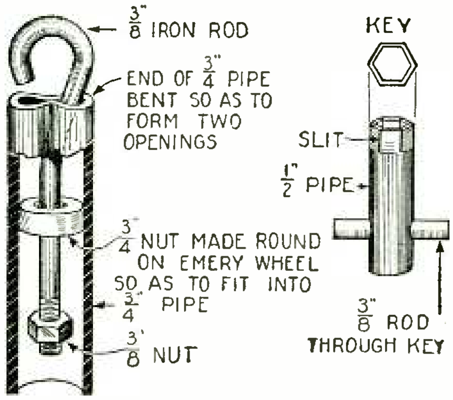
A boat which secures its motive power from surface tension is shown above. A is a test tube with the lower end drawn out. This is placed upon a thin board. The test tube is now filled with absorbent cotton and alcohol, or soapy water is poured in.—H. H. Roseberry.

CORNET MUTE



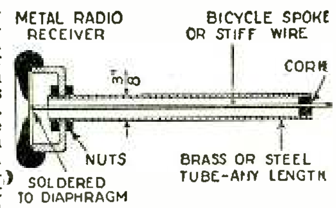
A mute can easily be made out of a cardboard core, such as that upon which string is wound. Four strips of cork are glued around the cone at the small end.—B. Binning.

HOME-MADE LOCK



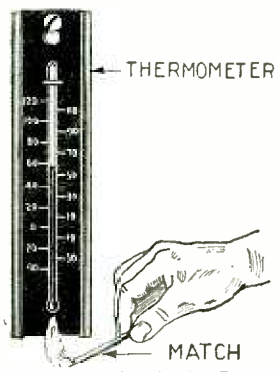
The above illustration shows the constructional details of a simple home-made lock which can be made from a few odd parts. The main portion is made from a piece of ¾-inch pipe, one end of which is crimped together, so as to leave two openings.—Paul Louque, Jr.

LEAK DETECTOR



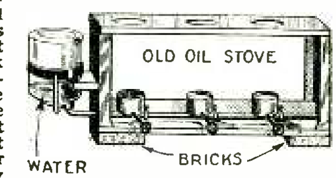
A simple device for finding leaks in pipes or knocks in engines is shown here. A pipe threaded on one end and a radio receiving unit are the main parts. A bicycle spoke or stiff wire is soldered to the diaphragm.—Michael Duzmal.

THERMOMETER KINK



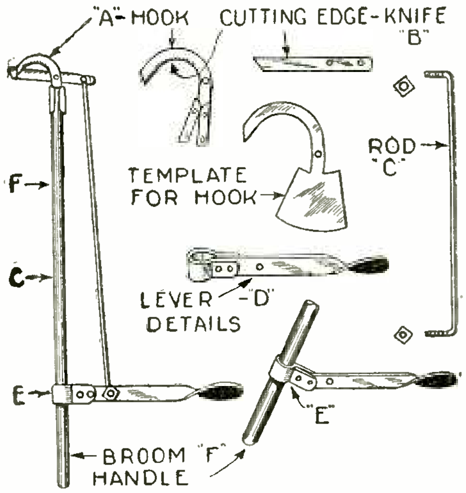
When the mercury column in a thermometer is broken, the thermometer will not register correctly. A good method to repair the break is to hold a lighted match under the bulb, so that the mercury goes almost up to the top of the tube. This forces the pieces together, and the thermometer is as good as ever. Care should be taken so that the flame is not put too close to the bulb, otherwise it may break.—E. Zimmer.

WATER PAN FOR CHICKENS



An old kerosene oil stove makes an excellent water tank for the chicken yard. The supply pipe must be bent down so that the water comes nearly level with the top of the burners. The inner wall surrounding the wick should be bent toward the center.—P. B. Kehoe.

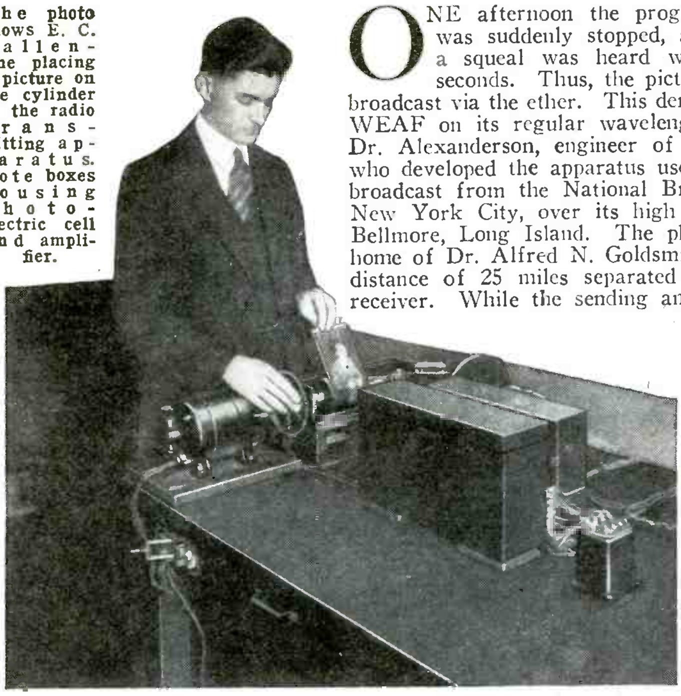
TWIG CUTTER



A home-made lever twig cutter can be constructed from the parts shown above. The handle is made from an old broom handle. A lever and collar (E) slip over the handle.—Tom Shivey.

Photographs In The Home By Radio

Pictures Broadcast in 90 Seconds with New Apparatus

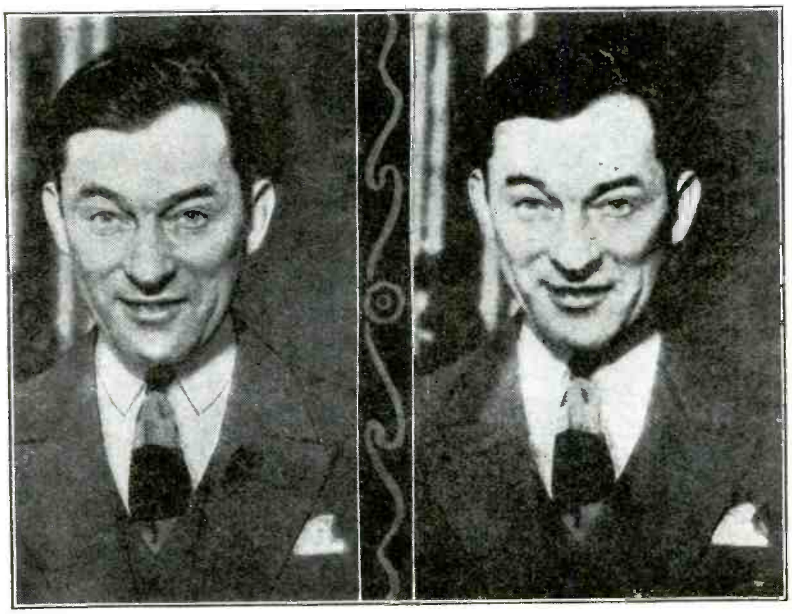


The photo shows E. C. Ballentine placing a picture on the cylinder of the radio transmitting apparatus. Note boxes housing photo-electric cell and amplifier.

Another view of the transmitting apparatus is shown below. The serrated disc may be seen in back of the revolving cylinder.

ONE afternoon the program coming over WEAF was suddenly stopped, and in place of the music a squeal was heard which lasted for about 90 seconds. Thus, the picture of Mayor Walker was broadcast via the ether. This demonstration, conducted over WEAF on its regular wavelength, was made possible by Dr. Alexanderson, engineer of the General Electric Co., who developed the apparatus used. The photographs were broadcast from the National Broadcasting Co. Studios, in New York City, over its high powered transmitter from Bellmore, Long Island. The photos were received at the home of Dr. Alfred N. Goldsmith, in New York City. A distance of 25 miles separated the transmitter from the receiver. While the sending and receiving of pictures by radio has been done before in the experimental laboratory, this is the first time that a broadcasting station, using its regular wavelength, has publicly demonstrated this feat.

The transmitter, which was located in a small room in the N. B. C. Studios, consisted of a rotating cylinder, a small automobile headlamp, a synchronous motor, a revolving disc and a photo-electric cell. The photograph to be transmitted is wrapped around the cylinder, which is driven by a small synchronous motor. The light from the lamp is focused through a lens onto the revolving picture. The image, as reflected by the beam of light, is broken up by the serrated edge of a revolving disc which is placed in front of the photo-electric cell. These light waves or impulses which are broken up by the revolving disc, are converted into electrical energy and are then amplified. Leaving the amplifier, they are transmitted by means of the antenna in the same way as radio programs are transmitted today. The apparatus used at the receiving end is quite simple and consists of a standard radio receiver, loud speaker, a Moore-neon gas lamp, a revolving cylinder housed in a light tight box, and a synchronous motor geared to the cylinder. The radio receiver detects and amplifies the signal coming through the air from the transmitter. The incoming impulses are then carried to a transformer, rectifier and amplifying tubes, and then to the Moore lamp. The light beam from this lamp varies with the intensity of the electrical impulses. The orange-pink beam from the lamp is projected through a lens, into the box housing the revolving cylinder. A sheet of ordinary bromide photographic paper is wrapped around this cylinder, which revolves in synchronism with the one at the transmitting end. The motors at receiver and transmitter are kept in synchronism by using the same alternating current system. It takes about 90 seconds to transmit the picture in this manner, and after transmission is finished, the photographic paper is taken out and developed and fixed in the usual manner.

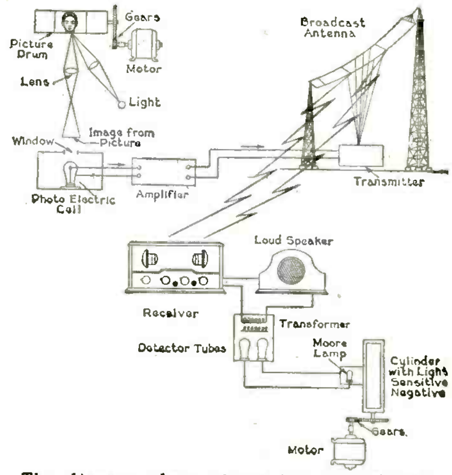


Above at left is the original picture of Mayor Walker of New York City; on the right, the picture as received on the home radio-picture receiver, 90 seconds later.

Before the picture is sent, instructions are given from the transmitting station and are picked up by the loud speaker at the receiving end. A milliammeter situated near the amplifying unit, indicates to the receiving operator when his picture receiver is properly framed and set to the correct intensity strength for tone shades. It takes but a minute to adjust the receiver for the reception of the transmitted picture.

The radio picture machine has been greatly simplified so that the apparatus can be used in the home. Although the broadcasting of stationary pictures is more limited in scope than television, it is nevertheless an important step forward. From this time on,

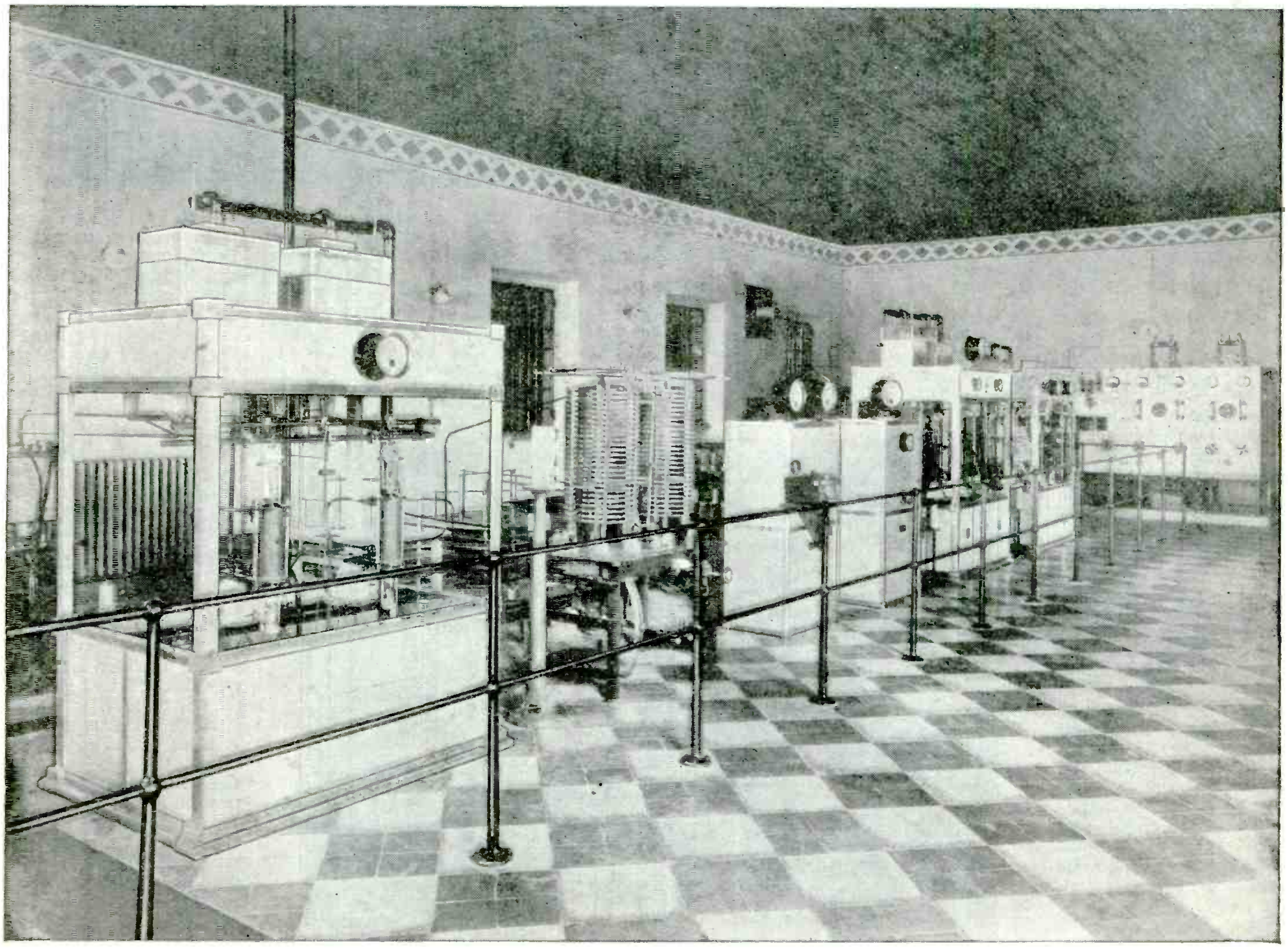
Above is Dr. E. F. W. Alexanderson and his home radio-picture receiver. Against the wall is a box containing the rectifying and amplifying units. The cover of the receiver has been lifted, showing the photographic paper.



The diagram above shows how the pictures are sent and received by radio. A slotted disc, not shown in this diagram, revolves in front of the window which admits light to the photo-electric cell.

one may expect the development of specialized radio picture transmission methods, each adapted to its particular field. A wide field of application of still picture transmission appears in educational broadcasting. Text book diagrams, maps, drawings, and the like, may now be broadcast soon.

New Radio Broadcast Station at Milan, Italy

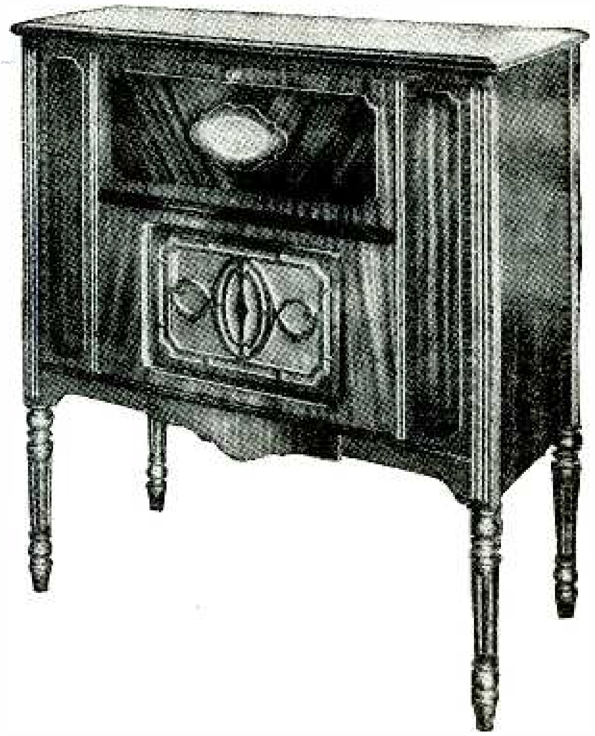


The new broadcasting transmitter recently put in operation at Milan, Italy by the Unione Radiofonica Italiana is shown above. The studio is in Milan, but the transmitter is situated three miles to the southwest of that city. The aerial is 260 feet high. The power used is 7 K.W.

The four main panels are shown above. Marconi water cooled transmitting tubes are used, the water being sprayed into tanks mounted on the top of the frames. The water circulates through the jackets of the tubes and runs into tanks in the bottom of the frame, from which it is pumped back to the main supply.

An All Electric Six

Better Control of Oscillation and Electric Operation Are Features of New Receiver



A view of another model of similar design appears above. The set is housed in a cabinet panelled with mahogany and rich inlays. A useful desk-type drop cover closes the entire set when not in use

THE dream of a radio receiver operating directly from the house current is now a reality. Worry about charging batteries, watering the eliminator and the like has now been relegated to the past. The photographs appearing on this page show an all-electric receiver of advanced design which uses six tubes. All the necessary power equipment is placed conveniently within the console, no unsightly wires being visible. A scientifically built 12 inch cone speaker is housed below the set in the console, and is covered by an

Above we have a front view of the receiver showing the neat panel arrangement and grill work covering the built-in loud speaker. A.C. tubes are used throughout, except on the D.C. set.

artistic grill. Incorporated in the cone speaker is a protective device (a one-to-one ratio output transformer), which permits any desired voltage to be used on the last tube, without harming the speaker. The two models shown here are housed in beautifully designed cabinets, panelled with mahogany with contrasting artistic inlay work. The same manufacturer also makes various other models built in cabinets of mahogany or walnut. The sets use an illuminated drum control which is calibrated in wave-lengths, so all that has to be done is to pick out the station you like to hear and set the dial to the wave-lengths specified. A new system of stabilization for the control of oscillation is used in all models. As may be seen from the photograph of the chassis, the receiver is a six tube tuned radio frequency set, having three stages of tuned radio frequency amplification, a detector and two stages of audio. The particular receiver shown here was designed to operate directly from 105 to 120 volt, 60 cycle alternating current. However, various other models are available which will operate on 25 to 45 cycle, 110 volt alternating current, and also on direct current which may vary from 105 to 120 volts. The power supply unit in A.C. models contains a transformer for heating the filaments of the A.C. tubes and a rectifier-filter system for furnishing the necessary plate current.

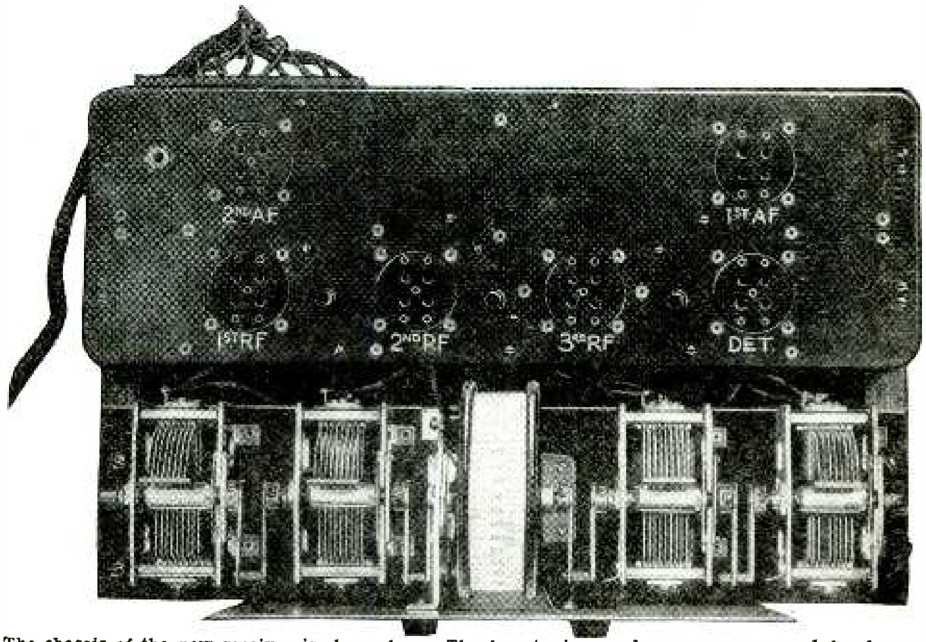
HOW CIRCUITS ARE BALANCED

THE circuit which has been utilized for balancing the receiver consists of a coil and condenser in parallel with a resistance in each branch of a parallel circuit. If the resistances in the two paths are equal to each other, and to the square root of the inductance divided by the capacity, the impedance of the circuit, as far as the previous tube is concerned, is a pure resistance at every frequency; therefore the plate current of the previous amplifier has no inductive reactance in it and so the tube can not oscillate, provided that the inductance, capacity and resistance are properly adjusted. Nearly double the co-efficient of coupling between the primary and the secondary may be used in this new system. The radio frequency transformers are wound on small bakelite tubes with their turns slightly spaced. This type of winding can be controlled, so that the inductance of the coil may be held to within .5 per cent of accuracy when manufactured in large quantities. The primary of the radio frequency transformer is a spiral wound on a wooden form, and is placed at the ground end of the secondary. Thus, the advantages of comparatively large coupling and at the same time small capacity between the primary and the secondary are obtained. The audio transformers have a turn ratio of 4 to 1. The secondaries of the audio transformers are of the split or balanced type and have a low distributed capacity, and a low capacity between windings. The result is, that uniform amplification is obtained between 100 and 5000 cycles.

TUBES RESILIENTLY MOUNTED

THE R.F. inductances and audio frequency transformers, as well as all the other apparatus which is not accessible to the controls on the front panel, are mounted on a metal shelf suspended by springs. The tubes are mounted on this shelf, which is provided with rubber dampers, in order to eliminate microphonic feed-back. The variable condensers have plates of heavy construction with rather wide spacing, so that the capacities of condensers in any receiver are practically identical throughout their entire range. The plate supply in the receiver is of the conventional type and uses

(Continued on page 1127)



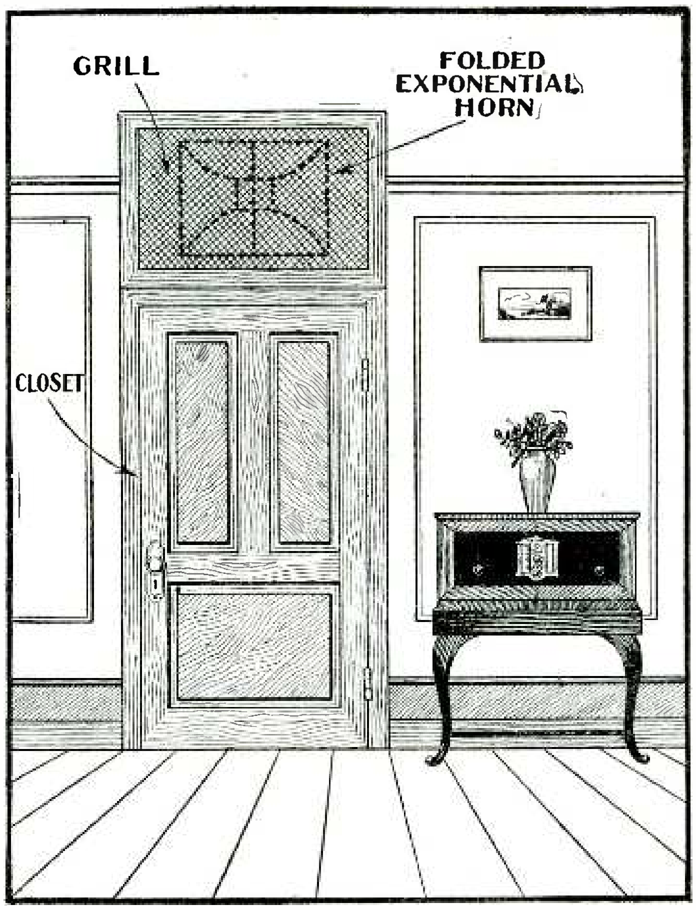
The chassis of the new receiver is shown here. The four tuning condensers are arranged for drum control. Another novel feature lies in the fact that the illuminated dial is calibrated in wave-lengths.

(Name of manufacturer furnished upon request.)

Exponential Horns—How to Build Them

Constructional Details for Building Folded and Straight Horns

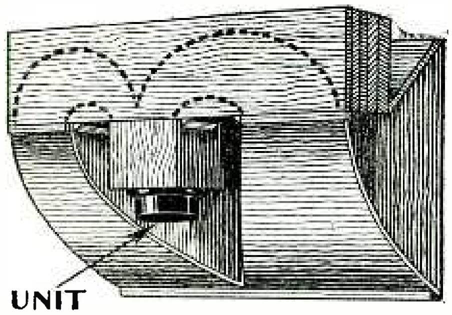
WHEN broadcasting first started, the only type of loud speaker available was that designed expressly for wireless telegraph work and consisted of a straight conical horn. Later the shape of the horn was altered, but still proved to be unsatisfactory, as shapes and dimensions were chosen at random. Recently, there has been developed by Clinton R. Hanna and Dr. Slepian, of the Westinghouse Elec. and Mfg. Co., a loud speaker known as an exponential horn, which is built entirely on a mathematical basis. Furthermore, it was found that a horn did not have to resonate in order to reproduce a sound. In fact, the best horns do not resonate strongly at any frequency. The exponential horn is an important development in the science of acoustics. The best horn is one which reproduces uniformly over the required range of pitches. A horn does not amplify but increases the amount of sound radiation by causing a greater load to be placed on the diaphragm.



The above illustration shows how an exponential horn of the folded type may be concealed in the upper portion of a closet. The grill work covering the front does not effect reproduction in any way.

RATE OF EXPANSION

THE rate of expansion is an important factor in horn design, for it determines the frequency cut-off, below which the radiation is very small. A horn whose area doubles every foot has a cut-off frequency at 64 cycles, one expanding half as rapidly has a cut-off of 32 cycles, and one expanding twice as rapidly cuts off at 128 cycles. If we know how low a frequency we wish to produce, the contour of the horn may be determined. In order to have a horn with a low frequency cut-off it is necessary to build one 6 to 15 feet in length. A straight horn built on the exponential principle would then be too large to place in an ordinary room. In order to fit an exponential horn into a small space, they may be folded. On this page the dimensions of a 5-foot square section exponential horn, having a cut-off frequency of 128 cycles, are given. Plans are also given for exponential horns having cut-off frequencies of 64 to 128 cycles.

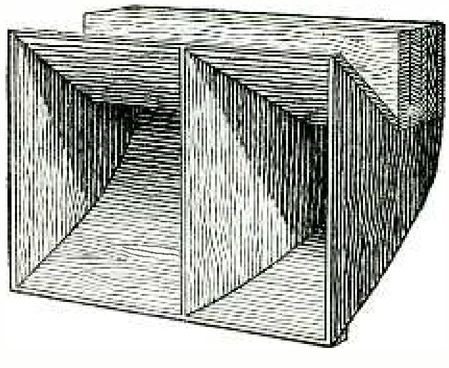


REAR VIEW

A rear view of a folded exponential horn is shown above. Note the placement of the loud speaker unit and shape of the air columns.

A STRAIGHT HORN EXAMPLE

THE straight horn can be built up without any great difficulty, using cardboard, wallboard, or plywood, according to the builders desires. The overall length of the four sides will have to be 5 feet 3 inches to allow for the curvature of the contour. The sides may be fastened together by means of small metal angle pieces, or, in the case of a temporary job, may be held together with wide strips of adhesive plaster. The structure will also have to be braced with a square form at intervals. To make the connection between the throat and the speaker unit, it will be necessary to use a short piece of metal tubing. Care should be taken to make the junction between the metal tubing and the wooden throat air-tight.



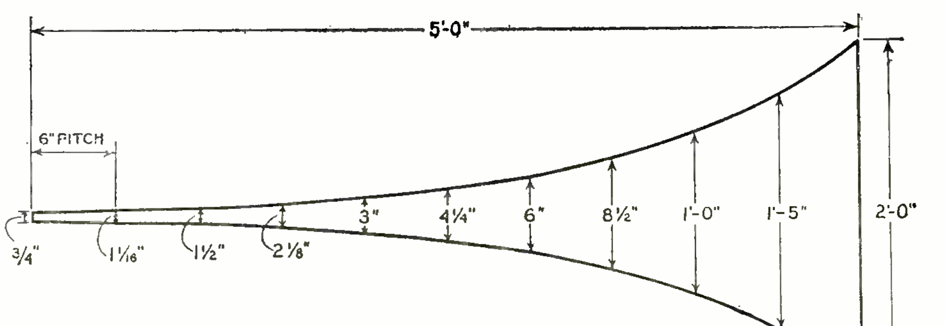
FRONT VIEW

A front view of the exponential horn shown at the left is given above and should help to make the construction of folded horns clear.

FOLDED EXPONENTIAL HORNS

THE ingenious folding of the exponential horn in no way impairs its performance, provided that it is of proper design. Splitting the area equally over two parallel channels has no detrimental effect. Complete drawings for an exponential horn of folded design, having a cut-off frequency of 128 cycles, are shown here. Heavy pieces of timber will be required for the heart-shaped blocks. If single blocks of timber of this size are not obtainable, they will have to be built up from several laminations. The baseboard and top board should be constructed of planking and closely fitted and then screwed to external battens. All the necessary blocks should then be prepared. After the blocks have been put in place, the top may be also screwed down. The plywood sides should next be screwed in place, starting by attaching the back edge to the back blocks and gradually working forward. Throughout the entire assembly care should be taken so that all parts fit accurately and the shape of the sound channels are not distorted. Once the correct position for all screw holes are found, the horn may be taken apart for sand-papering and polishing, after which it can be reassembled. During the final assembly all parts should be glued together under pressure as well as screwed.

The manner of external finish of the horn is a matter of personal taste. The outside may be stained and polished and the mouth covered with artistic grill work. The folded horn may be placed out of the way on top of the closet, the front of



Above are given the dimensions of a square-section exponential horn, which has a cut-off frequency of 128 cycles. The area of the mouth is 4 sq. ft., and the throat area of the horn measures 3/4-inch square. The total length of the horn is 5 feet.

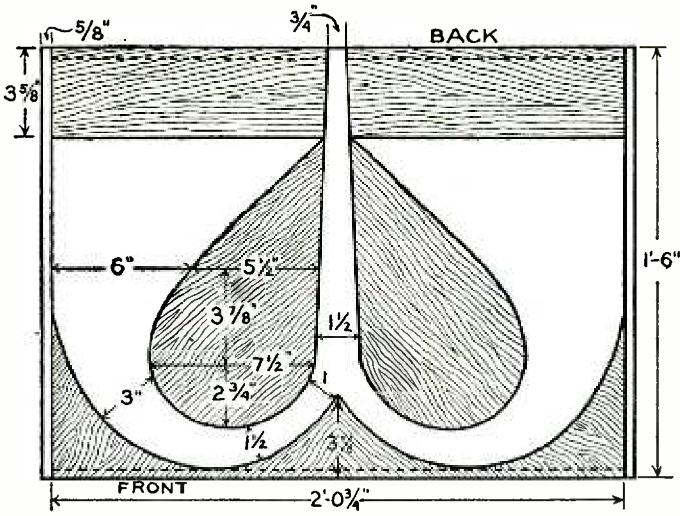
which has been provided with a grill which in no way impairs the operation of the speaker. For those who live in bungalows, a novel plan is to mount the horn in the attic with a grill work fastened in the ceiling, as shown in the illustration.

CONSTRUCTION NOT DIFFICULT

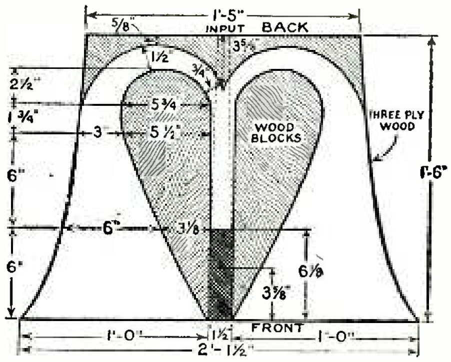
THE design and construction of an exponential horn is not so difficult as it seems, and, in fact, may be undertaken by anyone possessing a slight knowledge of woodworking. The straight horn, with a cut-off frequency of 128 cycles, may be constructed from heavy cardboard as an experiment. It may be well to mention here, that although the horn has a cut-off frequency of 128 cycles, this does not mean that the lower notes will be inaudible. They will be reproduced, but not proportionally to the diaphragm movement, as is the case with frequencies above 128 cycles. It is much easier to construct a square horn than a round one, and all dimensions for the square horn are given in the drawing shown here. Even with a horn fashioned from cardboard, the results will be a revelation. Low notes which were scarcely audible will come out with full volume and with a great depth of tone. As far as the ear can judge, the exponential horn will reproduce uniformly over the entire range of frequencies, giving better volume than the ordinary horn.

WOOD IS THE BEST

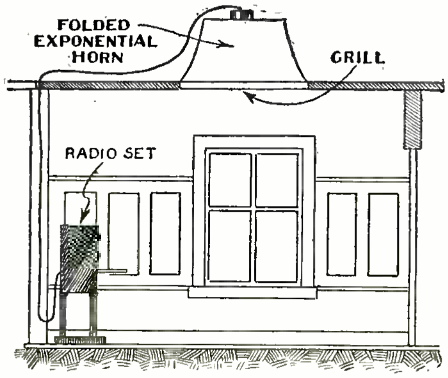
THE use of wood in a horn has the same effect as it does in a violin, eliminating vibration and enabling every note, from the deepest bass to the highest range of the violin, to come forth free from distortion. Even static is somewhat subdued by the soft tonal qualities of a wooden horn. The harsh, metallic rattle and crackling disturbance is smoothed out and toned down by the vibration - resisting wooden walls of all wood speakers. Light, flimsy wood and construction is not recommended, on account of resonance effects which may be introduced, or the interference between sound waves in adjacent channels which would undoubtedly take place through thin dividing walls. The heaviest pieces of timber which are used for the heart-shaped blocks cannot be replaced by hollow chambers enclosed in bent wood sides.



A section of the central part of a folded exponential horn is given above. The entire section is 1½ inches thick and fits into the central section, which is shown below. This horn has a cut-off frequency of 128 cycles.



The layout of the baseboard and central section of the folded horn shown at the top is given here. The horn has a mouth area of 4 square feet and is similar to the 5-foot straight horn.



An exponential horn can easily be concealed in the attic. A grill is placed in the ceiling.

These enclosed places would resonate at their own frequency.

ECONOMY IN OPERATION

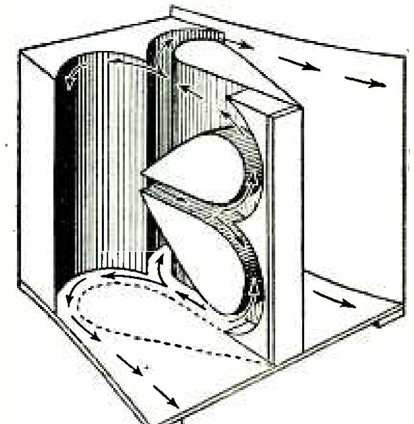
ONE of the reasons why the cone loud speaker became popular is the fact that it was capable of giving good reproduction over a wide range of frequencies when used with a suitable unit. With some types of this speaker, it was also possible to handle a great deal of volume without chattering. In order to get the same results with a horn, it would have to be rather long. In fact, a straight horn of the exponential type, capable of reproducing frequencies as low as 16 cycles, would have to be about 44 feet in length. Besides the inconvenience attached to the size of such an instrument, its construction would be both difficult and expensive. However, the folded exponential horn is inexpensive and quite simple to construct, although it does take up more room than the ordinary loud speaker. Rather small driving mechanisms requiring small power will reproduce ample volume when used with this new type of horn. For a given volume, the exponential type of horn speaker requires much less power from the amplifier than any form of open diaphragm speaker. Thus, by using a horn, those having moderate or low-power amplifiers and small speaker units can obtain more volume free from horn or diaphragm distortion than is possible in any other way.

REQUIREMENTS FOR GOOD HORNS

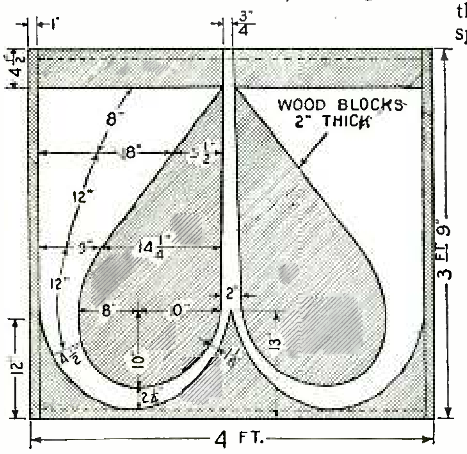
A GOOD exponential horn must be designed to reproduce the lower register, the mouth must be large in order to eliminate any noticeable horn resonance, and the throat must be relatively small, in order to cause sufficient radiation pressure to be exerted on the vibrating diaphragm of the unit. These requirements, would of course make for a long horn. The exponentially-shaped horn is shorter than any other horn, covering the same range of frequencies, and it has the added advantage of being free from horn resonance.

TYPE OF UNIT USED

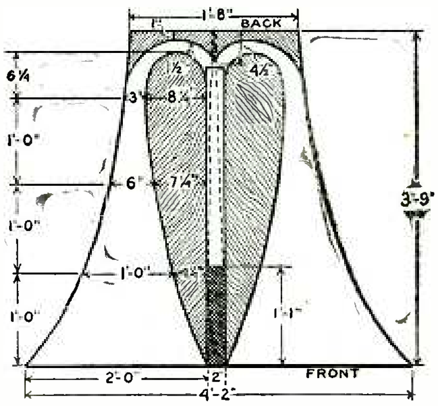
THE performance of an exponential horn, of course, can be no more perfect than the amplifier and unit used with it. Probably the best type of unit for use with a horn of this nature is the moving coil type, especially for high power work. The balanced armature type will perform very well, and almost any kind of a unit will show a decided improvement in its performance when connected to a properly designed exponential horn. If a greater amount of volume is required for the purpose of filling a very large hall, the exponential type of speaker is the best, as it is the most effective converter of electrical energy into sound waves. Some of the drawings appearing here, which contain construction dimensions, are reproduced through the courtesy of *Wireless World*, London. Extreme care should be taken to see that all joints are made air-tight. One of the leading exponential horns in this country is made of three - ply laminated wood, about one-half inch in thickness. This is ideal for horn construction work.



Above—A sectional view of an exponential horn folded into a small compass is shown above.



Above—Section of central portion of 12-foot horn having a cut-off frequency of 64 cycles.

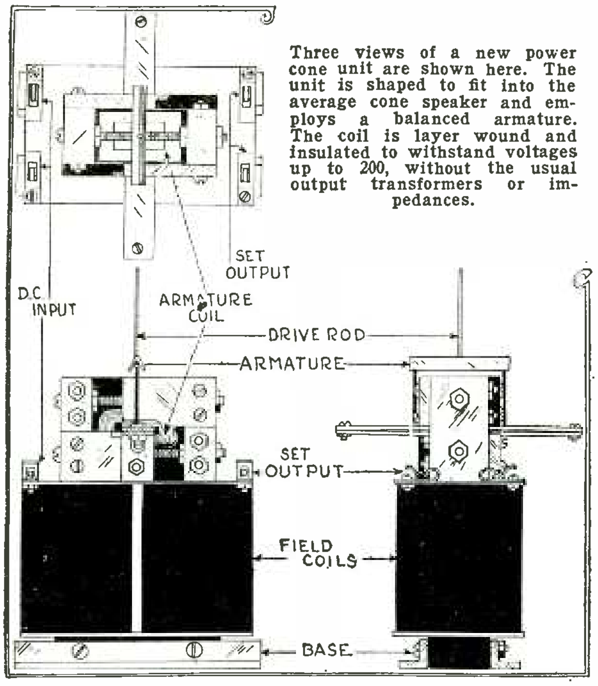


Plan layout of baseboard and central section of the 12-foot horn is given above.

NEW RADIO DEVICES

Accessories Recently Developed Which Will Improve Any Radio Set

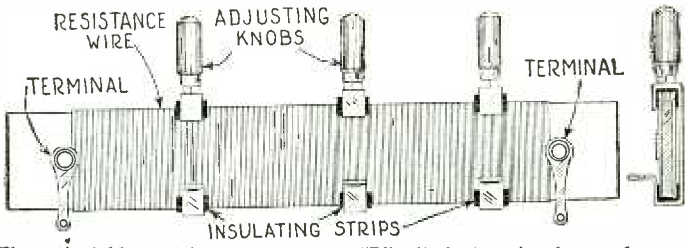
POWER CONE UNIT



Three views of a new power cone unit are shown here. The unit is shaped to fit into the average cone speaker and employs a balanced armature. The coil is layer wound and insulated to withstand voltages up to 200, without the usual output transformers or impedances.

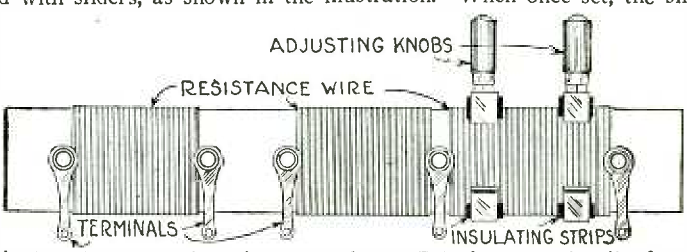
The unit shown above, a product of a New York City manufacturer, employs a powerful electro-magnet, instead of a permanent magnet. The electro-magnet draws .3 ampere, the current being supplied from a 6-volt source.

"B" ELIMINATOR RESISTANCE



The adjustable resistance for use in "B" eliminators is shown above. These are wound with enameled wire and are provided with sliders for obtaining different voltages.

A NOVEL type of resistor for "B" eliminators is now being manufactured by a Chicago concern. These resistors may be used for obtaining various "B" and "C" battery voltages from the eliminator. They are provided with sliders, as shown in the illustration. When once set, the sliders



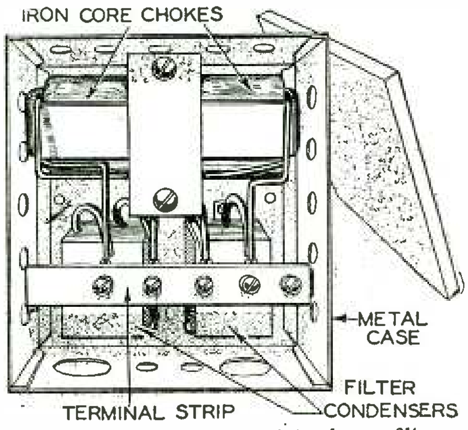
Another type of resistor is shown above. This is used primarily for obtaining "C" battery voltages from the "B" eliminator.

may be locked in place by turning the adjusting knobs, the shaft of the adjusting knob making contact with the resistance wire on the top edge of the strip. The sliders are equipped with insulated adjusting knobs, which simply have to be loosened and the slider shifted, in order to obtain any desired voltage.

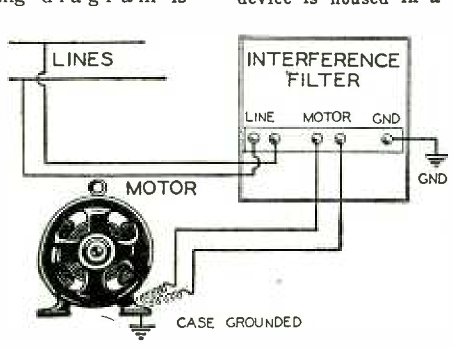
INTERFERENCE FILTER

A MASSACHUSETTS radio manufacturer has recently brought out a line of radio interference filters, designed to be used with motors and other electrical appliances which cause interference in the radio receiver. Both filters are connected to the appliances directly, and not to the receiver.

In the case of motors, they should be cut in close to the brushes. A wiring diagram is furnished with the device, so that its connection is easy and simple. The filter shown here can be used with equipment up to 5 horsepower, and is designed for house elevator motors, motor generator sets, and the like. The equipment is not enclosed in wax, but is entirely in the open so as to be properly cooled, and is enclosed in a ventilated metal case. The terminals are brought out to a bakelite strip, and cut-outs are provided in the bottom of the box for the leads.



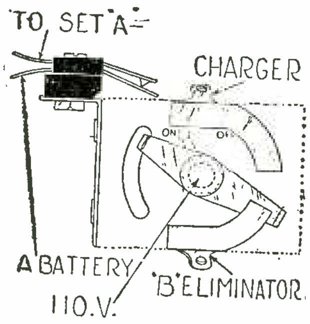
A front view of the radio intereference filter with the cover removed is shown above. The device is housed in a ventilated metal case.



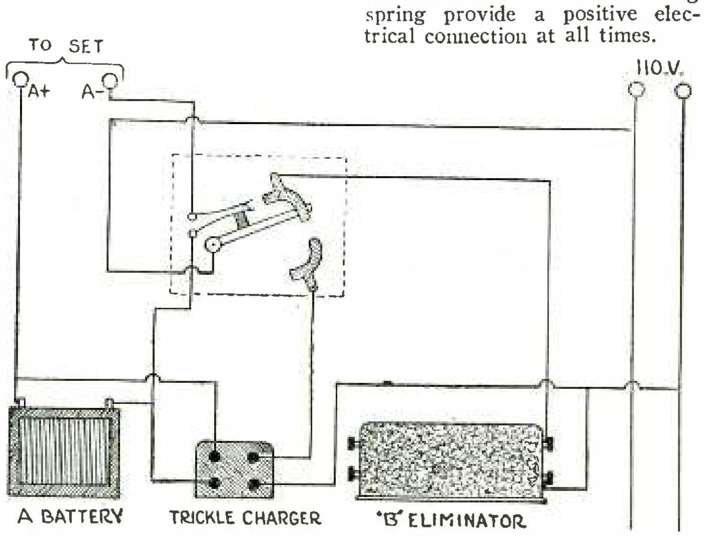
The wiring diagram of the radio interference filter is given above. The manufacturer of this device makes a small filter for use with equipment rated up to one-quarter horsepower, and a large filter to be used with motors and other appliances up to 5 horsepower at 220 volts. Five terminals are provided on the filter.

POWER SWITCH

A POWER SWITCH, designed to take the place of an automatic power control relay, has recently appeared on the market, and is a product of a well-known Chicago radio manufacturer. The switch is provided with two sets of contacts, so that the "B" eliminator and "A" battery are automatically turned off and the charger turned on. The metal frame of the switch is insulated from both terminals, so that it may be mounted on a metal panel without difficulty. The device is a snap switch of the latest quarter-turn construction and is very compact. An efficient double contact and strong spring provide a positive electrical connection at all times.



A rear view of the panel-mounting type power switch is shown above.



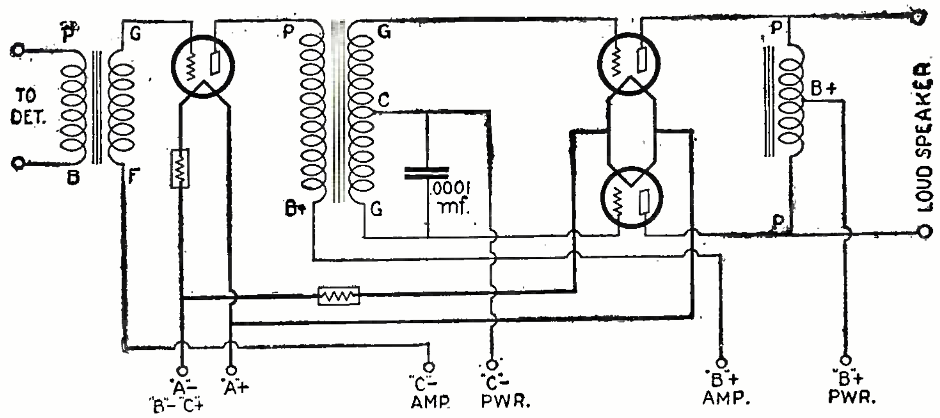
The wiring diagram of the 110 volt power switch is given above. It can be mounted on the panel of the set, and takes the place of an automatic relay.

(Names of manufacturers of parts supplied upon request.)

RADIO ORACLE

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

PUSH-PULL AMPLIFIER



The circuit diagram for a push-pull amplifier using Radiola III-A audio transformers appears above. A small unbalancing condenser having a capacity of about .0001 mf. is connected across one-half of the secondary of the push-pull input transformer.

(614) W. L. Prescott, Paragould, Arkansas, asks:

Q. 1. I have recently taken apart my Radiola III-A receiver and would like to know how to hook-up the audio transformers, so that I may make a separate amplifier for another receiver.

A. 1. You will find illustrated on this page a circuit diagram of an amplifier using the transformers mentioned above. An ordinary audio transformer, a push-pull input transformer and a push-pull output impedance are used in the Radiola amplifier. The output from the radio receiver is connected to the primary of the transformer used in the first audio stage. Self-adjusting filament ballasts are placed in the "A" negative lead, their size depending upon the type of tubes used in the amplifier. The center tap of the push-pull input transformer is connected to the "C—" power. A small fixed condenser having a capacity of .0001 to .00015 mf. is connected across one-half of the secondary of this transformer and prevents any tendency of the amplifier to "sing." The center tap of the push-pull output impedance is connected to the "B+" power. Power tubes of the 171 or 210 type should be used in the push-pull stage for best results. A 201A- or 112-type tube is used in the first audio. The "A—," "B—," and "C+" are connected together.

VOLUME CONTROL

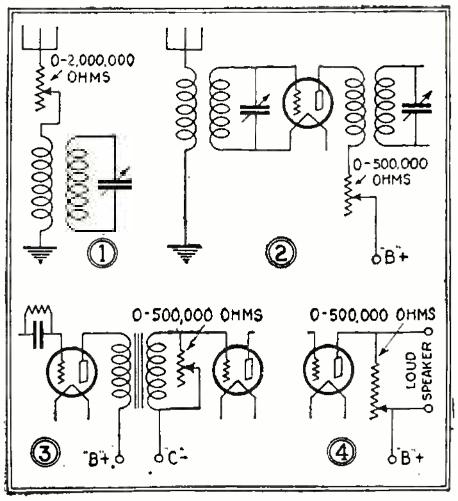
(615) H. W. Hillwell, New York City, asks:

Q. 1. Which method do you consider the best for controlling the volume in a radio set?

A. 1. The simplest volume control is a variable high resistor in the antenna lead, which serves to cut down the signal energy and is of real value, especially when intercepting powerful local signals. This is shown in Fig. 1. In some cases the resistor is shunted across the antenna and ground posts on the set. The resistors used for this purpose range from 0 to several million ohms in the case of the resistor placed in the antenna lead, which appears the better of the two arrangements. If we do not control the energy at the very entrance to the radio set, the next best point is to control it as soon as possible in the radio frequency stages. Here the best practice is to place a variable resistor in the "B" battery lead supplying current to the radio frequency tubes, as shown in Fig. 2. This resistor should be of the 0 to 500,000-ohm type. With a volume control in the plate circuit of the radio-frequency tubes, it is possible to use coils which will normally oscillate with 90 volts on the tubes, together with whatever stabilizing method is employed. Then, with variable plate voltage the receiver can be worked at its highest efficiency right at the verge of oscillation, and if desired it may be brought down to very low volume without considerable distortion. In this way, we combine both a sensitivity and volume control in one.

If the set is of the regenerative type, the regeneration is the most logical thing to control. In this case, a 0 to 500,000-ohm resistor shunted across the terminals of the tickler or feedback coil serves to control the volume. This is the most popular method of controlling regeneration and, at the same time, volume, especially in critical short-wave receivers.

The next point at which volume may be controlled successfully is at the secondary of the first transformer shown in Fig. 3. A resistor is placed across the secondary and serves both as a volume control and for matching the characteristics of the transformers used in the amplifier. In this way, a more uniform amplification curve may be obtained. In case of resistance coupling and impedance coupling, a potentiometer arrangement is more desirable, as a rule, but it is a good practice to shunt a variable resistor across the input of such an amplifier to by-pass more or less the energy delivered by the detector. The next and last place for controlling the volume of a receiver is to shunt a resistor capable of handling the plate current, across the load-speaker terminals. This method will be seen in Fig. 4.



The illustration above shows four methods of controlling the volume in radio receiving sets. The simplest volume control is a variable high resistor placed in series with the antenna lead.

From all standpoints, the use of a variable resistor in series with the antenna lead is probably the most satisfactory means for controlling the volume. Furthermore, this method controls the sensitivity as well as the volume and is of considerable value in this respect, since it is possible to prevent the detector tube from being overloaded by local high-power stations. Obviously, it is equally true that one or more variable resistors employed in the "B" power leads of the tuned-radio-frequency amplifiers will allow the volume and sensitivity to be altered in much the same way as a variable resistor in the antenna lead. but it is hardly as convenient a method as the latter, unless the variable resistors are employed for stabilization as well as volume control.

DYNAMOTORS

(616) J. B. Clinton, Brooklyn, New York, asks:

Q. 1. How may I obtain high voltage in the nature of 350 to 400 volts suitable for running a 210-type tube or a pair of these tubes in push-pull. The house lighting current supplied here is from a 110 volts direct current circuit.

A. 1. "B" eliminators can be constructed to operate on 110 volts direct current, but it is impossible to secure a higher voltage from such eliminators than the line voltage. It is impossible to step-up direct current through the use of a transformer, but it is sometimes possible to secure 220 volts D.C. from the 110-volt three-wire systems, by having the electric company approve installing a special line from the meter switch box to the radio set. This permits using a 220-volt D.C. eliminator which will deliver at least 180 volts and operate a 171-type power tube. The most efficient eliminators operate from alternating current. To use these eliminators at a location where the power lines are direct current, it is necessary to change the direct current to alternating curent. This can be best accomplished by using a dynamotor. The dynamotor is similar to a motor but has extra collector rings mounted at one end. One end of this device is a motor and the other end a generator. The dynamotor will run off the 110-volt direct-current lines and will deliver 110 volts, 60-cycle alternating current. This current can then be used to run the regular A.C. "B" eliminators. It is suggested that the dynamotor be located in the basement of the house and controlled from a remote-control switch at the receiver. These dynamotors come equipped or not equipped with filters. The filters should always be included when the dynamotor is used to operate radio devices. The dynamotor requires very little care but has to be oiled occasionally.

BALLAST TUBE

(617) R. Langweil, Owensboro, Kentucky, asks:

Q. 1. Can you tell me something about the operation of the 876-type line-voltage regulator or ballast tube?

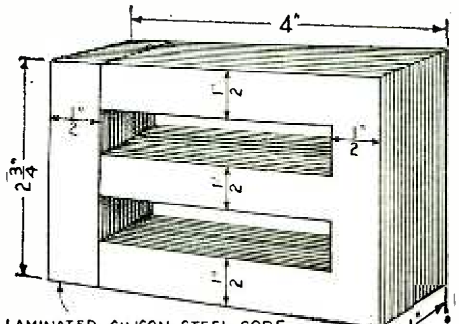
A. 1. The ballast tube is designed to regulate the input voltage across the primary of transformers used in "B" eliminators. The tube will pass 1.7 amperes at any applied voltage between 40 and 60 volts, and the load on the transformer secondary must be so adjusted as to bring the voltage on the tube to 50 volts at normal line voltage. If the line voltage averages 115 volts, the transformer, under load, should be designed to take 1.7 amperes at 65 volts, the remaining 50 volts being dropped in the ballast tube. If the line voltage drops or rises 10 volts, the voltage across the ballast tube will change accordingly, but the transformer primary voltage will remain constant at 65 volts. The tube requires several minutes to heat up and the voltage drop increases rapidly for the first three minutes and then slowly up to about 10 minutes, by which time the tube has reached its final temperature. The voltage will remain constant thereafter, as long as the device is in operation.

"A" ELIMINATOR CHOKE

(618) J. S. Nichols, Elizabeth City, North Carolina, writes:

Q. 1. Will you please publish constructional data for a ¼-henry choke coil capable of passing 2 amperes to be used with an "A" eliminator?

A. 1. On this page you will find illustrated the design of the steel core used. All dimensions have been marked on the illustration. The winding which is wound on the middle leg consists of 360 turns of No. 16, D.C.C. wire. The center leg of the core should first be taped and the winding put over this. The core is made of silicon steel .014-inch thick. Seventy-one rectangular laminations and 71 W-shaped laminations are necessary for the core. The core should be suitably clamped together after the choke coil is finished.



The construction details of a ¼-henry choke coil suitable for "A" eliminator work are given in the above illustration.

Scientific Humor

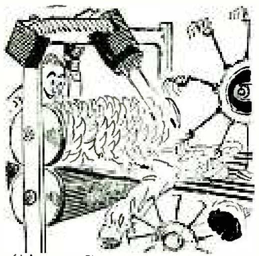
MANY LIKE THIS

JONES: "I don't care much for a radio."
SMITH: "No, neither do I; my home-made outfit wouldn't work either!"
—*Mont Hurst.*

ONLY A SAMPLE

BOXING INSTRUCTOR: "That was what is called a half-hook."
FRESH FRED (rubbing his jaw): "Well, you can keep the other half!"
—*Henry A. Courtney.*

THEIR REPUTATION'S AT STAKE



"Why is it that Jones, the shirt-maker, and Smith, the laundryman, do not speak when they meet?"
"Well, you know Jones advertised a new, indestructable shirt?"
"Yes."
"And Smith immediately installed more powerful machinery in his laundry."
—*Stanley Stanbery.*

ONE WAY TO DO IT

ENGINEER: Why build a one tube radio in a four foot cabinet?
ASSISTANT: To avoid short circuits.
—*Leslie Carpenter.*

FEETS IN ENGINEERING

ATTORNEY: You say that the officer awakened the defendant by whacking him across the soles of his feet with a night-stick?
WITNESS: Yes, he was giving him about three foot-pounds per second.
—*Gleason Pease.*

ALSO A PAIR OF HOSE

HIRAM: "Last summer it was so dry that I had to walk all over my farm to keep the crops from dying of drouth."
ALEX: "I don't see how you created any moisture by merely walking over the ground."
HIRAM: "I wore a pair of pumps."
—*Stanley Stanbery.*

IN EYE—OPTIMISM

"I have rheumatism in my hip very bad!"
"Sure it ain't 'hypnotism'?"
—*William Lemkin.*

HOW TO GET A DRINK
FIRST PRIZE, $3.00

Order the following from your grocer:
1 bottle BEEF IRON AND WINE.
1 bottle EXTRACT OF BEEF.
I can RUST REMOVER.

Directions:
Drink BEEF IRON AND WINE, then drink EXTRACT OF BEEF. This eliminates BEEF, leaving IRON AND WINE. GIVE IRON TIME TO RUST, THEN DRINK RUST REMOVER, leaving only wine.
Note: If it doesn't agree with you, use it for Auto Polish.
—*Leslie Carpenter.*

GOING UP

BILL: "Did you see the fire at the circus?
JIM: "No, was it bad?"
BILL: "Yes, the heat was in tents (intense.)—*Jerome Lang, Rep. No.* 34,402.

ALL jokes published here are paid for at a rate of $1.00 *each;* $3.00 *is paid for the best joke submitted each month.*
Jokes must have a scientific strain and should be original.
Write each joke on a separate sheet of paper and add your name and address to each.
Unavailable material cannot be returned.

SH-H-H-H

SAM: "How's the milkmaid?"
HAM: "That's a trade secret."
—*Marguerite Ray.*

VERY GENERAL SCIENCE

TEACHER: What is pasteurization?
STUDENT: Where they paralyze milk to kill the germs.—*E. F. Barney.*

THREE IN ONE

"Please use the word 'avaunt' in a sentence, so that I can learn what it means."
OLE OLSON: "Avaunt vat avaunt ven avaunt it."
—*Earle Bennett.*

ACOUSTIC INCONVENIENCES

SHE: "No, let's not go to that theater."
HE: "Why, dear?"
SHE: "Oh, the acoustics are too good. Everyone within ten rows of us will hear you when you insist on holding my hand!"
—*Henry A. Courtney.*

YES—WE HAVE ONE

"How does your new cigarette lighter work?"
"Fine, I can light it with one match now."—*Adolph F. Lonk.*

SOON BE NONE

RAH: "There's many a slip 'twixt the cup and the lip."
HURRAH: "Yes? There's only ONE today between the skin and the outside dress!"
—*Henry A. Courtney.*

NOT A VERY WEIGHTY JOKE!

"Goodness! Isn't my music case light," muttered Prof. B. Sharp.
"That is because it contains light fantasies," answered the "light" headed one.
—*Gerald E. H. Hurdle.*

SOME DRIVE

HE: "Is that bad tooth making you nervous, dear?"
SHE: "Yes, its driving me to extraction."
—*H. P. Sedgwick.*

NEW USES

MRS.: What are you going to do with that porous plaster,
MR.: I am going to see what tune it will play on the player piano. — *Stanley Stanbery.*

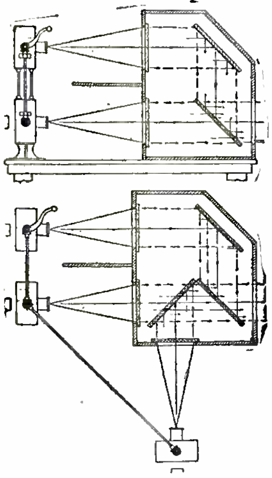
ROCKED IN THE CRADLE OF THE DEEP

NAN: Ever hear of Petrified Bed Clothes?
NATE: Sure Sheetrock.
—*L. F. Carpenter.*

SCIENTY SIMON, Scientist

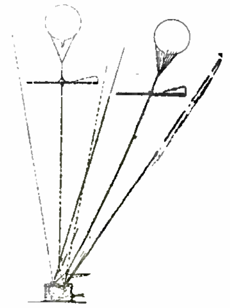
Latest Patents

EXHIBITING MOVING PICTURES



No. 1,636,834, issued to Thomas K. Peters and Thomas C. Bartlam. This invention pertains to the art of exhibiting moving-pictures wherein the pictures appear in three dimensions. There is an appreciable distance between the foreground and the background of the picture. Only one of the screens is normally exposed to view, the other being concealed.

NIGHT AERIAL ADVERTISING



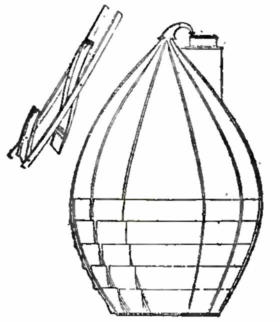
No. 1,652,996, issued to Luis Azarraga. The object of this machine is to provide a sign which can be held aloft by a captive balloon, and further be continuously illuminated at night. The balloon is free to swing in any direction and is fastened to a tether line.

TALKING MACHINE

No. 1,633,745, issued to Isaak Jacobsohn. The talking machine shown above uses a record which is composed of an endless flexible steel band, having on its edge a magnified reproduction of the sound waves. The band is strung over pulleys and is moved under the sound reproducing needle. By this arrangement a record of considerable length can be employed.

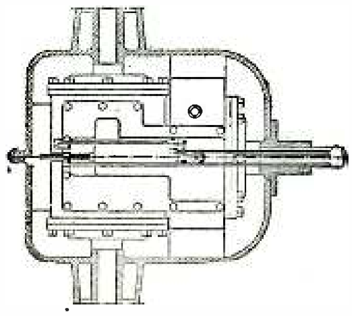
SOUND DIRECTOR

No. 1,647,439, issued to Walter S. Dickson. The sound director shown below consists of a shell having an enlarged center and reducing ends provided with a number of pivoted shutters used to exhaust the sound.



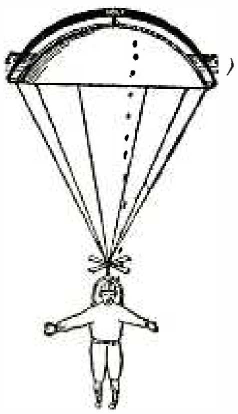
FLUID PRESSURE TRANSMISSION

No. 1,615,341, issued to Leland Stanford Murray. The principal object of this device is to provide a unitary structure which will take the place of the usual clutch, change speed gearing, or transmission and service brakes. The casing is filled with oil or other liquid.

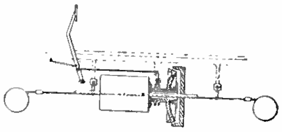


TOY

No. 1,639,550, issued to Frederick C. Bender. This invention consists of a toy to be used in water, the same being so constructed to simulate the action of a parachute jumper. It is so constructed as to raise and lower itself automatically.

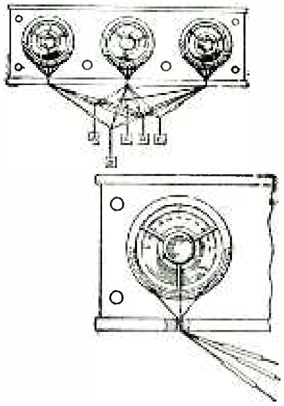


AUTOMOBILE BRAKE MECHANISM



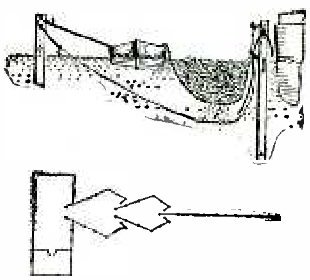
No. 1,644,671, issued to Emilio Garcia. The brake mechanism shown here is under the control of the driver at all times and utilizes the rotation of the propeller shaft to powerfully apply the brakes, with but little effort upon the part of the driver. The preferred design of the invention is shown in the above illustration.

METHOD FOR TUNING RADIO RECEIVERS



No. 1,638,734, issued to Wilfred Paul Heath. The object of this invention is to provide a means for tuning all the dials on a receiving set simultaneously to a certain wave. A number of flexible cables are attached to the dials and may be adapted to any ordinary receiver. A number of tabs are provided for different wavelengths and are simply pulled downwardly to rotate the dials.

METHOD OF REMOVING FISH SCALES



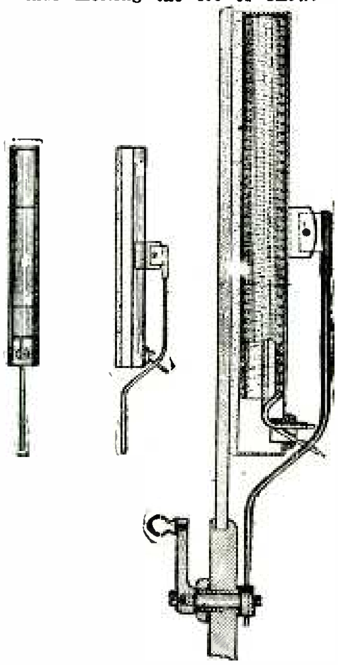
No. 1,640,990, issued to George H. Hinton and Thomas W. Marsh. This method of collecting scales from live fish consists in trapping the fish in a net and permitting the tides to wash through, thereby confining the fish in a small space and rubbing them together. A fine net is employed under the trap net in order to catch the fish-scales.

THERAPEUTICAL INSTRUMENT

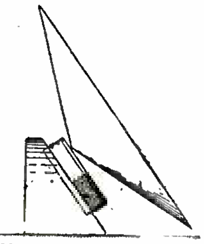
No. 1,653,901, issued to Leo J. Haessly. The instrument shown here has a handle on one side and an electric heater mounted on its bottom. A pad of absorbent material can be affixed to the instrument.

GLASS WIPER

No. 1,636,916, issued to Julius H. Lehman. The glass wiper shown below comprises a U-shaped housing, in the edges of which an electric heating unit is mounted, so as to radiate heat against the glass, thus melting the ice or snow.

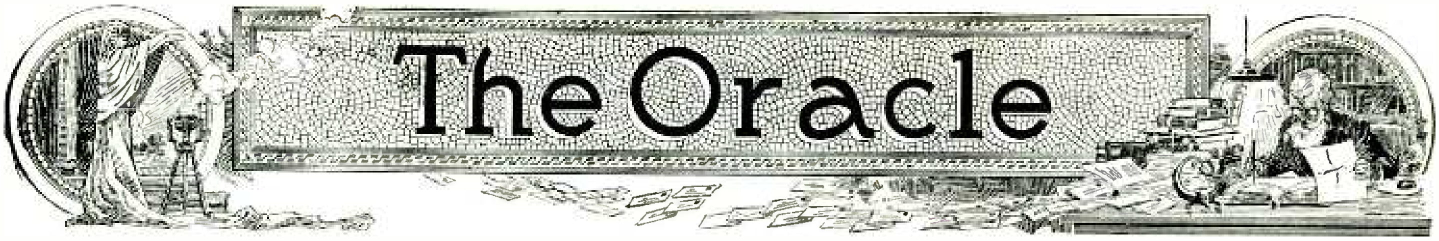


PIEZO-ELECTRIC LOUD SPEAKER



No. 1,574,302, issued to Alexander M. Nicolson. The invention shown here consists of a piezo-electric crystal and means for transmitting the elastic vibrations of the crystal to a diaphragm. A tube of water for moistening the crystal is also provided.

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



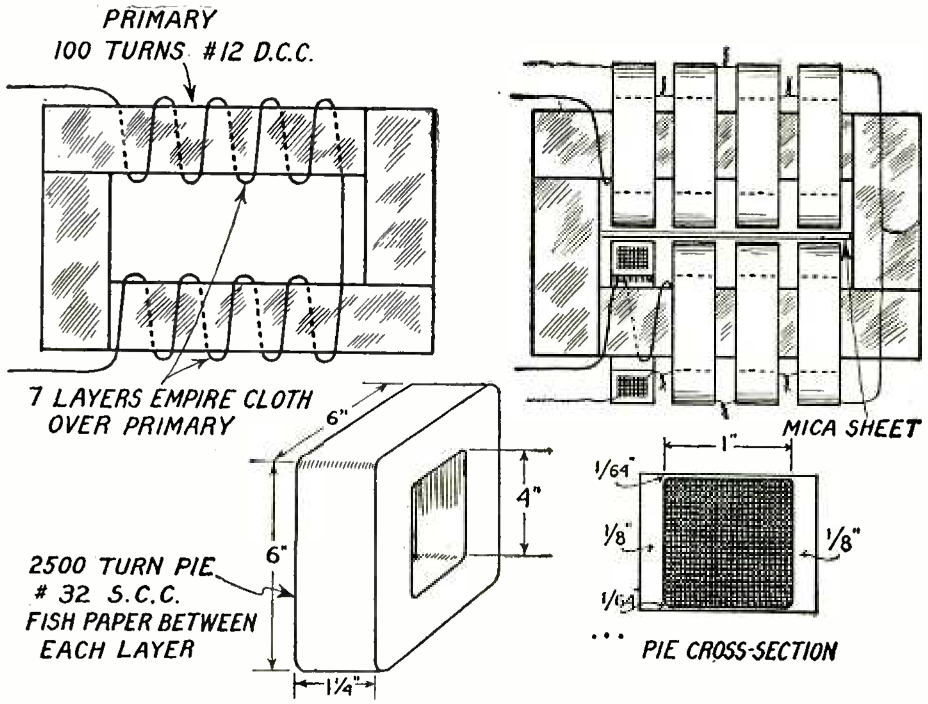
The "Oracle" is for the sole benefit of all scientific students. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 50 cents is made for each question. If the questions entail considerable research work or intricate calculation, a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

HIGH VOLTAGE TRANSFORMER

(2243) E. A. Rathbun, St. Paul, Minn., asks:

Q. 1. Will you kindly publish the necessary information for the construction of a 20,000 volt transformer suitable for use with a Tesla or Oudin coil?

A. 1. On this page you will find an illustration showing the construction of the transformer mentioned above. The core, which is made of sheet silicon steel, measures 14 inches long, 8¾ inches wide, and 2½ inches thick. Each lamination is 1/32 of an inch thick, and 160 laminations, 11½ inches by 2½ inches and an equal number of laminations, 5½ inches by 2½ inches will be necessary in order to construct the core. The primary winding consists of 100 turns of No. 12 D.C.C. wire, and is wound on the core as shown. The core should first be wound with tape before winding the primary. Seven layers of empire cloth are wound over the primary and the secondary sections are then slipped over this. Each pie consists of 2,500 turns of No. 32 S.C.C. wire with fish paper placed between each layer. The completed pie measures 6 inches square, and has a window 4 inches square, in its center. The dimensions and also a cross-sectional view of these pies are shown in the drawing. Four of these pies are slipped over each leg and are connected in series. A sheet of mica is placed in the center of the transformer between the secondaries as shown. The finished transformer will deliver a high voltage in the nature of 20,000 volts and is rated at 2 K.V.A.



The above illustration shows various details in the construction of the 20,000 volt transformer. The secondary consists of eight sections, each one having 2,500 turns of No. 32 S.C.C. wire.

SWITCHING ARRANGEMENTS

((44) H. Pulasky, Best, Texas, writes:

Q. 1. Will you kindly publish diagrams showing how it is possible to control lights from two or more different points, so that they may be turned on or off from either switch. Will you also print a diagram showing how the porch light may be controlled from the living room, garage, or hall?

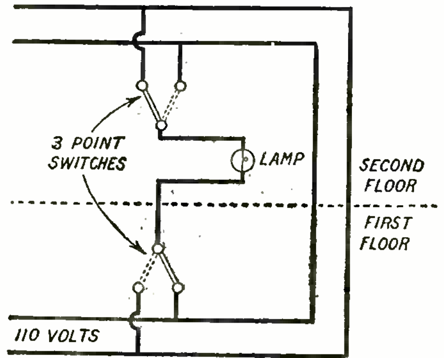
A. 1. You will find illustrated on this page, three methods showing the use of three- and four-point switches as asked for above. Three-point and four-point switches are used quite extensively in controlling lights from two or more different points, regardless of the position of the other switches. For two points of control, such as stairway control, three-point switches are commonly used as shown in Fig. 2. Fig. 1 shows how a light may be controlled, either from the first or second floor, by the use of two three-point switches. Any number of points of control may be added by connecting four-point switches between the three-point switches, as shown in Fig. 3. Three-point switches cannot be used anywhere, except on the end position for independent control, but as many four-point switches as desired may be used for the intermediate positions. In connecting a number of four-point switches between two three-point switches, it will be necessary to cross-connect at each switch one of the two wires passing through all the switches.

CLEANING MARBLE

2245) E. W. Goldman, Sioux City, Iowa, asks:

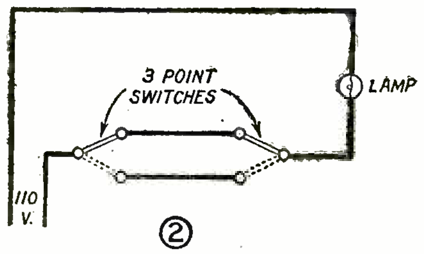
Q. 1. Can you give me a formula for a cleanser which will effectively remove copper and bronze stains from marble?

A. 1. Copper or bronze stains may be removed by using the following mixture: Mix together 1 part of ammonium chloride (sal ammoniac) and 4 parts of powdered talc. Add ammonia water and stir until a paste is obtained. Place this over the stain and leave until dry. When working on polished marble, use a wooden paddle to scrape off the poultice, but on a dull finish a trowel may be used. A stain of this kind that has been collecting for several years may require several repetitions of this procedure to completely remove it. Sometimes aluminum chloride is employed in the above procedure instead of ammonium chloride. Another solution which has been found to be an effective eradicator of these stains is the following: Dissolve 8 ounces of potassium cyanide (a strong poison) in 1 gallon of water. Saturate a thick white cloth in the solution and place it over the copper stain. When the cloth has become dry, soak it again in the cyanide solution and repeat the operation until the stain disappears. Sometimes it may be advantageous to combine this and the method above; that is, remove the greater part of the stain with the ammonium chloride and talc paste and finish with the cyanide solution. This solution is virulently poisonous. Such stains are found on marble bases of bronze statuary, or other places where the wash from bronze, copper or brass runs over the marble. These stains of copper or bronze are nearly always green, being due to the formation of copper carbonate, but bronze work apparently causes a brown stain in some cases. Further information on this subject may be found in the technologic paper No. 350 of the U. S. Bureau of Standards, which is entitled, "A Study of Problems Relating to the Maintenance of Interior Marble. Potassium cyanide is a virulent poison—be careful in using it.



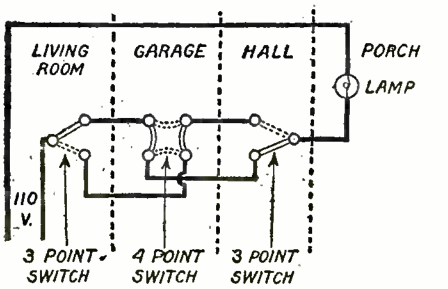
①

The use of two three-point switches is shown above. It will be seen on following out the diagram that the lamp can be lighted from either of two separated points.



②

Two three-point switches connected as shown above can be used for turning a light on and off from two different locations. For two points of control, such as stairway control, three-point switches are commonly used as shown above in Fig. 2.



③

Any number of points of control may be added by connecting four-point switches between the two three-point switches, as shown above in Fig. 3 for garage use.

MOTOR HINTS

CONDUCTED BY GEORGE H. LUERS

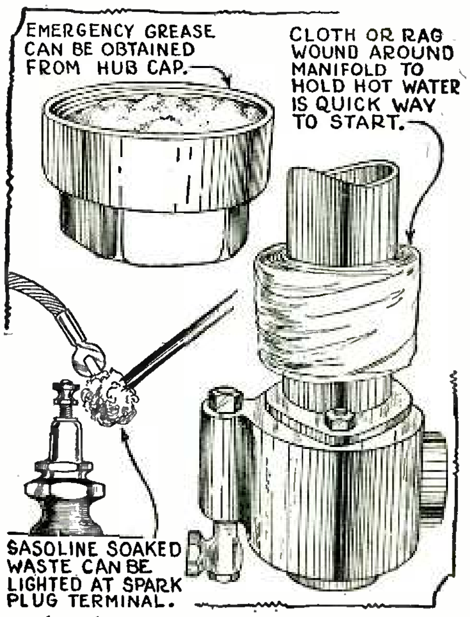
(*Continued from page* 1101)

(a) Spare grease may be obtained from the supply in hub caps.

(b) A rag or towel around the cold manifold or carburetor with boiling water poured upon it is the surest way to start the cold engine.

(c) A piece of gasoline soaked waste can be lighted from the spark plug terminal by detaching the terminal and holding this about one fourth of an inch away, while the engine is running.

(d) When lights flare up suddenly, look for a loose battery ground wire, as this is the most frequent source of trouble.



Emergency grease can be obtained from the hub cap. A cloth wrapped around the manifold, with boiling water poured upon it, will help to start a cold engine. Gasoline soaked waste can be lighted from the spark plug terminal, by detaching the wire as shown.

(e) Telephone and telegraph wires, lead to large towns. When in doubt as to roads, follow these.

(f) A spare lamp bulb and a fan belt should be part of the equipment.

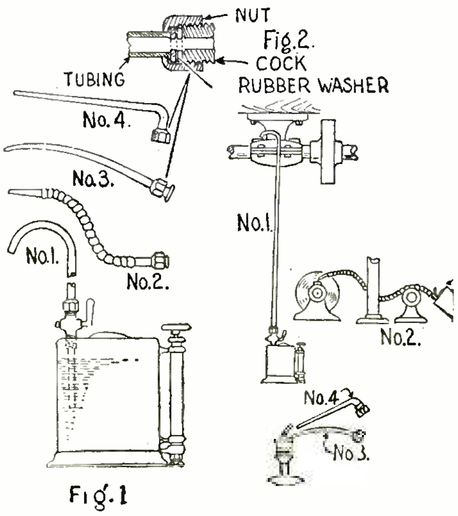
(g) A wooden plank, one inch by four inches by three feet and a block two inches by four inches by one foot, will stow away under the seat. These serve as base for the jack, can be used to block up an axle or are useful to hold up a broken spring.

Hints for the Mechanic

Mechanics' needs have caused us to start this new department—"Hints for the Mechanic," in which we intend to publish wrinkles useful to mechanics in general. You can help us with this department by writing a brief description of your favorite shop wrinkle and sending this to the editor of this department, together with a pencil or pen and ink sketch of the wrinkle. The ideas published herewith will give you some idea of what we want. Our draughtsmen will make the necessary mechanical drawings, so you need not send us finished drawings. We will pay $10.00 each month for the best Wrinkle or Hint sent in; others published will be paid for at space rates. Address all letters to Editor, Hints for the Mechanic Department, in care of this magazine.

FIRST PRIZE—$10.00

PRESSURE OILER

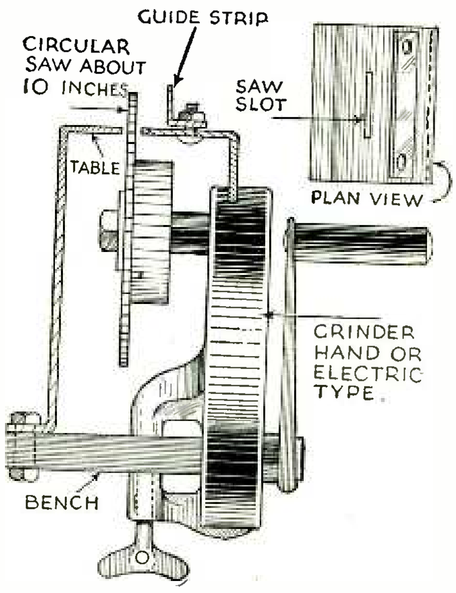


The above drawing gives the details of the pressure oiler, and also shows various shaped spouts which can be used with this ingenious device. The spouts are removable.

A PRESSURE oiler for lubricating out-of-the-way positions can be made as shown in the above illustration. The oil tank is obtained from a blow torch and is fitted with a valve, so that the flow of oil can be regulated. A number of different types of spouts will be necessary for oiling various inaccessible places. The types of spouts and their uses are shown in the illustration.—*Contributor, send name and address.*

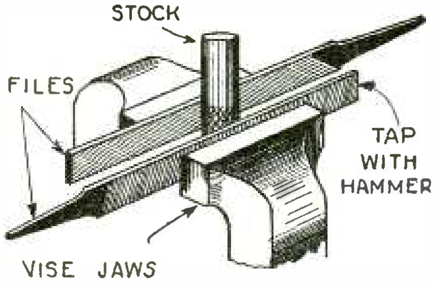
BENCH SAW

THE sawing of light wood may be readily accomplished by using a circular saw blade attached to the grinder spindle of the usual type of hand bench grinder. The saw blade is bolted against the grinding wheel, or a heavy pulley can be used to replace the wheel. A sheet metal table is provided above the saw.—*G. A. Luers.*



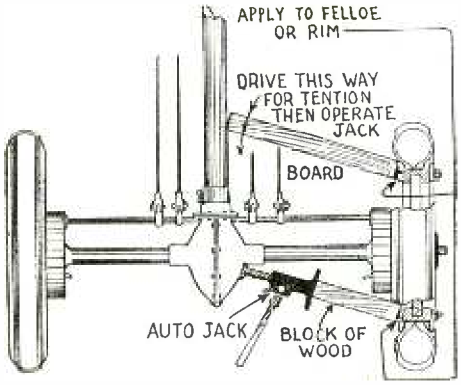
A small circular saw can be attached to the bench grinder as shown above. A saw about 10" or so will facilitate light sawing. Details of a sheet metal table top are also shown.

KNURLING WITH A VISE



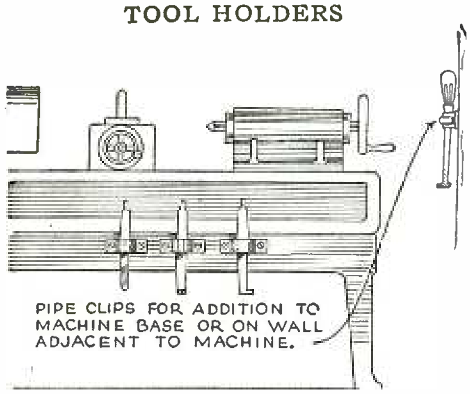
A SIMPLE and efficient means of knurling can be accomplished as shown above. The work or stock is clamped between two milling files, a moderate pressure is applied and the end of one of the files is tapped carefully, so that the work rolls between the two files. Both files must be parallel and the work must be placed at right angles to them. The tangs of the files are placed at opposite ends.—*H. Pelder.*

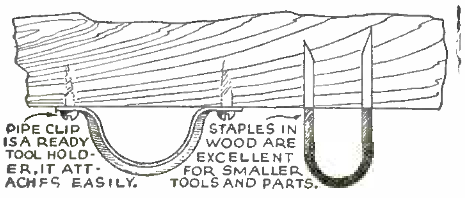
REMOVING AUTO WHEELS



AUTOMOBILE wheels which have become stuck and cannot be removed can be loosened as shown above. A board is wedged for the proper tension and a jack and another block of wood are placed as shown. The wooden boards are applied to the felloe or rim.—*Contributor, send name and address.*

TOOL HOLDERS





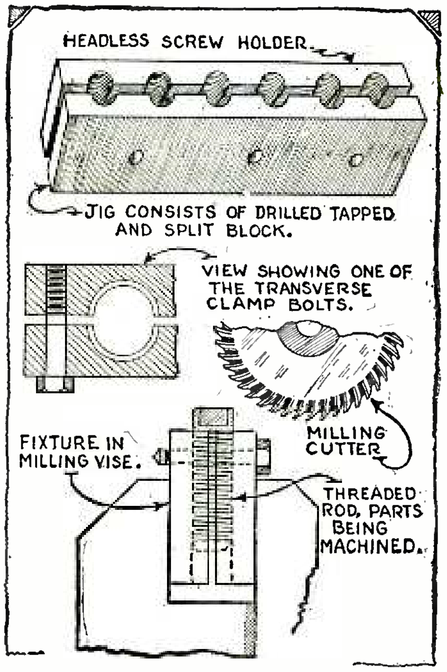
ORDINARY light sheet iron pipe clips secured to the wall behind the machine or on the machine stand, provide perfect hangers for all kinds of tools. The clips are obtainable in various sizes. Ordinary wire staples will provide excellent hangers for small tools such as reamers, taps and drills. —*G. L.*

HINTS FOR THE MECHANIC

(*Continued from page* 1125)

HOLDING HEADLESS SCREWS

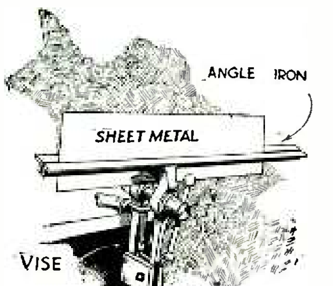
A SIMPLE jig, such as that shown in the sketch below, provides a means for holding headless set screws while they are being machined. A block is tapped for holding six or eight screws, and is then drilled and tapped transversely for dowel screws. To use the jig, the transverse screws are loosened, the threaded rods placed in it, and the screws tightened. The device will prove useful for holding threaded rods.—*G. A. Luers.*



The above drawing shows a jig for holding headless set screws for machining. A block is tapped out for holding six or eight screws.

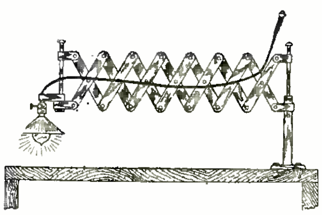
BENDING SHEET METAL

LARGE sheets of metal can be neatly bent by using two pieces of angle iron as shown in the illustration. The pieces of iron are placed in the vise and the sheet of metal between them. This holds it firmly throughout its entire length and the upper portion can be bent over and pounded down with a wooden mallet. Large sheet of metal may be bent perfectly straight when using this kink.—*Harold Jackson.*



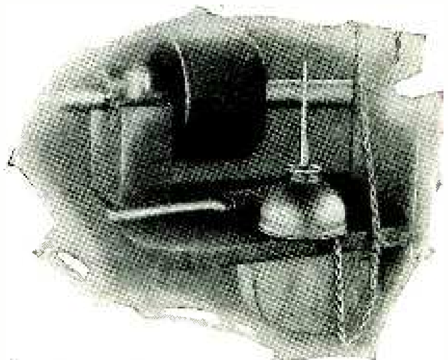
EXTENSION LIGHT

A telephone extension bracket serves admirably as a support for the electric light. The illustration shows how it is done. Contributor send name and address.



OIL CAN KINK

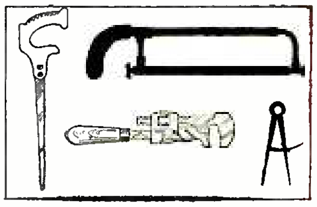
IF the shop oil can is soldered to a light chain as shown, it will never become lost and will not be injured by falling on the floor. The chain is just short enough to keep the can off the floor.—*Wm. J. Douglass.*



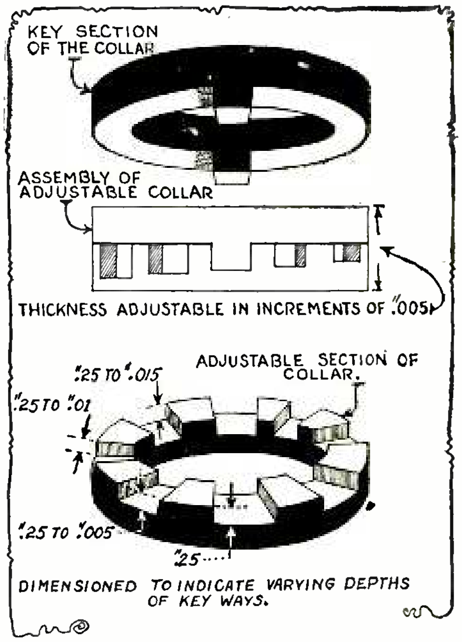
The above photo shows the oil can soldered to a chain. This proves to be a great time and trouble saver.

TOOL SUPPORT HINT

A NOVEL idea which will save much annoyance consists in painting the outline of the tool on the board or wall where it is hung. The tool is first hung up and its outline marked on the wall with a pencil. This outline may then be filled in with paint of any color desirable, and the tools will then always be hung in their correct position.—*Contributor, please send name and address.*



ADJUSTABLE COLLAR



THE collar shown above can be made cheaply and quickly, and will do away with the use of thin shims. The collar can be made in size to be adjustable to any fractional part of an inch and for use with any piece of machinery. It consists of two parts. One part is made with two keys and the other with key seats of varying depth.—*G. A. Luers.*

An All Electric-Six

(Continued from page 1115)

a 280 type tube for full-wave rectification. Various plate voltages are obtained from taps on a resistor which is connected across the output of the filter. The grid bias for the various tubes is obtained from the drop across the resistance in the plate circuit of the tubes. Two independent tests are made on the sensitivity of the receiver before it is shipped. Any slight error in a component is discovered during the tests before the receiver leaves the factory, and thus, it can be sent back to the repair bench for final adjustment. The method of preventing oscillation is one which does not affect the selectivity of the receiver once it is properly adjusted. Tuning is surprisingly sharp, even for congested city districts.

It is a false impression that to possess a modern radio receiver, combining fidelity of reproduction and artistic merit, one must spend a large sum of money. This is not necessarily true, since many radio set makers have now produced smooth-working electrified receivers, and housed them in rich looking cabinets, all at a moderate price.

FROM STATION STYX

(A Radio Program with an All-Star Cast of Artists.)

10:00 A. M.—Violin Solo—"Roman Fire Dance"—*Nero.*

10:30 A. M.—Chafing Dish—"Recipes for the Unwelcome Guest"—*Lucrezia Borgia.*

11:15 A.M.—"How to Make a Fountain of Youth in Your Own Back Yard—*Ponce de Leon.*

12:00 Noon—"Those Waterloo-Loo-Loo Blues—*Napoleon's Old Guard Band.*

1:00 P. M.—Educational Series—"Easy Lessons in Beginner's Latin"—*Julius Caesar.*

1:30 P.M.—"How Ten Can Live as Cheaply as One"—*Brigham Young.*

2:15 P. M.—First Aid Talk—"What to do When Hit by an Apple"—*Sir Isaac Newton.*

3:00 P. M.—Tenor Solo—"Starboard Watch"—*Admiral Christopher Columbus.*

3:15 P. M.—Address to the Gladiators—Spartacus (by request).

3:45 P. M.—Old English Folk Song—"O, Come With Me and Be My Love"—*Henry VIII and Chorus of Wives.*

4:30 P. M.—Joshua's Trumpeters in a Medley of airs that brought down the house at Jericho.

5:15 P. M.—Domestic Science Talk—"Bread vs. Cake"—*Marie Antoinette.*

6:00 P. M.—Weather Reports—*Noah.*

7:30 P. M.—London Tower Bed-time Stories—*Richard III.*

8:30 P. M.—Joymaker's Jazz Quartet—Beethoven, Bach, Brahms and Wagner in popular dance music.

—*Alma Severeid.*

Radio Wrinkles Wanted!

The Radio Editor, Mr. Paul E. Welker, wants to hear from you, if you have a good idea or wrinkle. Make a pencil or pen and ink sketch of the contrivance, write 50 words or so of description, and mail to the Radio Editor, c/o this magazine.

ANSWER TO SCIENTIFIC PROBLEMS AND PUZZLES

(Continued from page 1102)

THE SUBMERGED BALLOON

THERE are several points to be remembered in considering this puzzle.

1. Water produces a pressure at each point on the balloon that is proportional to the depth at that point.

2. The tension on the balloon produces an inward or central pressure that depends upon the curvature, i.e., the shorter the radius of curvature the greater the central pressure.

3. The pressure of the air inside the balloon must be everywhere the same and yet equal at every point to the sum of the pressure due to tension and to the water.

From these three points we see that at the bottom of the balloon, B, where the water pressure is greatest the pressure due to tension must be least, while at the top, at A, the pressure due to tension must be greatest. But since the balloon is flexible the tension must be the same. Hence, the only way this situation can exist is to have the balloon assume a somewhat egg-shaped form at the top and the broader end at the bottom. Air bubbles must take on something of this shape when they are rising to the surface of water though their form is probably also modified by their motion through the liquid.

THE WEIGHT OF A MOVING CAR

As far as the pull of gravity is concerned there is no reason to suppose that a car in motion on level ground would weigh either more or less than it does when standing still. Atmospheric pressure might make some difference, which would probably tend to lift the car slightly. The reason for this is to be found in the fact that a moving stream of air exerts less side pressure than air that is still. Now, when a car is standing still the upward and downward pressure of the atmosphere would be equal, but when it is in motion it is probable that that air does not pass under the car as rapidly as it does over the top. Hence, the downward pressure would be reduced more than the upward pressure and the result would be a lifting effect which would depend considerably on the shape and build of the car and the speed at which it was being driven.

The apparent lifting effect, one experiences when driving rapidly is probably more fancied than real, however, as the actual lifting effect would in most cases be too slight to be noticed.

THE PAPER SAW

If a sheet of writing paper be cut in the form of a circle and rotated rapidly like a circular saw, it may be used to cut thin pieces of wood. The centrifugal force of rotation gives the paper a surprising rigidity.

THE BATTLESHIP

The static friction of water or any true liquid is zero. By this we mean that a liquid offers no resistance to the motion of a body within it, until the body was actually in motion. Thus the slightest force applied to a freely-floating body, even one as large as a battleship, would be sufficient to displace it a little. Of course, any force that a silk thread would stand would be slight, and it would be a long time before its effect on a battleship would be noticeable.

THE MIRRORS

An image in a plane mirror appears to be as far behind the reflecting surface as the object is in front of it. When the person is at the middle of the room, at O in the diagram, the images A and B would each appear to be at a distance behind the mirrors that is equal to half the length of the room. Thus the images would be twice the length of the room from each other. Now if the person approaches, say one foot nearer one of the mirrors, the image will recede by the same amount. Hence, the distance between the two images is constant and equal to twice the length of the room, regardless of the position of the individual.

THE FLATIRONS

The power that an electrical appliance such as a flatiron draws is proportional to the product of the current passing through it by the applied voltage. Letting P stand for the power in watts, E the voltage in volts, I the current in amperes, and R the resistance in ohms, we have the equation:

$$P = E \times I = \frac{E^2}{R}$$

And since the power taken by each device is the same, we have:

$$\frac{220^2}{R} = \frac{110^2}{R_1} \text{ or } \frac{R}{R_1} = \frac{(2 \times 110)^2}{110^2} = \frac{4}{1}$$

Thus it appears that the resistance R of the 220-volt appliance is four times as great as R_1 the resistance of the 110-volt iron.

THE SAILBOAT

When a breeze strikes the sail of a boat the molecules of which the air is composed exert a force on the sail first in the direction, AB, in which they are moving, and second, on recoil, in a direction opposite to that in which they bound away, i.e., opposite to BC. The effect of these two forces is to produce a pressure, BF, at right angles to the sail. Hence, that is the direction in which the boat would tend to move. Of course if the pressure were not uniform over the sail or if the sail were not exactly symmetrical with respect to the hull under water there would be a tendency to rotate the boat one way or the other.

WILL A FAN KEEP ICE CREAM FROM MELTING?

Ice cream melts by absorbing heat from the surrounding air. As the air near it is cooled it descends and is soon replaced by warmer air from above. The faster this interchange of air takes place the faster the cream will melt, hence, a fan would certainly hasten this process. The person eating this ice cream would probably find his body was being cooled by the same process that helped to melt the ice cream. His body is, if anything, a little warmer than the surrounding air and easily affords the heat necessary to evaporate some of the moisture on his skin. Hence, his body is cooled by the process of evaporation. But the ice cream is much cooler than the surrounding air and so the heat that produces any evaporation of the cream must come sooner or later from the air.

UNSINKABLE BOAT

Besides being unsinkable, a new lifeboat is reversible, self-emptying and uncapsizable. It is built like two broad punts placed bottom to bottom. If it were possible to overturn the boat there would be another exactly similar in its place. But the power of suction under the boat is so great that it prevents it overturning under almost any conditions. In the bottom of each boat are two non-return valves which let out water. Tanks of fresh water and food at each end can be reached whichever side is uppermost.

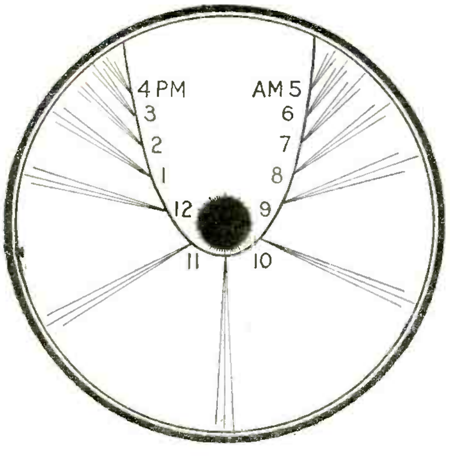
COMETS

By W. J. LUYTEN

(Continued from page 1095)

work to calculate, to the utmost precision, the influences exerted upon the comet by the heavy planets in our system, Jupiter and Saturn especially. They found that Jupiter would hold back the comet for 500 days, and Saturn would add another 100, so that the comet should not be expected much before 1759. And to be sure, on Christmas Eve, 1758 the comet was first picked up by a farmer in Saxony, it came closest to the sun on March 12, 1759 not more than a few weeks different from the prediction.

The next return was observed in 1835, and the most recent one in 1910. At this last appearance, it was a disappointment for observers in the northern hemisphere, it was a small, faint, hazy object, not worthy of its name. In the tropics, however, it afforded a spectacle so magnificent that it will not easily be forgotten by those who saw it. When it appeared in the morning sky, it stood there as a great fiery signal, as a broom which had swept the whole heavens clean. All the stars seemed dimmed



The great comet of 1843. On Feb. 27, 1843 it passed to within 100,000 miles of the sun's surface. Its speed was then 1½ million miles per hour, and it had a tail over 200 million miles long. The diagram shows the path of the comet from 5 a. m. until 4 p. m. on Feb. 27, 1843.

in significance, only Venus and the thin crescent of the old moon were at all noticeable alongside the splendor of this great object, the tail of which reached from the horizon almost to the zenith, pointing straight up in the sky, as if it were a herald of the oncoming dawn. Its next return will not be before 1985 or 1986, still long enough away not to pay too much attention to it.

OTHER FAMOUS COMETS

OTHER famous comets were the great comet of 1843, which marked the beginning of the Harvard College Observatory in this country, Donati's comet of 1858 and the enormous comet of 1883. In recent years, although many comets have been discovered, no single object has reached a state where it was easily visible to the naked eye. Perhaps the best known of all recent comets is Delavan's which appeared in 1913-1914 and was blamed for the World War, it remained just visible to the naked eye for several months.

DISCOVERING COMETS

WHEN we say that a great many comets have been discovered in recent years the reader may perhaps think that this is

COMETS

(Continued from previous page)

due to our recent powerful telescopes. Strangely enough, this is not the case; the very large instruments have contributed very little to our total number of discoveries of comets. What one needs to discover comets with is firstly: luck and secondly a small but very efficient telescope, with which one sweeps across the sky, and which must show faint objects and have a large field of vision. A large number of the recent discoveries were therefore made by amateurs. The late Joel Metcalf, who has been particularly successful in this branch of astronomy, once had the good fortune to find three new comets in 48 hours. Few, however, have been as lucky as Perrine at Lick Observatory. A cable in cipher had been received announcing the discovery of a new comet, but an error had crept in to the deciphering. Perrine did not know this and pointed his telescope to the wrong position but lo, and behold he saw a comet, a new one, entirely different from the one he was looking for. A similar event occurred at the Van Vleck observatory quite recently. Stearns who was observing distances of stars with the large photographic telescope had just set on a particular star, looked in the finder, and saw a bright new comet.

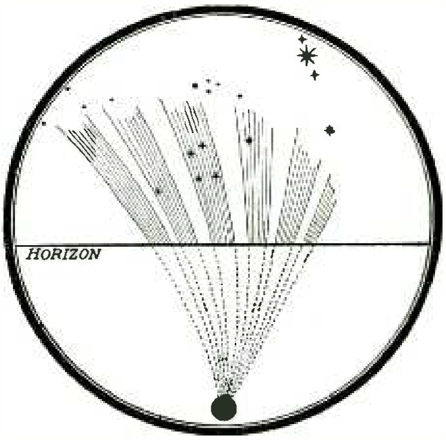
Nowadays when a comet is discovered, a cablegram is immediately despatched to the observatories at Harvard and at Copenhagen. These cables are in cipher, arranged in such a way as to reduce errors to the lowest possible minimum and yet giving the maximum amount of information with the smallest number of words. From these two central stations local telegrams are then sent out to all persons who are interested in comet observing, and within two or three days new observations come pouring in, again to Harvard and to Copenhagen. These are again sent out, now to the calculators who following a short method devised by Professor Leuschner at the University of California, put three observations of a comet into a computing machine at one end, and the orbit, the path of the comet round the sun, comes out at the other end. The poor comet is then left alone for a while, new observations are made from time to time in order not to lose sight of it, and after a few years when the object has disappeared again, all the observations are utilized to calculate a definitive orbit. If it is found that the comet has a relatively short period of revolution around the sun, predictions about the when and where it will next return are made, in order to facilitate its being picked up again. But, when as often happens, the period found from the calculations comes out to be several thousands of years, the orbit is simply put on file, the case against the comet is dismissed for want of evidence. But some times the planets interfere with this form of terrestrial and solar justice. Take e.g., the case of Sun versus Comet Brooks.

Here the comet first had a period of revolution of 27 years, that is to say, it came to call on the sun every twenty-seven years, paid its respects and disappeared again. But in 1886 the comet became too curious or too friendly, it approached its big brother, Jupiter, too closely, ten times closer than the distance Sun-Earth, and considerably closer than was good for the comet's health. Jupiter became angry and told the comet that now it had to go round the sun once every seven years. It did that and was discovered by Brooks in 1889. But the comet was not satisfied with this punishment, it revolted, and in August of that year it broke up in four pieces. Three of these faded away, but the fourth eventually became brighter than the parent. When the comet returned in 1896 this piece, too, had become very faint, and in 1903 it had become almost invisible. In 1911 it was again seen but missed in 1918. In 1921 it was due for another pow-wow with Jupiter, but apparently the big boy was merciful this time, and the comet's career did not come to a sudden and tragic end as was feared for a while. In October 1925 Brooks's comet reappeared, but very much the worse for wear, being only just visible in the very largest telescopes.

This year another periodic comet is due, viz: Pons-Winnecke. At the time we write this, the comet has already been sighted, and it has even been calculated that it will come as close to us as three and one half million miles, much closer than any other celestial body except the moon, and if we have any luck at all it should become visible to the unaided eye.

WHAT ARE COMETS?

BUT what are comets? Undoubtedly they are all members of the solar system; unlike the planets however, they are not always permanent members of it. The planets may be considered as the legitimate children of the sun, the comets on the other hand have oft been acquired in illegal ways. They are the loot the sun has collected on its journey through space, by virtue of his stronger will. Where they come from we do not know, they may be fragments torn off a star that has traveled the same course we are on now, they may be bits of our own planetary system, they may be bits of garbage the sun is picking up in the universe, or perhaps free lances of the universe reconnoitering space all by themselves by their right of self-determination. But generally they forget their own free will when they feel the irresistible force of the sun's attraction.



The famous "Cat o' nine tails," the great comet of 1744, which never itself appeared above the horizon, but showed only its six tails. One notices the first magnitude star Altair, the brightest star in the Eagle, at the upper right of the drawing. De Cheseaux, who saw this strange phenomenon on March 8, 1744 was convinced that no other explanation except the tails of a comet with its head below the horizon would do.

So here they come, sailing through space, quite peacefully until they get too close. As moths in a candle, they burn their wings. The sun pretending to be just and fair, pulls the comets toward him with one hand, but pushes their tails away from him with the other. Why comets' tails always point away from the sun has long been a mystery.

Now we think we have the solution. It is because of the pressure exerted by the sun's light on the very substance the comets are made of. Generally this repulsive force of light, which is experienced by all material things on which light falls, is very small, practically immeasurable. But, when we are dealing with the extremely light substances a comet's tail is made of, it is a different situation; here the push of the sun's lightrays may be far greater than the pull of the sun's attractive force, and the tail must point outward.

And this brings us to the question what are comet's tails made of? We know from their behavior toward other objects that they have practically no weight. Yet they are enormous in size, "ten million cubic miles of head, ten billion leagues of tail" as Oliver Wendell Holmes, allowing himself the traditional extravagance of a poet, described them. The largest observed tail was that of the comet of 1843 which afforded itself the luxury of a tail 150,000,000 miles long, and 3,000,000 miles wide. The tail and nucleus together contained over 1,000,000,000,000 cubic miles of luminous material, and yet we were unable to observe the slightest deflection in the motion of the planets. Comets really do seem to be mere wisps, ghosts of the solar system, ethereal beings, subject to the laws of matter, but not exerting any influence in return, creatures that sacrifice themselves to do the will of others. You may perhaps ask what will happen when a really big comet comes very close to the earth. The French astronomer du Sejour once computed that if a comet just as heavy as the earth came as close to us as 40,000 miles, it could do no more than lengthen the year by two days. We should escape unscathed, save for a small change in our calendar! Considering that we have yet to find a comet that weighs as much as one ten thousandth part of the earth, or one that comes as close as 1,000,000 miles, your mind may rest at ease, comets will never harm us in this universe.

A HOME-MADE REFLECTING TELESCOPE

By WILLIAM H. CHRISTIE

(*Continued from page* 1107)

edge. For further information on figuring mirrors I must refer my readers to an excellent book recently published and entitled "Amateur Telescope Making," which sells for $2.00.* Test frequently until the shadow pattern is of the form of the fourth example in Fig. 6a,—looking like a "life-saver candy with the hole filled in" as Porter puts it.

We are now ready to measure up the various radii of curvature of the different zones of the mirror, to see if the figure is correct or not. Cut a set of cardboard disks the size of the mirror and from one of these remove the center, leaving a circular hole 1½ inches in diameter. Cut out concentric rings from the other diaphragms, making their radii as given in the first column of the table below. The central portion of these diaphragms may be held in place by small radial strips left for the purpose. These disks may be held over the mirror by being pinned to a couple of little wooden blocks which rest on the mirror edge, as shown in Fig. 5.

Tack a smooth strip of wood to the edge of a small squared board to serve as a guide for the knife-edge base, and another to the bench to act as a guide for the board, this latter being at right angles to the axis of the mirror. Pin a sheet of smooth paper to the board and place the knife-edge base upon it. Now mask the mirror with the first diaphragm and very carefully determine the point where the central part of the mirror darkens uniformly as the knife-edge cuts the beam, making sure that the board and a knife-edge base are pressed against their respective guides. With a *sharp* pencil, using the bevelled knife-edge base as a guide, draw a line on the paper. Substitute the second mask and determine in a similar manner where that zone darkens uniformly, and so on until the outer zone is reached. Measure, to the nearest tenth of an inch, the distance from the center of the mirror to the knife-edge. With a scale, divided into fiftieths, or hundredths, of an inch, measure the distance from the first line drawn on the paper to the others. Now compare these distances with a set computed from the simple formula $\frac{r^2}{R}$, where r is the mean radius of the zone in question and R is the radius of curvature of the central portion of the mirror. (For the benefit of those who are not familiar with algebraic shorthand the foregoing formula simply means:—multiply the radius of the middle of the zone by itself and then divide the result by the radius of curvature of the mirror.) As an illustrative example suppose that the radius of curvature of our mirror is 100 inches, we would make up a table as follows:—

Diaphragm radii	Mean radius	$\frac{r^2}{R}$
¾"—1¼"	1"	$\frac{1 \times 1}{100}$ = 0.010 inches
1¼"—1¾"	1½"	$\frac{1.5 \times 1.5}{100}$ = 0.022 "
1¾"—2¼"	2"	$\frac{2 \times 2}{100}$ = 0.040 "
2¼"—2¾"	2½"	$\frac{2.5 \times 2.5}{100}$ = 0.062 "
2¾"—3¼" etc.	3" etc.	$\frac{3 \times 3}{100}$ = 0.090 "

Now compare the computed values of $\frac{r^2}{R}$ with the measured values. They should not differ by more than .004 inch at the most. It will pay you to make several determinations of these values by repeating the process throughout, thus eliminating observational errors to a certain extent in the mean. Use a magnifying-glass when measuring the distances between the pencil lines and estimate to the nearest five-hundreth of an inch.

If the measured values of $\frac{r^2}{R}$ are smaller than the computed values the center must be deepened a little more; if larger, the deepening process has been carried too far and it will be easier to go back to the spherical stage and try again.

THE FLAT

The small diagonal mirror, known as the flat, must now be made but first it will be necessary to determine its size. Draw the rays converging from the mirror to the focus accurately to scale, remembering that the distance from the mirror to the focus is one-half the radius of curvature. Measure a distance OY, along the axis from the focus, equal to the radius of the mirror plus five inches. At this point draw a line AB cutting the axis at an angle of forty-five degrees, and the two converging lines at E and F. Bisect EF and through the mid-point draw CD cutting the axis at right angles and the converging lines at G and H. The distances EF and GH now serve to determine the minimum size of the flat.

If you have a working knowledge of geometry the above work may be omitted, for it will be a close enough approximation to write $OX : OY :: 2r : GH$ and $EF = GH\sqrt{2}$

From a piece of good plate glass, about ¼" thick, cut three or four elliptical pieces; making the major axis ½" greater than EF and the minor axis ¼" greater than GH. Cut off the end of a wooden cylinder at an angle of forty-five degrees,—the ubiquitous broom-handle will again serve—and mount it after the fashion indicated in Fig. 7a. Cement one of the pieces of glass to the end of this cylinder, centering it up as accurately as possible. Grind the edge with a flat abrasive stone held just in contact with the most eccentric portion, resting the stone on a firm support and taking care that it does not rise and fall as the glass is turned. Keep the stone wet during the grinding process and continue until the edges are smooth and flat.

If you are fortunate enough these mirrors may be perfectly plane, for good plate glass is often optically flat over small areas; if tests show that these are not satisfactory they will have to be polished flat on a large sheet of thick plate glass until tests made with the knife-edge, when the mounting is completed, show that they are satisfactory. It will be found to be a good plan to scratch the back of these flats so that when you come to silver them you will know "which side is which."

SILVERING THE MIRRORS

The reflecting surface of the mirrors must now be given a thin coat of silver. (Need it be said that it is the *front* surface that must be silvered and *not* the back?) If you do not care to do this job yourself send your mirrors to an *optician* who does this work, not to a "mirror silverer"; the process used in silvering optical mirrors is different to that used in silvering looking-glasses. If you are going to do your own silvering, which is by far the most satisfactory, write to the Bureau of Standards, Washington, D. C., and ask for "Letter Circular No. 32": this circular contains all the information necessary for using the well-known "Brashear process" which is very easy to handle if a few precautions are taken. This circular, by the way, is free.

* Name of publisher on request from Editor.

In silvering it will be necessary for you to know the areas of your mirrors so the following two formulae are given for those who are not familiar with them:

$$\text{Area of circle} = \frac{22}{7} \times r \times r \quad (\pi r^2)$$

$$\text{Area of ellipse} = \frac{22}{7} \times a \times b \quad (\pi ab)$$

where r is the radius of the mirror; a is the semi-major axis of the ellipse (one-half the longer diameter) and b is the semi-minor axis (one-half the smaller diameter.)

Let me advise the tyro to try his hand at silvering a flat, or several of them, before trying his hand at the large mirror. It does not need much of the expensive silver nitrate to silver a flat so that failures will not cost more than a few cents, whereas a series of failures with the large mirror would soon run into money.

The quantities given in the above mentioned circular are for a mirror about eighty square inches in area, or about a ten-inch mirror; you will have to reduce all the quantities in a like proportion to suit the size of your mirror.

Having finished a four inch disk successfully you can try your hand at a larger one. The glass disks in this case should be cast disks and must not be cut out of plate. The proper disks may be purchased from a Pittsburgh glass concern. Their thickness should in no case be less than one-eighth the diameter, preferably one-sixth. The thickness of the grinding tool may be somewhat less than the above, but it should not be too thin otherwise it will lead you into trouble. It is perhaps better to go to the expense of a thicker disk as it may be used later if you should wish to construct a solar telescope that I may some day describe, should the readers care for it.

In the next part of this article I will describe a simple mounting for the mirrors that you make.

(Part II will appear in next issue.)

Live Insects Exhibited in Natural Settings

By COUNT A. N. MIRZAOFF

(*Continued from page* 1083)

tribute various kinds of food for the little living world.

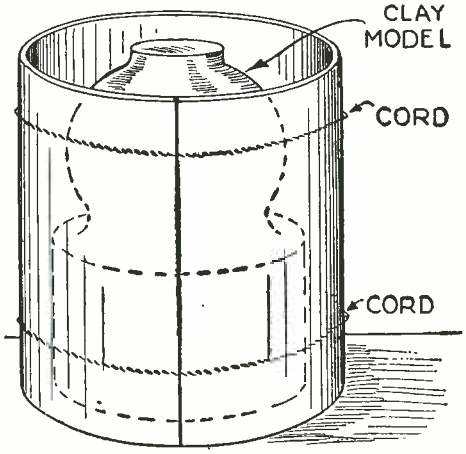
One of the queerest cages to be seen is the one in which are seen small sand hills protruding from a miniature lake; this is called an aqua-terrarium. It is so-called on account of being both a land and water habitation for the amphibian insects. Here are gathered a number of small creatures collected from the Pyrenees mountains down to the Carpathian hills. They come from little brooks, rivers, lakes and ponds of inland water throughout Europe. Here you will see how the larva is formed and gradually becomes a full-grown crab, salamander, singing frog of the Alps mountains, or it may be a shrimp coming from the Rumanian swamps.

Further on we find ourselves in front of a very warm cage in which tropical fauna are kept. The temperature is maintained constantly from 80° to 90° F. Here and there are seen small patches of sand, tepid under an artificial sun, similar to the Sahara desert; here are found sand fish and various other African insects, and further on are seen the famous chameleon of Algeria, whose habit it is to live exclusively under the bushes in order to keep out of the hot sun. The warm electrical rays are installed in this cage in such a manner that the chameleons are constantly protected under the shade against a temperature of 100 degrees or more.

COLOR CEMENT CRAFT FOR THE HOME

(*Continued from page* 1108)

cement objects can be started after they have been allowed to set for 48 hours. Then they are cleaned off in warm water and polished with ordinary floor wax. The durability of magnesite cement makes it adaptable for hard service. It can stand the stresses of the changes brought about by climatic conditions very well, and therefore can be used to ornament arcades in the form of inserts, or for similar outdoor purposes.



THE PLASTER IS POURED INTO A MOLD MADE OF SHEET METAL OR LINOLEUM.

In order to make the plaster mold a clay model surrounded with sheet metal or linoleum is used and the plaster poured into this.

For this reason it is used for garden walks. When used as a facing only, it can either be poured into the mold first and the cement or concrete backing poured on top to the proper thickness after the magnesite mixture has set, or the cement or concrete backing can be poured first and the magnesite mixture facing poured on top. If a pattern is to be made in the magnesite mixture, this mixture is poured first on the plaster or other type of mold.

THE USE OF PLASTER IN CEMENT HANDICRAFT

PLASTER-OF-PARIS is a valuable accessory in the making of molds and models in cement craft. Plastic forms can be made from which to cast tile, pottery, vases, book supports, door stops, and various descriptions of architectural design.

But the right kind of plaster must be used, whether it is to be utilized in the casting of staple plaster art objects or used in the making of plaster molds or equipment for producing cement articles.

If regular moulding plaster is asked for, usually the proper kind will be obtained at market prices. This should be kept dry until ready to use and then it can be sifted through the fingers into a utensil containing water and stirred with a wooden paddle or metal spoon. The mixing consistency should be about that of lard. Just heavy enough to stand up about as lard does when lard is cold. Then when it comes to pouring the plaster into a mold it can be thinned lightly with water so that it will flow readily and evenly into the mold.

Assuming that some original art pottery is to be made for garden use, the first step is to make a solid form to use as the model. Clay is a good working material for this.

It is easy to get a clay model of circular formation into shape for this purpose by the use of a metal template as shown in the second diagram herewith attached. The clay is worked into a condition which will assure its firmness so that the lines formed by the template will hold their shape in the future operations. The template can be roofing tin and the necessary design cut into its edges with tin shears.

A pin is inserted in the center of the top of the clay mass and this pin holds the template properly centered as the latter is worked around a number of times. The edges of the tin will scrape the clay smoothly and leave a compact surface.

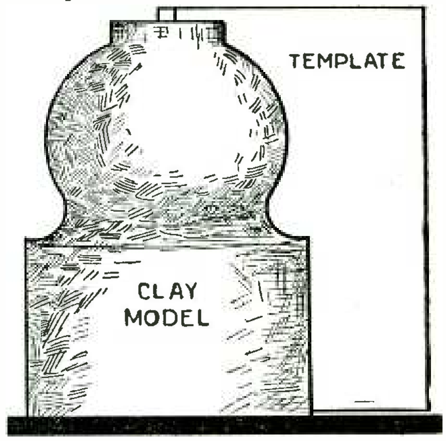
PREPARATION OF THE MOLD

THE clay model is next employed to make a plaster mold in which any number of vases can be cast. This is done by surrounding the model with sheet metal or linoleum, as shown in the next view, and tying the same in place with cords at a distance of about two inches from the ends of the model. The affair is placed on a flat surface and the plaster is poured in after the surfaces of the model and the mold have been greased to prevent the plaster sticking. The hardening action of the plaster will start at once and in a few hours the sheet metal or linoleum sides can be removed. Thus a plaster mold is made but as it has to be used in two or three sections when casting cement vases with it, the mold has to be divided. The plaster at this stage is still soft enough to cut through and the sections made.

The next drawing shows one half of the new plaster mold set up ready for pouring in the cement for making cement vases. A funnel is used for this purpose.

The other half of the plaster mold is adjusted in place against this half and the two secured together with cords. Sometimes three sections are required in the mold, according to the character of the form of the object to be cast. A mold cannot be used intact for pottery because there would be no way to get the cast object out of the mould, as is the case with straight objects, like tile.

The hollow of the pottery objects cast in this manner is obtained by rotating the mold by hand. A quantity of cement is poured in which is calculated to be about sufficient to cover the interior surfaces of the mold, and as the mold is revolved about, this cement will adhere as it hardens. What does not hang on is poured out and another lot poured in and the rotating action repeated. This has to be kept up until the proper thickness of cement has set around all the sides and bottom of the vase. Thus are cement bowls and like objects cast in the round in plaster molds. Line patterns can be incised into the plaster surfaces and these will reproduce in the cast cement articles.



THE CLAY MODEL IS SHAPED WITH A TEMPLATE

After the clay model has been made roughly, it should be shaped with a template as shown.

To Save Tower of Pisa

By HUGO GERNSBACK

(Continued from page 1079)

subject of our cover illustration, is due to the author of this article, and the scheme, in short, is as follows:

There are two alternates to the author's particular scheme, one is, to shore up the tower by means of steel beams, so that the ensuing work will not be responsible for crashing the tower. The first scheme then would be to provide a multitude of stays in all directions, and then demolish a small section of the tower, little by little, near the ground, and as the bricks and marble are removed, substitute wooden or steel beams therefore, so that after all the demolishing was done, the tower would then rest on a platform of steel or wood, supported only by this platform. Previous to that, a great number of steel rails would have been placed under the shoring, so that by the time the tower was resting upon its false foundation, this foundation itself would be resting on top of the steel rails.

It will be noted from illustration No. 1, that the steel booms are resting on a sort of concrete embankment, which embankment carries steel rails. The booms would be on wheels or ball bearings, and the whole idea is to move the tower bodily to a new concrete foundation which had been provided before the moving was done. The moving itself is to be done by means of hydraulic jacks, and by means now familiar in America when tall buildings are moved.

Recently, in New York, a 12-story apartment building was moved in this manner, and while it was moved the elevators, telephones and electric lights were not disturbed. Of course, a 12-story apartment house weighs a great deal more than the Pisa tower, so the engineering difficulties to move the Tower of Pisa in its leaning position are not great. In the moving of the tower to its new foundation, the tower itself would have to be braced externally by means of cross-lacing and it would also have to be safeguarded by placing iron rings around it, as shown in our illustrations.

As the false shoring foundation is moved toward the new foundation, the steel booms are moved likewise by means familiar to engineers. Having reached its new foundation, it could stay on that foundation forever, or if this was not deemed advisable for historical purposes, a modern concrete foundation could be sunk in the original position of the tower. The tower could then be moved back and left in that position. For historical purposes, it would, of course, never do to straighten the tower entirely, for the reason that very likely the City of Pisa would never consent to such a move, inasmuch as its fame is derived from the very leaning tower itself. But the point is, that with a modern foundation, there would be no fear that the tower would crash some day, and it would be preserved for centuries.

It is true, that in operations of this kind, as well as in any other, due to the antiquity of the tower, cracks would certainly appear in some parts of the tower, which of course, would have to be renovated; but it is believed that no great damage would be done in the removal to a new foundation, or even the double removal, back to the original site of the tower.

This method may seem cumbersome, and some engineers will be of the opinion that such a removal is not necessary and that the work can be done right under the tower, while the tower is standing in its original position. This is, of course, quite true, but even in that case, careful shoring of the tower will be necessary and the work will have to proceed slowly and at great cost, while a new foundation is being built under the tower. Several other methods to save the tower are shown in Figs. 3 and 4 of our illustrations. We consulted a number of famous American foundation engineers and we obtained the following reactions:

VIEWS OF FAMOUS ENGINEERS

THE chief engineer of one of the leading American foundation companies, an engineering concern whose everyday work comprises such tremendous jobs as building foundations for 30 and 40-story skyscrapers, gave the following suggestions as to how they would put a new foundation under the Tower of Pisa.

This authority stated that while a new foundation could be built a short distance from the present site of the tower, and the tower moved over on the new foundation, their experience as foundation experts would tend to indicate the preference for leaving the tower in its present position. Presumably the leaning tower of Pisa is to be left in approximately the same angular position as it at present occupies, with possibly a small correction in the angle, as the tower is now approaching a position near the limit of equilibrium. It would be a simple matter, with the aid of 100-ton hydraulic jacks, to lower the high side of the tower, until the tower assumed a leaning angle, but a safe one.

USE OF CAISSONS

According to the information available, and in order to place a substantial new foundation under the Tower of Pisa, steel or possibly wood caissons would have to be sunk to a depth of about 50 feet, reaching down to firm soil. These caissons would be sunk in a staggered row, one at a time, under the tower wall, as one of the accompanying drawings show. After a caisson is sunk to a sufficient depth to reach firm soil, it is afterward filled with concrete. The engineer whom we interviewed frankly stated that he did not think it would be necessary to put any braces or stays around the tower while this operation was being carried on, especially in view of the fact that but one caisson would be put in place at a time. Contrary to the usual practice in the case of new foundations, where the caissons can be sunk in long sections, they would have to be moved in under the foundation wall in short sections most probably in this case, the various sections, if of steel, being welded together with an oxyacetylene flame.

The engineering method of sinking these caissons in place under the tower wall is very interesting. This engineer pointed out that they would probably push the caisson downward, a pressure being brought to bear between the head of the caisson and the under surface of the tower wall, this pressure being supplied by a group of hydraulic jacks. These jacks, while small, are tremendously powerful, and the common sizes used in foundation work is 50 to 100 tons lifting capacity each. It was roughly computed that the Tower of Pisa weighs about 10,000 tons.

The caisson sections are slid into place one after the other, welded together, and forced down progressively. The whole caisson tube is possibly six feet in diameter and reaches down to a depth of 40 to 50 feet, in order to reach firm soil. The hydraulic jacks would be left in place and grouted in with cement, after the caisson had been filled with cement. This process is repeated all the way around and under the tower wall, until finally we have the whole tower underpinned with a staggered ring of caissons all filled with concrete. With these caissons in place, this engineer stated that they would not worry any more about the water veins which are now seriously undermining the old stone foundation under the tower, much of which was laid up without cement.

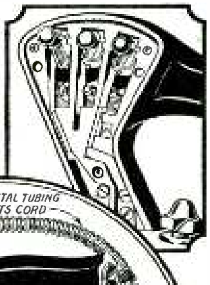
In passing, it is interesting to note that sand-hogs, or those men who work under air pressure inside of foundation and tunnel caissons, cannot work under a pressure greater than three atmospheres, or 45 pounds' air pressure. This corresponds to a water depth of about 100 feet, and where a caisson has to be sunk to a greater depth than this, then freezing of the soil is resorted to. This method is shown in our Fig. 4.

In the illustration No. 4, there is shown a method by a French engineer who proposes to freeze the watery soil beneath the tower. The freezing method utilized is quite unique. The refrigerating brine is forced down through a small pipe placed inside of a larger one; the result is that the brine runs down to the bottom of the small pipe, and then comes up inside the large pipe to the surface of the ground, where it is carried off through suitable piping and returned to the refrigerating machine or compressor. The soil surrounding the larger pipe freezes for a distance of several feet all around it. By freezing the soil and water at depths below 100 feet, the workmen are enabled to dig out the soil immediately below the caisson, while the caisson is gradually and progressively driven down to greater and greater depths. The soil and water is frozen repeatedly as the caisson is sunk deeper and deeper.

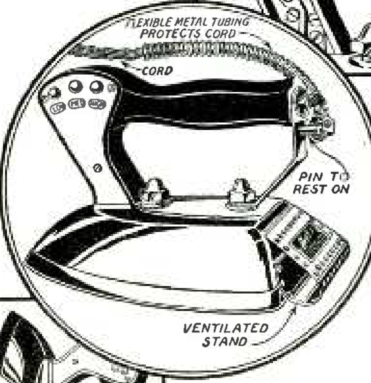
If the Tower of Pisa weighs about 10,000 tons, as an approximate calculation would indicate, then in the event that the tower had to be supported momentarily by hydraulic jacks of the 100-ton capacity, it would be seen that approximately 100 of these jacks would be required.

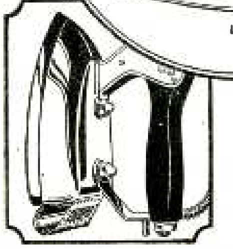
It would seem that one of these three methods will probably be used in order to save the tower, and it is most likely that it will be done in the very near future. All of the three methods discussed are not very difficult today, and it is only a question of cost. We believe that the City Government of Pisa is alive to the problem and that the foundation work will be undertaken soon, because if the tower were to fall, there is no question that Pisa would find it necessary to rebuild it at once, and it may be added that the cost of rebuilding this tower in the leaning condition would be many times that of providing a new and modern foundation.

NEW 3-HEAT ELECTRIC IRON

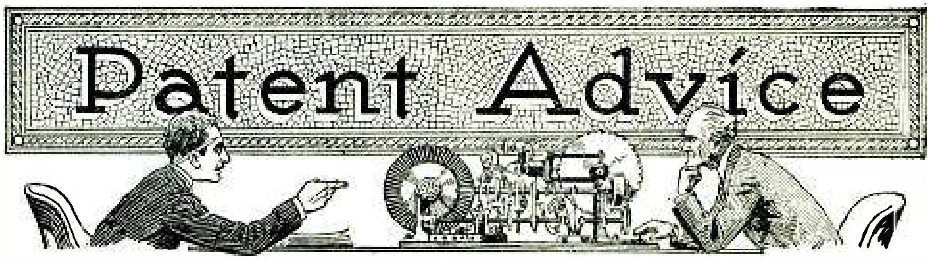


The switches on the new three-heat electric iron are arranged in the handle, as shown at the left. Three different temperatures can be obtained by pushing the switch buttons.





The iron is equipped with a ventilated stand and a cord protected with flexible metal tubing. At the left it is shown resting in an upright position upon the stand.



In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain patent phases. Regular inquiries addressed to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are published here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

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

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

SHAVING BRUSH

(1079) Edward D. Becker, Waterloo, Ont., Canada, sends a description of a shaving brush so arranged that the soap is contained within the handle of the same, which soap can be expelled as desired by the user.

A. 1. The suggestion advanced by you is not very new and it is doubtful if you can possibly secure a patent on the same. This article is not found on the market today, to the best of our knowledge, and the reason is primarily because of the fact that the soap hardens between successive uses of the brush and it then becomes quite impossible to force the soap out through the opening at the base of the bristles without first scraping the hard cake away from the mouth. Any attempt to put an automatic valve in this position produces the same effect, namely, that the soap hardens around the valve and prevents the valve from being operated.

There is no doubt but that someone will manufacture an anti-caking soap for use in brushes of this nature. When this soap is manufactured, then the brushes designed by you could find a market.

PERPETUAL MOTION

(1080) Charles P. Kline, Reading, Pa., submits a plan for a perpetual motion machine consisting of an endless belt revolving around two wheels and provided with pockets along the periphery. The motion of the wheels is communicated to the center, where a small pulley on the shaft operates another endless belt which is to pick up the balls and return them to the starting place at the periphery of the larger wheel, and practically at the center thereof. He desires our opinion on the possibility of making an article of this nature work.

A. 1. Your quest is hopelessly impossible. Here we have several balls on the descending side of the machine which, of course, will cause the machine to rotate. These balls leave the periphery of the wheel and return toward the center at a distance slightly less than the distance from which they are to be lifted. In other words, the ball must be lifted through a greater distance than it can possibly act through on the periphery of the wheel. You expect, of course, to have the increased leverage lift the ball, but you must remember that for every ball descending, one ball must ascend; otherwise the mechanism will cease its operation.

If you can discover any reason why a dropping ball can lift the same weight through a distance greater than that through which the first one fell, then of course you would have a perpetual motion device, but unfortunately, no such thing is known in physics. No object can drop any distance and lift a weight equivalent to itself, through a greater distance.

RESTAURANT TABLE TELEPHONE

(1081) O. E. Synan, Philadelphia, Pa., asks our opinion on a telephone placed on every table in a restaurant so that the waitress can telephone her orders to the kitchen.

A. 1. Your suggestion for a telephone to be placed on every table in a restaurant so that the orders could be directly communicated to the kitchen would save perhaps a few seconds, no more. The difficulty of getting the orders straight might operate against this system. In those restaurants where small metal indicators are placed in racks for orders, the method would necessitate an extra attendant in the kitchen to answer the telephone and set up the metal tag.

Further, the waitress must go into the kitchen and come back with her orders. First, there is butter, bread and water. On one of these trips she can very easily deliver the order. Her trips to the kitchen are so frequent that an extra trip is rarely required. We do not suggest further action.

DUPLEX GUN

(1082) G. Goodwin, Ottawa, Canada, submits an idea for a small calibered gun directly added to a Howitzer, for the purpose of locating where the shell of the larger gun will hit. He intends to employ it for target ranging purposes and when the small calibered shell actually strikes the object, the larger shell is to be fired.

A. 1. You state that your idea of a smaller calibered gun attached to a Howitzer is yours and yours only. Undoubtedly you have never seen the practice rifles that are used on the big guns of the U. S. Navy. You will find that mounted directly on the gun itself is a small calibered gun, which is used for target practice. In this event, smaller targets are used, and all preparations are made the same as if one were loading the big gun, except that instead of setting off the charge, the small rifle actually fires the charge, giving the gunners and all other attendants full experimental information. It might also be well to add that the small calibered shell cannot be expected to strike the same place which the larger shell would hit. Were that the case, it would be unnecessary to use a large shell to carry from 12 to 18 miles. One could expect a smaller shell to do likewise.

We are quite confident that you could not possibly protect the idea of which you claim to be the originator.

GOLF BAG

(1083) Bert C. Flynn, San Francisco, Calif., submits an illustration for a new style of golf rack which will stay put in any position desired by the player.

A. 1. It depends entirely on how you market the article as to whether or not the golf rack which you have designed will be worthy of patenting. If you are in a position to so market and advertise your product rather extensively, the article might be offered for sale at a profit to yourself. Certain organizations that are interested in manufacturing material for the golfer might also undertake its construction.

Nevertheless, we are of the opinion that the spring clips into which the golf clubs are to fit are of no particular value primarily because they will not hold the clubs in place. It might be better to drill holes in the wooden disk at the top and insert the golf clubs as one would insert them into a golf club bag.

MARKETING SAW

(1084) Sidney M. Pepper, Cleveland, Ohio, asks for our opinion of the manner in which he should market a combination saw.

A. 1. With reference to the manner of marketing your invention of a combination saw, we would suggest first, the sale of the invention to some manufacturer. The best way to proceed would be to send at least a dozen copies of your patent to as many different manufacturers of tools or saws. If you have a model, so much the better. Merely notify the manufacturers that a model is available for inspection, should they be interested. Either quote them terms for the sale or ask them concerning the best price they would offer for the invention. The terms of the sale can be approached from several different angles, the first being an outright sale, the second being royalty with a small cash down payment and the third being a combination of the cash sale and royalty. Your own attorney should draw up the terms.

In the event that you fail in your negotiations along this line, the next best thing to do is to manufacture the article or have it manufactured for you and sell it through your own agents. This requires capitalization and requires a certain financial arrangement between yourself and the manufacturing concern to enable you to get the best available price. Sometimes this arrangement is worked out by asking the manufacturer to quote on a price of ten thousand such articles with delivery of the same for over a period of months and the payment to be made thirty days after such delivery. Of course, if you cannot sell the articles, you are in difficulty. The gamble may or may not be worthwhile, it depends much upon the public.

Readers Forum

(*Continued from page* 1111)

hold that there is anything in phrenology, physiognomy, astrology, numerology, or any of the other fortune-telling systems. While it is true that some analyses of the handwritings of certain men seem to indicate their character (as graphologists point out), the character reading is of an exceedingly superficial nature. Such character readings generally flatter the man who submits his writing for examination, to the extent that he gullibly believes he possesses the attributes with which the graphologist endows him.

Every classification should be compared with some known standard. Let us cite an example. The graphologist will write "you are very fond of music." This statement undoubtedly befits all of us. Then the graphologist may further state "Hayden, Mozart and Beethoven had the same characteristic slant in crossing their t's" . . . Reading this we should feel flattered. Perhaps we will become a Hayden, a Mozart or a Beethoven, or perhaps even a Fritz Kreisler. But in comparison with John Jones down the street, we might not even be able to pluck a note on the ukelele or sound the A string of a violin.

The average graphologist never tells you your shortcomings, your failings. He does not usually find fault with you because he knows exactly how vain human nature is. The average man likewise does not like to have his faults brought to the surface; he prefers to believe that he is not the perfect specimen, but just next to it.

In a period of three months, anyone can acquire an entirely new system of penmanship. Does it mean that in this same period, while practising the new system, the individual automatically acquires a new character—nonsense! No, there is nothing in graphology.—EDITOR.)

How Animals Grow New Limbs

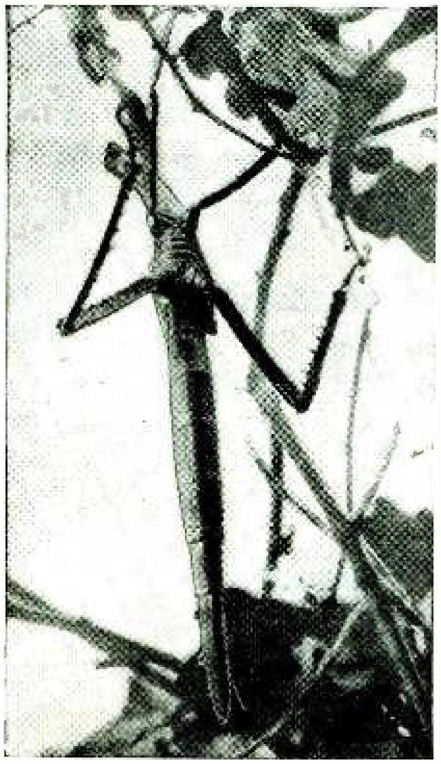
By DR. ERNEST BADE

(*Continued from page* 1091)

off. The insect weighs about three grams; a weight of about 187 grams is required to tear it off, and then it will not break at that point where self-amputation takes place.

Are not such more or less helpless creatures really the stronger? If they can replace their lost parts, and many can, their battle for life is made easier. And if apparently fatal wounds are easily healed, are

(*Continued on page* 1157)



Certain grasshoppers, like the katydid and their relatives, chew off their legs at the moment of capture.

The Metal Emperor
By A. MERRITT
(Continued from page 1097)

THE METAL EMPEROR

"The Metal Emperor!" breathed Drake. They swept on until they had reached the base of the cones. They paused at the edge of the crystal tabling. They turned.

A flashing as of a burst meteor, and the globe had opened into that splendor of jewel fires before which had floated Norhala, and I saw again the luminous ovals of sapphire studding its golden zone, the pulsing rose of petaled flame, the core of incandescent ruby that was the heart of that rose.

Now the flanking pyramids shot forth into twin stars, blazing with violet luminescences. And one by one after them the ten lesser spheres expanded into flaming orbs.

There came a little wailing; far away it was at first. It drew nearer. Was it a tremor that passed through the crowded crater? A quick pulse of—eagerness?

"Hungry!" whispered Drake amazingly. "They're hungry!"

"Drake!" I looked at him, fearfully. "Drake—you're crazy!"

"But I felt it," he said, "I felt that jump. It was a hunger shake. The damned things are hungry!"

Closer was the wailing. Again that faint tremor quivered over the place. And now I caught it—even as he had—a quick and avid pulsing.

"Hungry," whispered Drake again. "And like a lot of lions with the keeper coming along with meat."

The wailing was below us. I felt an unmistakable shock pass through the horde. It throbbed—and passed.

Into the field of our vision, up to the flaming Disc rushed an immense cube. Thrice the height of a tall man—as I think I have noted before—was that shape of mingled beauty and power Drake had called the Metal Emperor. This thing eclipsed it. Blue black, uncompromising, in some indefinable way brutal, its square bulk blotted out the Disc's effulgence. And a shadow seemed to fall upon the crater. The violet fires of the flaming stars pulsed out—watchfully.

For only an instant the darkening block loomed against the Disc.

There was another meteor burst of light. Where the cube had been was now a tremendous, fiery cross—a cross inverted.

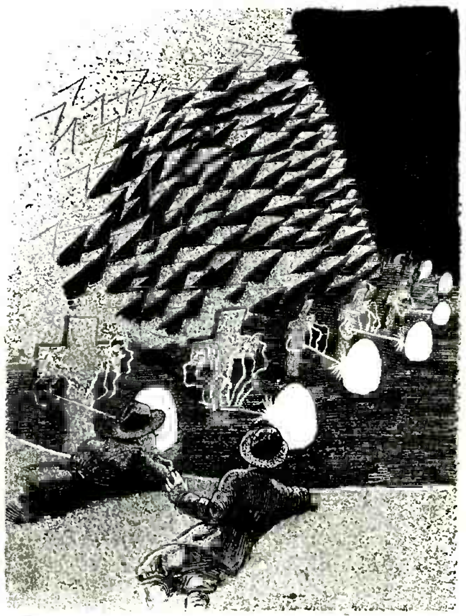
Its upper arm arose to twice the length of either of its horizontals or the square that was its foot. In its opening it must have turned, for its face was toward us and away from the cones, its body hid the Disc, and almost all the surfaces of the two watchful stars. Eighty feet at least in height was this cruciform shape. It flamed and flickered with angry, smoky crimsons and scarlets; with sullen orange glowings, and glitterings of sulphurous yellows. Within its fires were none of those leaping, multicolored glories that were the Metal Emperor's, no trace of the pulsing, mystic rose, no shadow of jubilant sapphire, no purple royal, no tender, merciful greens nor gracious opalescences. Nothing, even, of the blasting violet of the stars.

All angry, smoky reds and ochers the Cruciform Thing blazed forth—and in its lurid glowings was something sinister, something cruel, something—nearer to earth, closer to man.

Once more that pulse, that avid throbbing, shook the crater. And as swiftly in its wake rushed back the stillness and the silence.

The Cross turned. It slipped sidewise past the Disc, its ministers and its stollated guardians. As it went by they swung about with it, facing it.

And now at last was clear to me what had puzzled greatly—the mechanism of that open-



Before me, glimmering pallidly, bristled the mount of the cones. Around its crystal base glittered immense egg-shaped lights. They were rayless, they threw no shadows nor did their diamond brilliancy lessen the dimness. Beside each stood one of the Cruciform shapes—the Things that now I knew for the opened cubes of the Horde.

ing process by which the spheres became oval discs, the pyramids the four-pointed stars, and the blocks this inverted cruciform shape.

The Metal Folk were hollow. Spheres and tetrahedrons and cubes—hollow.

In their enclosing sides dwelt all their vitality, their powers—themselves. And those sides were—everything that they were.

Folded, the oval disk became the sphere; the four points of the star and the square from which those points radiated, became the pyramid when shut; the six faces of the cubes were, when opened, the inverted cross. Nor were these flexible, mobile walls massive. They were indeed, considering the apparent mass of the Metal Folk, most astonishingly fragile. Those of the huge cross upon which I was gazing could not have been more than a foot in thickness. At the edges, I thought I could see groovings, and noted the same appearances at the outlines of the stars.

Seen sidewise, the body of the Metal Emperor showed as a convexity, its surface smooth, with a suggestion of transparency.

The cruciform Thing was bending, its oblong upper plane dropping forward as though upon a hinge. Lower and lower this flange bent—in a grotesque, terrifying obeisance. The oblong that was its upper half extended now at right angles to the horizontal arms. A rectangle forty feet long, it hovered as many feet above the floor at the base of the crystal pedestal.

It bent again, this time from the hinge that held the outstretched arms to the base. And now it was a huge cross, a T-shaped figure, hovering only twenty feet above the pave.

Down from the extended planes writhed and flicked a tangle of tentacles, serpentine and whiplike. Silvery white, they were dyed with the scarlet and orange flamings of the surface now hidden from my eyes. They reflected those sullen and angry gleamings. Coiling, they seemed to drop from every inch of the overhanging planes. There was something beneath them—something like an immense and luminous tablet. The tentacles were moving over it—pressing here, thrusting there, turning, pushing, manipulating.

A shudder passed through the crowding cones. A tremor shook their bristling hosts, oscillated the great spire, and set the faceted discs quivering.

The trembling grew, the vibration in every separate cone becoming ever more rapid. There was a faint, curiously oppressive humming—like a distant echo of tempest in chaos.

Faster, ever faster grew the vibration. Now the sharp outlines of the cones were dissolving. And now they were gone.

The mount was a mighty pyramid of pale green radiance—one tremendous, pallid flame, of which the spire was the tongue. Out from the disked wheel gushed a flood of light.

The tentacles of the cruciform creature moved over the tablet; writhing cloudily; confusingly swift. The faceted disks wavered and turned upward. The wheel began to whirl—faster—faster—

Up from its flaming circle, into the sky, leaped a thick, pale green column of intensest light. With prodigious speed, as compact as water, concentrate, it struck—straight out toward the face of the sun.

It thrust with the speed of light—

The speed of light?

A thought came to me; incredible I believed it even as I reacted to it. My pulse is uniformly seventy to the minute. I sought my wrist, found the artery, made allowance for its possible acceleration, and began to count.

"What's the matter?" whispered Drake.

"Take my glasses," I muttered, trying to keep up my tally while speaking. "Matches in pocket. Smoke lenses. Want to look at sun."

With a look of amazement, he obeyed.

"Hold them to my eyes," I ordered.

If my count were right, four minutes had gone by.

There it was—that for which I sought. Clear through the darkened lenses I could see it, high up on the northernmost limb of the sun. The great sunspot of that summer—the hughest ever recorded by astronomical science, a cyclone of incandescent gases, a huge dynamo pouring its floods of electromagnetism upon all the circling planets. A solar crater which we now know was, when as its maximum, all of one hundred and fifty thousand miles across!

Five minutes had gone by.

There was no use keeping my eyes fixed to the glasses. Even if the thought were true—even if that radiant pillar was a bolt flying to the sun through space with the speed of light, still between eight and nine minutes must elapse before it could reach the sun. And as many minutes must go by before the image of its impact could pass back over the ninety millions of miles between.

And after all, did not my thought belong to the utterly impossible? Even were it so—what was it that the Metal Horde expected to follow? The shaft was infinitesimal compared to the target at which it was aimed. What possible effect could that feeble missile have upon the solar forces? And yet—nature's balance is delicate; and what great happenings may follow the slightest disturbance of her infinitely sensitive, her complex equilibrium? It might be—it might be—

Eight minutes had passed.

Nine minutes. The shaft, if I were right, had by now touched the sun.

Ten minutes.

"Good God!" gasped Drake. "What's happening? Look at the cones! Look at the Emperor!"

The pyramidal flame that had been the mount of cones was shrunken. The pillar of radiance had not lessened—but the mechanism that was its source had retreated

whole yards within the field of its crystal base.

And the Metal Emperor! Dulled and faint were its fires and dimmed its splendors; and fainter still were the violet luminescences of the watching stars, the shimmering livery of its court.

The cruciform shape—the Keeper of the Cones! Were not its outstretched planes hovering lower and lower over the gleaming tablet; its tentacles moving aimlessly, feebly—wearily?

I had a sense of force being withdrawn from all about me. It was as though all the City were being drained of life—as though vitality were being sucked from it. Drained from it to force that thrusting spear piercing sunward.

The Horde hung limply, inert. The living girders sagged. The living columns bent. They drooped and swayed.

Twelve minutes.

One of the laden beams fell and dragged down with it others, bending, shattering in their fall a thicket of the horned columns. Behind us, the sparkling eyes of wall were dimmed, vacant—dying.

Something of that hellish loneliness, that desire for immolation that had assailed us in the haunted hollow of the ruins, began to creep over me.

The crowded crater was fainting.

Duller grew the Metal Emperor's glories—Fourteen minutes.

"Thornton," whispered Drake, "the life's going out of them. Going out with that ray they're shooting! What does it mean? Why are they doing it?"

Fifteen minutes.

The tentacles of the Keeper groped feebly over the tablet. Abruptly, the flaming pyramid darkened and went out. The radiant pillar hurtled upward like a thunderbolt. It vanished into space. Before us stood the mount of cones, shrunken to a sixth of its former size.

Sixteen minutes.

All about the crater-lip the ringed shields suddenly tilted and thrust themselves on high, as though behind each of them was an eager lifting arm. Below them the hived clusters of disks widened into coronets.

Seventeen minutes.

I dropped my wrist, seized the glasses from Drake and raised them to the sun. For a moment I saw nothing—then a tiny spot of white incandescence shone forth at the lower edge of the great spot. It grew into a point of radiance, dazzling even through the shadowed lenses.

I rubbed my eyes and looked again. It was still there, larger—blazing with an ever-increasing intensity whose brightness pierced the eye like a needle. It did not change the contours of the spot. It seemed to be flashing from high above it.

I handed the glasses to Drake, silently.

"I see it!" he gasped, incredulously. "Thornton—the spot—it's widening!"

I snatched the glasses from him and caught again the dazzling flashing. But whether Drake had seen the spot widen, change—to this day I do not know. To me it seemed unchanged—and yet—perhaps not. It may be that under that finger of force, that spear of light launched by the Horde, the wound in the side of the sun had opened further—

That the sun had winced.

I do not know to this day. Whether it had or had not—still shone the point of intolerably brilliant light. And miracle enough, that was for me.

Twenty minutes—subconsciously I had gone on counting—twenty minutes—

About the cratered girdle of the upthrust shields a glimmering mistiness was gathering; a translucent mist, beryl pale and beryl clear. In a heart-beat, it had thickened into a vast and vaporous ring through whose sparkling swarms the sun's reflected image upon each disk shone clear—as though seen through clouds of transparent atoms of aquamarine.

The filaments of the Keeper moved again. As one, the hosts of circling shields shifted downward. Brilliant, ever more brilliant, grew the fast-thickening mists.

Again as one, the shields began to revolve. From every concave surface, from the surfaces of the huge circlets below them, a stream of green fire, green as the fire of green life itself, flashed out. Corpuscular, spun of uncounted rushing, dazzling ions, the great rays struck across, impinged upon the thousand-foot wheel that crowned the cones, and set it whirling.

Over it formed a limpid cloud of brilliant vapors. Whence came these sparkling nebulosities, these mists of light? It was as though the shields reached into the shadowless air, sucked from it some unseen, rhythmic energy and transformed it into visible, coruscating flood.

For now it was a flood. Down from the immense wheel came pouring a torrent, a cataract of the green fires. It cascaded over the cones, deluged them, engulfed them.

Beneath that inundation the cones grew! Perceptibly their volume increased as though they gorged themselves upon the light. Out, and further out upon the base of the crystal they crept. Higher and higher soared their tips, thrusting, ever thrusting upward toward the whirling wheel that fed them.

Now from the Keeper's motionless planes its tangle of tentacles writhing, uncoiling through the twenty feet of space between their source and the mechanism they manipulated.

The crater's shields tilted downward. They shot jets of green radiance into the vast hollow, drenching the Horde and splashing from the polished walls.

All about us was a trembling, an accelerating pulse of life. Rhythmic, quicker, ever more powerfully it throbbed; a prodigious vibration, monstrously alive.

FEEDING

"Feeding!" whispered Drake. "Feeding! All the City—feeding on the sun!"

Faster danced the rays. The crater was a cauldron of fires through which the conical beams angled and interwove, crossed and mingled. Where they mingled, where they crossed, there flamed out immense rayless orbs, pulsating for an instant, then dissolving in spiraling, feathery spray of pallid emerald flame.

Stronger and stronger beat the pulse of returning life.

A jetting stream struck squarely upon the Metal Emperor. Out blazed its splendors—jubilant! Its golden zodiac, no longer tarnished and dull, ran with sun flames. Up snapped the Keeper, all flickering scarlets and leaping yellows—no longer wrathful nor sullen.

The place dripped light. It was filling as if with chrism. Us, too, the sparkling mists bathed and the rays struck. I was conscious of a curiously wild exhilaration, a quickening of the pulse and an abnormally rapid breathing. I stooped to touch Drake and sparks leaped from my outstretched fingers, great green sparks that crackled.

Now on every side burst a hurricane of gem fires. From every girder and column, from every arras, pendant and looping, they flashed out.

"Feeding!" Drake's voice trembled. "Feeding on the sun!"

The circling shields raised themselves, lifting higher above the crater-lip. Into the crowded cylinder came now only the rays from the lower circles and the streams from the huge wheel above the still growing cones. Up and up the shields rose, by what mechanism raised I could not see. Their motion ceased, and in all their thousands they turned about. Over the City's top and out into the Pit they poured their torrents, flooding it,

$21,000.00 for Spirits

Dunninger, who writes exclusively for SCIENCE AND INVENTION Magazine and who is the Chairman of our PSYCHICAL INVESTIGATION Committee, will personally pay $10,000.00 to any medium or spiritualist who can present any psychical manifestation in so-called spiritualism, that he will not explain or that he cannot reproduce by natural means.

More than two years ago SCIENCE AND INVENTION Magazine offered a prize of $1,000.00 to anyone who could demonstrate his or her ability to communicate with the spirits or to give some definite form of a psychical demonstration which in itself was not trickery.

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

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So now we have a total of $21,000.00 offered for proofs of Psychical Manifestations. Spiritualists—get busy.

deluging it even as they had this inner pit that was the City's heart.

Feeding, I knew, those other Hordes without.

Sweeping down upon as through the circle of open sky, a clamor roared. Louder it grew, and now within began its mate. Linked chains of the lightning flashed through the vapors. Bolt upon bolt they flew, and even more thickly. Lightning green as the mists themselves. Bolts of destroying violets, searing scarlets. Tearing chains of withering yellows. Globes of exploding multi-colored incandescences.

Out from the star shapes hurtled shafts of emerald and of purple. Out from the crosses whirled linked chains of saffron and scarlet flame. Forth from the discs flew the blasting globes. The crater was threaded with them—the lightnings of the Horde. It was broidered with them, it was woven with vast and changing patterns of electric flame—

The clamor had grown stupendous, destroying—like armored Gods roaring at sword play in a hundred Valhallas; like the smitings of warring suns.

And all the City was throbbing, beating with life—was fed and drunken with life. I felt its pulse become my own, I echoed to it; throbbed in unison with it. I saw that I was outlined in flame and that around Drake a radiant nimbus was growing.

Through the chaos of the crater Norhala floated—clothed in shouting lightnings.

The body of Drake slipped by me, and lay flaming at my feet upon the narrow ledge.

There was a roaring within my head—louder, far louder, than that which beat against my ears. Something was drawing me out of my body. Something was hurling me out into depths of space that alone could darken the fires that encircled me—the fires of which I was becoming a part.

I seemed to leap outward—outward and outward—into—oblivion.

CHAPTER XXI.

PHANTASMOGORIE METALLIQUE

I OPENED my eyes. I stirred stiffly and painfully. I was lying upon my back. High above was the tremendous circle of the sky, ringed with the hosts of the feeding shields. But now the shields were wanly gleaming, and the sky was the sky of night.

Night? How long had I lain here? And where was Drake? I struggled to rise.

"Steady, old man," his voice came from beside me. "Steady—and quiet. How are you feeling?"

"Badly battered," I groaned. "What happened?"

"We weren't used to the show," he answered. "We got all fed up at the orgy. We had a sudden and violent attack of electrical indigestion. Sh-h-look ahead of you."

I turned. I had been stretched prone at the base of one of the crater's walls. As my gaze swept away I noted with a curious relief that the tiny eye-points were no longer sparkling. They were dulled and dim once more.

Before me, glimmering pallidly, bristled the mount of the cones. Around its crystal base glittered immense egg-shaped lights. They were rayless, they threw no shadows nor did their diamond brilliancy lessen the dimness. Beside each stood one of the cruciform shapes—the Things that now I knew for the opened cubes of the Horde.

They were smaller than the Keeper, less than half his height. They ranged in an almost unbroken crescent around the visible arc of the immense pedestal. The lights were a few feet closer to that pedestal than they. Egg-shaped, as I have said, the wider end was undermost, resting in a broad cup upheld by a slender pedicle, silvery-grey and metallic.

"Been watching them for a long time," whispered Drake. "Saw you were alive and all right, and was afraid to wake you. They're building out the base. The cones have grown so big they have to give them more room."

The cross-shapes bent, hinging above the transverse arms. They bowed in absolute unison, as at some signal. Down from the horizontal plane of each whipped its tentacles.

At the foot of every one was a heap of some faintly glistening material. The tendrils coiled among this, and then drew up something that looked like a thick rod of crystal. The bent planes straightened and, simultaneously, they thrust the crystalline bars close to the lights. There was a curious brittle hissing. The ends of the rods began to dissolve into a dazzling rain that was drawn through the egg-shaped lights and fell upon the periphery of the pedestal. The bars melted rapidly. Heat there must be in these lights, terrific heat—yet the Keeper's workers seemed impervious to it.

As the ends of the bars melted into the annealing mist, the tentacles crept close and ever closer to the rayless flame through which the mist flew. And at the last, as the ultimate corpuscles drove through, the holding tendrils were thrust almost within it; touched it, certainly.

A score of times the Things repeated this process. They seemed unaware of us, or, if aware, indifferent. Their movements became more rapid, the glassy ingots streaming through the floating braziers without a pause.

Abruptly, as though switched, the lights lessened into candle-points. Instantly the crescent of crosses closed into a crescent of cubes.

They stood motionless, huge blocks blackened against the dim glowing of the cones; sentient monoliths; a Druid curve; an arc of a metal Stonehenge. And, as at dusk and dawn, the great menhires of Stonehenge seem to be praying priests of stone, so about these shapes gathered a hierophantic illusion.

The waned lights swayed, lifted and soared, upright, to their backs. Two by two with measured pace, solemnly, the cubes glided off into the encircling darkness. As they swept away there streamed behind them other scores not until then visible to us, joining them pair by pair, from the pedestal's hidden parts.

Into the shadows they floated, two by two, each bearing over it the slim shaft holding the serene flame. They, like a column of metal monks marching with dimmed candles to their worship.

Angled metal monks of some God of Metal, carrying tapers of electric fire, withdrawing slowly from a Holy of Holies whose metallically divine Occupant knew nothing of men.

Grotesque—yes. But would that I had the power to crystallize in words the underlying, alien terror every movement of the Horde when disintegrate, its every manifestation when combined, evoked; the horror lurking always close behind the threshold of the mind; the never lifting, thin-shuddering shadow.

For the Metal Horde I know now, had no more thought for us mortals, no more care for, or consciousness of, us than a man has for the ant-heap he treads upon, or the cobweb through which he brushes.

Therein lay the secret soul of our terror. If one destroys for hate—be it fellow man, devil, or God—there is at least the satisfaction of knowing that we have been a realized entity. But if we are destroyed indifferently, carelessly, as a man—again I use the simile—treads upon an ant-hill or stalks through a cobweb? Ah—there in truth dwelt the horror!

Dimmer waned the lights. They were gone.

We crouched, motionless. Nothing stirred; there was no sound. We arose and crept, together, over the smooth floor toward the cones, a full thousand feet away.

As we crossed I saw that the pave, like the walls, was built of the bodies of the Metal People; and, like the walls, they were dormant, their filmed eyes oblivious to our passing. Closer we crept. I noted that the crystal foundation was set low; was not more than four feet above the floor. The sturdy, dwarfed pilasters supporting it thrust up in crowded copses, merging through distance into apparent solidity.

Now, too, I realized, as I had not done when looking down from above, how stupendous the structure rising from the crystal foundation really was. A full mile in diameter the base must have been—yet not a yard in thickness.

I began to wonder how so fragile a support could bear the mount bristling above it—then remembered what it was that at first had flown from the cones, shrinking them, and at last had fed and swelled them.

Weightless magnetic atoms; swarms of electric ions; the misty breath of infinite energy breathing upon and condensing upon them.

They were weightless. How I knew I cannot say—but now, almost touching them, I did know. They were nebulous yet solid; compact, yet tenuous; dense and unsubstantial.

They were force made visible!

Energy made concentrate into matter!

We skirted, seeking for the tablet over

The rods were movable. They formed a keyboard unimaginably complex; a keyboard whose infinite combinations must have been like a Fourth Dimensional chess game. I saw that only the swarms of tentacles that were the Keeper's hands could be masters of its intricacies.

which the Keeper had hovered. Hesitantly I touched the crystal base. The edge was warm, but whether this warmth came from the dazzling rain which we had just watched build it outward, or whether it was a property inherent in the substance itself, I do not know. Certainly, there was no mark upon it to show where the molten mists had fallen. It was diamond-hard and smooth.

The nearest cones began a scant nine feet from its rim.

A GIGANTIC KEYBOARD

Suddenly we saw the tablet. The shape of a great T, glimmering with a faint and limpid violet phosphorescence, it might have been, in shape and size, the palely shining shadow of the Keeper. It stood a foot above the floor, and had apparently no connection with the cones. It was made of thousands of close-packed, tiny octagonal rods, the tops of some of which were cupped, the tops of others pointed; none was more than half an inch in width.

The rods were movable. They formed a keyboard unimaginably complex; a keyboard whose infinite combinations must have been like a Fourth Dimensional chess game. I saw that only the swarms of tentacles that were the Keeper's hands could be masters of its intricacies.

Yet why had it been so made that the sullen flaming Cross alone could relate its hidden meanings? And how were its messages conveyed?

There was no visible copula of the tablet with the cones, and there were no antennae between it and the circled shields. Could it be that the impulses released by the Keeper's tentacles passed through the units of the Horde that formed the pave, on to the upthrust units of the Horde of the crater rim that held the shields? That was unthinkable—unthinkable because if so this mechanism was superfluous. The swift response to the communal will that we have observed, showed that the Horde needed nothing of this kind for transmission of the thought of any of its units. There was some gap there—a gap that the grouped consciousness could not bridge without other means. Clearly that was true—else why the tablet, why the Keeper's travail?

Was each of these tiny rods a mechanism akin, in a fashion, to the sending keys of the wireless? Were they transmitters of subtle energy in which was enfolded command? Spellers out of a super-Morse, carrying to each responsive metal cell the bidding of those higher units which were to the body of the Horde what the brain cells are to us?

I bent, determined, despite the well-nigh unconquerable shrinking I felt, to touch, to move the tablet's rods.

A flickering shadow fell upon me—

The Keeper of the cones glowed above us!

Compared to it we were as a pair of Hop-o'-my-Thumbs to the Giant. Had it been man-shaped we would have come less than a third up to its knees. I focused my attention upon the twenty-foot-wide square that was its base. Its surface was jewel smooth, yet beneath it was a suggestion of granulation, of close-packed, innumerable, microscopic crystals. These grains, whose existence was more sensed than seen, were filled with dull red light, smoky and sullen. At each end of the square, close to the bottom, was a diamond-shaped lozenge, cabochon, perhaps a yard in width. These were dim yellow, translucent, with no suggestion of the underlying crystallization. Sense organs I set them down to be—similar to the great ovals within the Emperor's golden zone.

My gaze traveled up to the transverse arms. They stretched sixty feet from tip to tip. At each tip were two more of the diamond figures, burning angrily with orange-and-scarlet luster. In the center of the beam was something that might have been a smoldering reflection of the Disc's pulsing multi-colored rose had each of the petals of the latter been clipped and squared. It deepened toward its heart into a singular pattern of vermilion latticings. Into the entire figure ran numerous tiny rivulets of angry crimson and orange light, angling in interwoven patterns with never a curve nor arching.

Set at intervals between them were octagonal rosettes filled with slender silvery flutings, wan striations—like—it came to me—immense chrysanthemum buds, half opened, and carved in grey jade.

Above towered the gigantic vertical. Toward its top I glimpsed a huge square of flaring crimsons and bright topaz. Two other diamonds stared down upon us from just beneath it—like eyes. And over all its height the striated octagons clustered.

We were lifted, and floated upward. Drake's hand shot out and clung to me as we drifted up. Opposite the latticed heart of the square-petaled rose, our flight was checked. There, for an instant, we hung. The octagonal symbols stirred, and unfolded like buds—

They were the nests of the Keeper's tentacles, and from them the whiplike tendrils uncoiled, shot out, and writhed around us.

My skin flinched from their touch. My body, held in the unseen grip, was motionless. Yet their contact was not unpleasant. They were like flexible strands of glass. Their smooth tips questioned us, passing through our hair, searching our faces, slipping over our clothing.

The Keeper contemplated us!

The rhythm of the square rose became the rhythm of my own mind. But there was none of the vast, serene and elemental calm that Ruth had described as emanating from the Metal Emperor. Powerful it was, without doubt, but in it were undertones of rage, of impatience, overtones of revolt, something incomplete and struggling.

The swarms of tentacles grew greater, winding about us, covering our faces, making breathing more and more difficult—

The strangling clutch suddenly relaxed, and I was conscious of a surge of anger through the Thing that held us. Its sullen fires blazed. Another light beat past us. The hosts of tendrils drew back. I was plucked swiftly away.

IN THE CLUTCHES OF THE METAL EMPEROR

Drake beside me, I hung now before the Disc—the Metal Emperor!

It had drawn us from the Keeper—and, as I swung, I saw the latter's multitudinous, serpentine arms writhe out toward us angrily, and then sullenly, slowly, draw back into their nests.

Out of the Disc, clothing me, permeating me, came an immense tranquility, a muting of all human thought, all human endeavor, an unthinkable calm into which all that was human of me seemed to be sinking, drowning.

And as though I had been not an actor but an observer, the weird picture of it came to me—two men swinging like motes in mid air, on one side of the flickering scarlet and orange cruciform shape, on the other side the radiant Disc, and the glowing mount of the bristling cones, and high above all the wan circle of the Sun shields.

There was a ringing about us—an elfin chiming, sweet and crystalline. It came from the cones—and strangely was it their vocal synthesis, their voice. Into the vast circle of sky pierced a lance of green fire. Swift in its wake uprose others. It was the aurora.

We then slid gently down, and stood swaying at the Disc's base. The Keeper bent and angled. Again the planes above the supporting square hovered over the tablet, the tendrils swept down, pushed here and there, playing upon the rods some unknown symphony of power.

Thicker pulsed the lances of light, changing to vast billowing curtains. The faceted wheel at the top of the central spire of the cones swung upward. A light began to stream from the cones themselves—no pillar now, but a vast circle that shot whirling into the heavens like a noose.

And like a noose it caught the aurora, and snared it. Into it the mists of ions swirled, lost their colors, became a torrent of light flying down through a funnel top.

Down poured the radiant corpuscles, bathing the cones. They did not glow as they had beneath the flood from the shields, and if they grew it was too slowly for me to sec. The shields were motionless. Now here, now there, other rings whirled up—smaller mouths of lesser cones sucking down the magnetic flux.

Then, as when first we had seen the phenomenon in the blue valley, the ring vanished, hidden by fog—as though the force streaming through the rings became diffused after it had been caught. And I wondered whether the sea of light into which we had plunged when entering the valley had been formed of these same captured ions? Was it a reservoir for the night feeding of the City and its disintegrate units?

Crouching, forgetful of our captors, we watched the play of the tentacles upon the upthrust rods.

But if we forgot, we were not forgotten! The Disc slipped nearer and seemed to contemplate us—quizzically, amused: as a man would look down upon some curious and interesting insect, a puppy, a kitten. I felt a push—a push that was filled with a colossal, glittering playfulness. Under it I went spinning away for yards, Drake twirling close behind me. The force, whatever it was, certainly swept out from the Disc, and in it was no slightest hint of anger or of malice, no slightest shadow of the sinister. It was as though one would blow away a feather or urge gently some little lesser thing away.

The Disc watched our whirlings—there was sparkling, jeweled laughter in its pulsing fires.

Again came the push—farther yet we spun. Suddenly, before us, across the pave, shone a twinkling trail—the wakened eyes of the cubes that formed it, marking out a pathway for us to follow. As they glanced out the Emperor turned, its immense, oval, metallic back black against the radiance of the cones.

Up from the narrow gleaming path—a path opened by and obeying some mysterious command lifted the hosts of tiny unseen hands, the sentient currents of magnetic force that were the fingers and arms of the Metal Horde. They held us, thrust us along, and passed us forward. Faster and faster we moved.

I turned my head—the cones were already far away. Over the tablet hovered the planes of the Keeper, and still the oval of the Emperor was black against the radiance.

But the twinkling, sparkling path between us and them was gone—was fading out close behind us as we swept onward.

Faster grew our pace. The cylindrical wall loomed close. A high oblong portal showed within it. Into this we were carried. A corridor stretched before us, precisely similar to that which, closing upon us, had forced us out into the hall. Unlike that passage, the floor lifted steeply—a smooth and shining slide up which no man could climb. A shaft, indeed, which thrust upward straight as an arrow at an angle of at least thirty degrees, and whose end or turning we could not see. Up and up, it made its way through the City.

For an instant we hovered upon its threshold. But the impulse, the command, that had carried us thus far was not to stop here. Into it and up we were thrust, our feet barely touching the glimmering surface, lifted by the force that emanated from its floor, and carried on by the force that pressed out from the sides.

Up and up we went—scores of feet—hundreds—

(To be Continued)

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Can We Fly Without Engines?

By F. E. LOUDY

(*Continued from page* 1082)

1903, was made by means of a catapult projecting the machine along a rail, down a hill. If this was the only flight that the Wright Brothers had ever made, it would hardly be proclaimed successful! However, it was the repetition of this flight with a consistent increasing of the distance and duration which marked this flight at Kitty-Hawk, N. C., as the first successful flight made by man in a heavier-than-air machine. *So, until Dr. Gerhardt and Mr. White can make flights between two established points at a reasonable distance apart we can hardly call them successful.*

As a sporting event there is no doubt that these flights are an excellent thing, but even though they do prove successful in the future they will have very little practical utility. Comfort in air travel varies directly as the loading of the plane in pounds per H.P. and also in pounds per square foot of wing surface. In other words, a plane heavily loaded is not tossed about by the various air currents, which exist in the atmosphere.

A low powered plane with a light wing loading is moved about by the slightest disturbance in the air and makes air travel very unpleasant. The light planes developed in Europe had a very high power loading, but a wing loading of only 3 pounds per square foot. These airplanes were bounced about the sky in a very unpleasant manner and would wear a pilot out in controlling them over any great distance. The average wing loading of the soaring glider in Germany was 2 pounds per square foot, and those who have witnessed these flights or have seen the moving pictures of them will testify that the path was extremely erratic.

MAN-DRIVEN PLANE DOUBTFUL

It is, therefore, doubtful as to whether a heavier than air machine propelled by human-power will ever become an object of practical utility. It is true, however, that when Prof. Langley was making successful heavier-than-air flights with models in 1895, our foremost methematicians were proving that heavier-than-air flight was an impossibility. While human flight by a man-propelled aircraft of the airplane type may be successfully accomplished in the very near future, it is doubtful if the ornithopter operated by man-power will ever be successful, in view of the fact that up to the present time not a single ornithopter powered with an engine has ever succeeded in leaving the ground, under its own power.

$5,000 for Perpetual Motion

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

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

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

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

Human Nutrition

By WALTER RALEIGH

(Continued from page 1087)

which digestion and absorption take place, their reserves are quickly exhausted when food is withheld.

"With ruminants the food residues in the intestinal tract are very large, amounting at times, in the case of the steer, to one-fifth of the entire body weight. The possibility of these residues serving as a source of energy for a considerable period has long been assumed.

"Numerous fasting experiments of long duration (with men lasting over 30 days and with dogs over twice this time) have shown that the contents of the alimentary tract of man and of the dog are almost immediately exhausted. Consequently the whole expense of their life processes falls upon deposits in their body tissues."

SIGNIFICANT OBSERVATIONS

The following observations which the scientists also make are of special significance to persons who are trying to reduce their weight:

"The general behavior of fasting steers leads to the general deduction that the so-called 'hunger feeling' is merely the temporary sensation caused by physical contraction of the alimentary tract to meet requirements of a diminished bulk. In no sense does it represent distress due to lack of nourishment of tissues. After the second day no particular irritation or craving for food was manifested."

"It is definitely shown that live weight losses are no indication of real tissue changes. The latter can be intelligently studied only by urine analyses and particularly by respiration experiments which give the data for calculating the total loss of carbon and, in turn, the total heat output or energy transformation."

"With men a rise in nitrogen output during the first three days of fasting is proved to be directly correlated with an increased draft upon body glycogen. With ruminants although the nitrogen output on the first day of fasting is usually greater than on the last day when food is eaten, nothing more is shown than a general tendency to fall off as the fast progresses."

"Nitrogen losses indicate drafts upon body protein, but for sustaining the life processes during fasting, by far the largest draft upon the body stores is made upon fat. With steers the experiments showed a distinct tendency for the fat to fall off rather rapidly during the first one or two days of fasting."

"With humans there is an appreciable rise in metabolism following ingestion of food but this disappears in about 12 hours, after which the metabolism remains essentially constant for many hours. As fasting continues, however, the heat or energy production continually and regularly declines."

THE PHYSIOLOGICAL BASE-LINE

One of the principal objects of the experiments was the determination of the physiological base-line representing the feeding level needed to hold the animals at mere maintenance—a condition in which there is neither gain nor loss in body tissue. This may be called the organism's "overhead cost" of living, the minimum below which it is not possible to go. The measurement of this basal metabolism is important because it is the only logical basis for comparison of the relative heat or energy production among different individuals and among different species.

In referring to this basal metabolism the writers point out that in a study of 136 men

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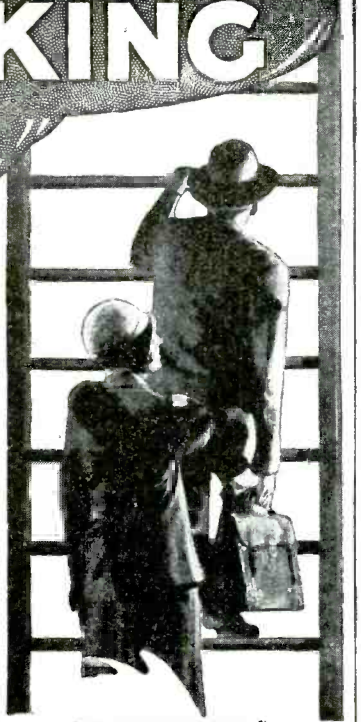

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$12 Day Representing Big Harley Factory. Established 35 years. Sell friends, neighbors—groceries, extracts, family medicines, toilet preparations etc. Steady profitable repeat business. $3.00 an hour part time. Samples furnished. Harley Company, Desk D-2584, Dayton, Ohio.

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Agents Make $3.00 Hour Taking orders for 40 fascinating "Handy Things" for Kitchen. Sell on sight! Write General Products Co., Dept. SM-7, Newark, N. J.

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Business of your own! Proved earnings $65.00 week. Large company established 1887 supplies all capital. Wonderful opportunity for men of unquestioned standing in their community. No traveling. Not stocks, insurance or books. Write giving age, and past business experience. Fairbanks, Dept. 12-D, Oakley & Wabansia Ave., Chicago.

$25.00 daily selling colored Raincoats and Slickers, Red, Blue, Green, etc., $2.95. Hat Free. Pay daily. Outfit Free. Elliott Bradley, 230 S. Wells, Dept. AF-4, Chicago.

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Sell Men's Fine Suits extra trousers free) for $16.95. Commission $4.00. $90 a week for you, also tailored pants, $3.95 ($5.00 value). Big extra commissions. Both sample outfits free if you write quick. Tru-Fit, C-8, 808 Broadway, New York

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Free Outfit With Actual Samples of Bostonian broadcloth gets quick sales for our nationally known Bostonian Shirts at three for $6.95, postage paid. Liberal cash commission of $1.50 on each order of three shirts earns big profits for you. Bostonian Mfg. Co., Desk SM2, 72 Summer St., Boston, Mass., Established 1863.

Old estab. mfg. co. gives you credit: starts you in business (city or country) selling 228 widely known household necessities. Permanent business; steady customers; large profits. McConnon, Dept.TH4, Winona, Minn

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Write for your Money-making Opportunities

Human Nutrition

(*Continued from page* 1154)

and 103 women the average basal heat production every 24 hours was 925 calories per square meter of body surface for the men and 850 calories for the women.

Under as nearly comparable conditions as it was possible to obtain the basal heat production of steers was found to be 1,300 calories every 24 hours per square meter of body-surface and of the white rat about 600 calories.

The scientists add:

"In this relatively small group of warm-blooded animals, therefore—the man, the steer, and the rat—there is a variability in heat or energy production per square meter of body surface ranging from 600 to 1,300 calories per 24 hours. It would therefore appear that the heat-production of the steer under conditions reasonably comparable with men shows a production fully 40 per cent greater. Thus it seems that the laws governing heat production and heat loss may be very different with different types of animals. Indeed it is possible that the two processes are to a considerable extent independent of each other."

EFFECT OF DECREASING THE RATION

These studies, it is interesting to note, demonstrate that steers can be carried through a period of several months on extraordinarily low rations without affecting their general health or lessening their power to regain a suitable market condition with subsequent liberal feeding—a conclusion of practical value to the stockman.

Other studies carried on by Dr. Benedict and his colleagues of the Nutrition Laboratory—studies of fasting men—show also that even with man, of all animals perhaps the most sensitive to nutrition conditions, a considerable decrease in food may obtain for prolonged periods without harm. Indeed, fasts of long duration, conducted under laboratory conditions, demonstrate that even complete abstention from food for a week or longer is not especially distressing nor does it have injurious effects which can be detected; while a reduction of 10 per cent in weight can easily be brought about in a few weeks with no bad effects by merely reducing the total caloric intake.

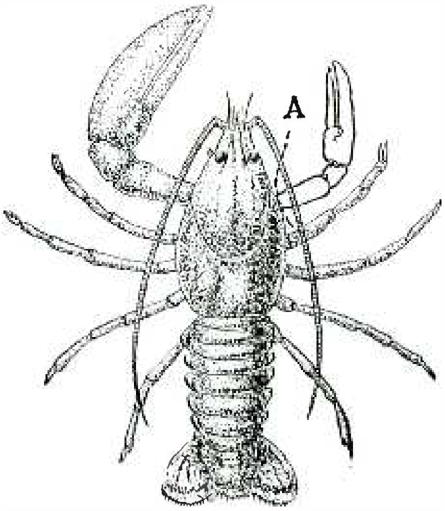
Rules for Model Contest

(*Continued from page* 1103)

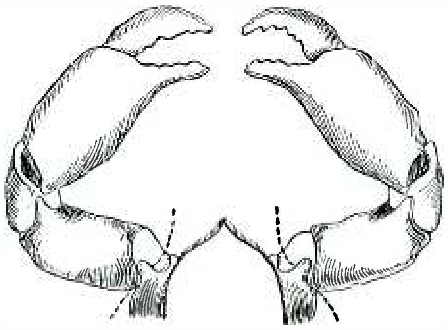
1. A handsome trophy cup engraved with your name, will be awarded as the prize for the best model submitted during the month. The decision of the judges will be final and will be based on: A—novelty of construction; B—workmanship; C—operating efficiency of the model as related to the efficiency of the device which the model simulates, and D—the care exercised in design and in submitting to us sketches and other details covering the model.
2. Models of all kinds may be entered. They may be working models or not, according to the subject that is being handled.
3. Models may be made of any available material, preferably something that is cheap and easily obtainable.
4. Models must be submitted in all cases. Good photographs are also highly desirable and where the maker does not desire the model to be taken apart, legible drawings with all dimensions covering parts that are not accessible must be submitted.
5. Models should be securely crated and protected against drainage in shipment and sent to us by parcel post, express or freight prepaid. Models will be returned when requested.
6. Models for entry in any particular contest must reach this office on or before the 25th of the third month preceding date of publication. For instance, models for the June contest must reach us on or before the 25th of March.
7. Address all entries to Editor Model Department, c/o Science and Invention Magazine, 230 Fifth Avenue, New York City.

How Animals Grow New Limbs

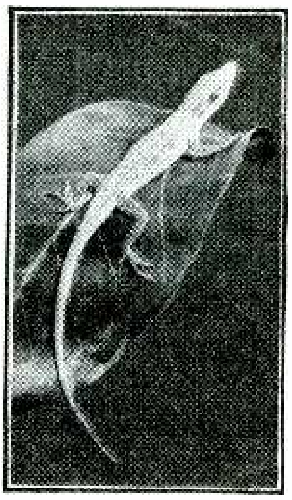
(Continued from page 1140)



When the larger claw of a lobster is lost, a new one is regenerated. The break occurs at A.



The dotted lines in the above drawing show where the claws are amputated.



they not the better equipped for this life? Take the star fish. They eat clams and oysters. Years ago, when they were caught, the fishermen tore them into many parts and cast them back into the sea. Each fragment soon became a new animal and the best of the oyster beds increased. Now they are killed, when caught, by drying.

The two photos herewith show a Carolina chameleon with a regenerated tail. The break occurs at a definite place and is never torn off. Furthermore, the break is clean and little or no blood flows afterward.

Opportunity Ad-lets

YOU will find many remarkable opportunities and real bargains in these columns. It will pay you to read and investigate the offerings made every month by reliable firms, dealers and amateurs from all over the country. No matter what you may be seeking, whether supplies, automobile accessories, the opportunity to make money, or anything else, you will find listed here the best and most attractive specials of the month.

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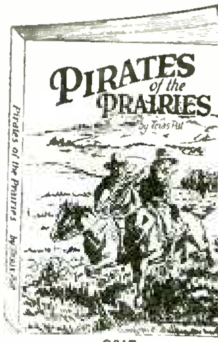

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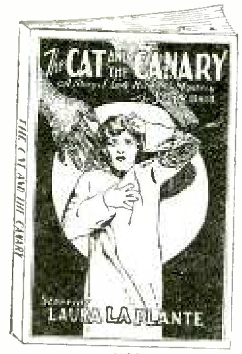

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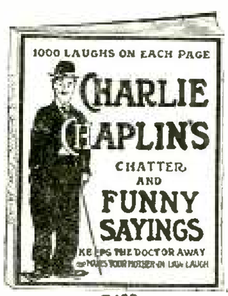

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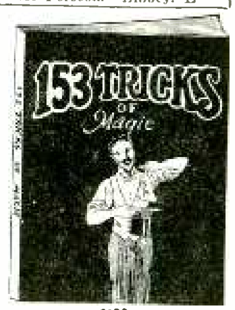

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