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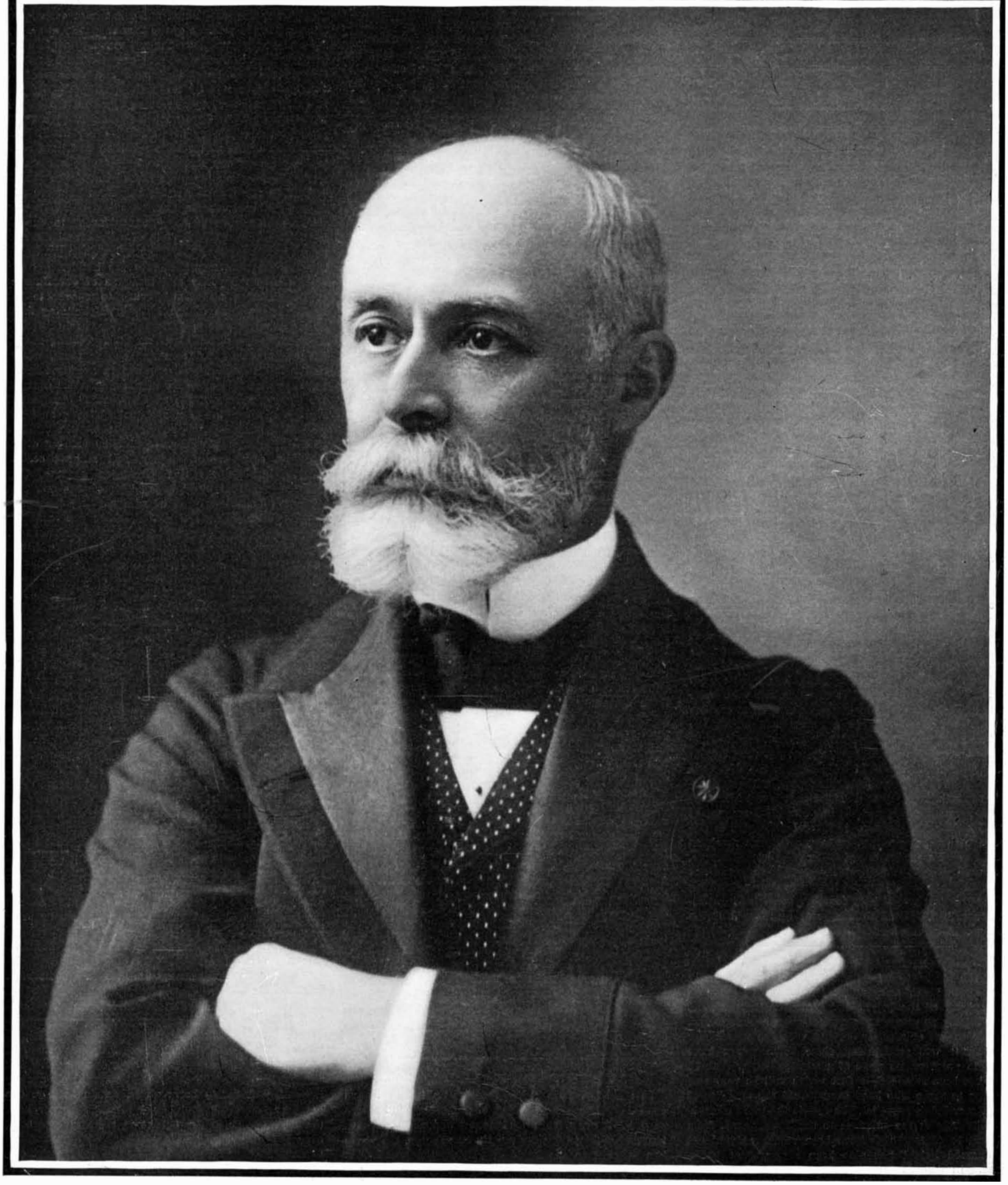

[See page 395.]

Henri Becquerel

SCIENTIFIC AMERICAN

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NEW YORK, SATURDAY, DECEMBER 3, 1904.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

PRODUCTION AND POPULATION.

We could not ask for stronger evidence of the increasing prosperity of the country than is afforded by the last publication of the Bureau of Statistics, embodying the annual review of the foreign commerce of the United States. It contains figures which show the progress in production and consumption, in the United States, of coal, iron, and petroleum. The increase is really astonishing, particularly when it is borne in mind that it has been far more rapid—five times more rapid, in fact—than the increase of population. Thus, in 1894, the production of coal was 152,447,791 tons; in 1903, it was 319,068,229 tons, an increase of over 100 per cent. In 1894, the production of pig iron was 7,000,000 tons; in 1903, it had risen to 18,000,000 tons, an increase of over 150 per cent. The production of petroleum rose from 2,072,469,672 gallons in 1894 to 4,219,374,154 gallons in 1903, an increase of over 100 per cent. Now, the increase of population in the United States is estimated as not more between the years 1894 and 1903, than 21 per cent, so that the production of these important materials of industry has increased from five to seven times faster than would naturally be called for by the growth of population. It should be noted, moreover, that during this increase, the exports of coal have been nominal, while the exports of petroleum have slightly decreased; showing that the home consumption is growing in a ratio proportionate to the increased production.

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GAS TURBINES.

It was inevitable that the success of the steam turbine should lead to an investigation of the problem of the gas turbine; for it is natural to argue broadly that the results obtained with one gas will be obtained with any other, unless indeed some radical difficulties inherent in the gas or in the mechanism employed for its expansion should be found to stand in the way. The prospects for the early development of the gas turbine were discussed recently in a paper read before the British Institute of Mechanical Engineers, and, according to the author, those prospects are not very bright. Of course, one of the chief difficulties is the high temperature of the gas, which necessitates, if the temperature is to be reduced to a degree that is not injurious to the cylinder, the carrying away of a large amount of heat by the cooling water. If it were attempted to dispense with cooling water, or to use only as much as would cause a moderate reduction of the temperature, the rotating parts of the turbine would have to run red hot, and there is no material known to the engineering art to-day that would hold together at such high temperature, if subjected to the great centrifugal forces that would be developed.

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POWER OF OCEAN WAVES.

At the International Engineering Congress, recently held at St. Louis, some unusual figures were given on the subject of the height and power of ocean waves, particularly as regards their effect upon harbor works. In the course of a paper dealing with the new Dover harbor, it was stated that since these works have been in progress, no wave of a greater height than 15 feet has been recorded—a fact which will be very surprising to those who have experienced the miseries of the Dover-Calais passage. The fact is the more remarkable because at the entrance to the Tyne, waves from 35 feet to 40 feet high have been measured, and the last-named height has also been observed at Peterhead. In dwelling upon the necessity for what are known as spending-beaches and wave-traps, for dissipating and controlling wave action, it was stated that the depth to which the latter extends is now known to be much greater than was once commonly supposed. Proof of this is shown by the fact that lobster pots placed in from 120 to 180 feet of water, have been found to be filled with sand and shingle after a heavy gale; moreover, sand had been found deposited after a heavy gale in the gallery of the Bishop Rock lighthouse, the latter being 120 feet above the water, and the depth of the water at that point 150 feet. That the water, even at considerable depths, must be moving during a gale with great momentum, is shown by the fact that at the Peterhead breakwater blocks weighing 41 tons and located over 36 feet below spring tide low-water, were displaced during a storm, while a section of the breakwater weighing 3,300 tons was moved bodily for a few inches without the brickwork being dislocated.

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ELECTRIC TRACTION FOR TRUNK ROADS.

The successful test of the first of the electric locomotives that are being built for the main line of the New York Central Railroad, marks a definite step toward the day when trunk-line passenger service will be worked by electrical traction. The locomotive did everything that had been expected of it, hauling its test loads with that rate of acceleration which is one of the chief advantages of the electric motor, whether applied to the locomotive or directly to the cars. The success of the New York Central installation, of which no reasonable doubt can be entertained, will be followed by the electrifying of similar stretches of steam roads, on which the traffic is sufficiently dense and heavy to warrant the change. There were special conditions connected with the New York Central service which rendered the use of the electric locomotive desirable; but when such systems as those of the Pennsylvania between New York and Washington or Pittsburg, or of the New Haven road between New York and Boston, come to be electrically equipped, we think it is altogether probable that the Sprague system of multiple control will be adopted, the electric locomotive being dispensed with. This implies a better distribution of the weight and power throughout the train, greater smoothness of running, and, of course, less wear and tear upon the track and bridges.

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SUBWAY RESULTS.

The New York Subway has been in operation for a sufficient time to enable the public to realize how far its performance comes up to its high promise. In spite of a pretty liberal bombardment by the crank and the faddist, carried on from the vantage ground of the correspondence columns of the local press, there is little doubt that New York city is greatly pleased with its new system of transportation. The feature that appeals most strongly to the downtown business man and the theater-goer is the system of express trains, in which the operating company has fully redeemed its promise of a fifteen-minute service to Harlem. These trains have hitherto been run under a four-minute headway, but now that the east side branch of the road has been opened, the expresses will be run under a two-minute headway as far as the junction at Ninety-sixth Street, and a four-minute headway upon the two branches of the road from that point to their respective termini. There are two features in particular that mark the road as constructed on the most up-to-date practice in electrical traction. One is the remarkably rapid acceleration, which amounts to 1.25 miles per second, and the other is the splendid condition of the track. The combination of 100-pound rails with a tie-plate on every tie, and broken stone ballast laid on a concrete foundation, provides a remarkably smooth track, in which both surface and alignment are all that could be asked. Another feature that contributes to comfortable riding is that the curves are "spiraled," that is to say, the track runs from the tangent to the maximum curvature in a parabola, the change of direction being so gradual that the jolt which usually accompanies the entrance of a train upon a curve is entirely removed. The express train service is undoubtedly the most valuable feature of the new Subway; and it augurs well for the future service of the system that Mr. Belmont has expressed the conviction that the Subway was intended primarily to provide service of this nature, and that the more completely it is given up to express trains, the more fully will it meet the needs of this great and populous city.

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A UNITED STATES WARSHIP ON TRIAL.

In the life of a warship there is no event—always excepting, of course, the day of battle—around which so great interest, both sentimental and practical, centers as her trial trip; for rightly or wrongly, the world has fallen into the habit of placing the speed of a warship as first in value of the many separate elements that go to make up the sum total of her efficiency.

It was, therefore, with no small amount of interest that the editor recently boarded the United States armored cruiser "Pennsylvania" as the guest of her builders, the Cramps, of Philadelphia, to witness the government speed trial on the well-known Cape Ann course off the coast of Massachusetts. Outside of the small party of invited guests and the ship's trial crew of 450 officers and men, the persons on the ship most immediately interested in the trial were the Government Trial Board, composed of eminent officers of the navy, and the officers and representatives of the company that built the ship. To the first named, a speed trial is an event of profound importance, since upon it depends the acceptance by the government of the United States of a vast and complicated machine which, in the completed condition, will represent the expenditure of between five and six million dollars from the national treasury. To the representatives of the firm, the issue is of even more vital importance, since it involves the payment to them of a sum of nearly four million dollars, and what is of even more importance, the prestige of the firm is greatly at stake; for of all misfortunes that may happen to a big shipbuilding firm, there is none that can give more positive chagrin than to know that such and such a great warship constructed by themselves, and designed for 20 or 22 knots an hour, must go down on the official register as having done no better than 19 plus or 21 plus, as the case may be. On the other hand, it is always an object of laudable ambition and keen competition among the respective builders of a class of sister ships to be able, as in the case of the "Pennsylvania," to say that she heads her class in speed and economy of coal consumption.

The performance of the "Pennsylvania" in exceeding the contract speed by 0.43 of a knot, and the contract horse-power by 5,000, is a result that is gratifying both to the government and to the builder. It has always been the policy and tradition of our Bureaus of Construction and Engineering to encourage the hearty co-operation of the leading shipbuilding firms of the country; and in this particular case, the excellent results are directly attributable to certain modifications in the boiler room and engine room, which, as the trials have shown, resulted in greatly improving the speed and efficiency of the ship. The contract for the six vessels of the "Pennsylvania" class called for the development of a speed of 22 knots an hour, with an indicated horse-power of 23,000. The builders of the "Pennsylvania" decided that, by using a different type of water-tube boiler, and making certain modifications in the triple-expansion engines, they could secure a larger indicated horse-power, and thus serve the double purpose of safeguarding their own interests and giving the United States government a better ship. The suggested changes which were allowed by the government were as follows: The battery of thirty Babcock & Wilcox boilers was replaced by a battery of thirty-two modified Niclausse boilers, the modifications being in the direction of larger tubes and drum, and a general simplification of details. The main steam pipe was increased from 13 inches to 15 inches diameter, because it was considered that for a piston speed of nearly 1,100 feet a minute, a pipe of the larger diameter would be a necessity. The boiler pressure was raised from 265 pounds to 300 pounds, and the arrangement of the cylinders was modified, so as to give a more direct flow to the steam; the order in the departmental design being low pressure, high pressure, intermediate, and low pressure, which was changed in the Cramps' design to high pressure, intermediate, low pressure and low pressure. Another radical change was that, instead of the low-pressure cylinders being assisted by introducing live steam from the boilers, this connection was dispensed with, and, instead, the exhaust from the auxiliaries was fed direct to the low-pressure cylinders. It will thus be seen that the changes were thoroughly in touch with the latest marine practice, involving high boiler pressure, ample steam-pipe connections to convey an abundance of steam to the cylinders, and a literal adherence to the principles of triple-compound expansion, by using live steam only in the high-pressure cylinders, and allowing it to develop its full expansive efficiency from throttle to condenser.

The value of these changes is seen in a comparison of the trials of the "West Virginia" with those of the "Pennsylvania," the first-named ship being built strictly to the original designs. On her trial trip the average speed of the "West Virginia" was 22.12 knots with 25,750 horse-power, on a coal consumption of 3.2 pounds per indicated horse-power per hour. The "Pennsylvania" averaged 22.43 knots with an average indication of 27,750 horse-power, on an average coal consumption of 2.2 pounds per horse-power per hour, the temperature in the uptake in the first case being over 1,000 degrees, and in the case of the "Pennsylvania" 650 degrees. We quote these figures not only for their intrinsic interest, but as showing the wisdom of the departmental policy of encouraging the private builders to offer and put in practice their own amendments to departmental designs. The low coal consumption is, perhaps, an even more valuable feature than the higher speed, for it means that if the "West Virginia" and the "Pennsylvania" were both using their forced draft in chase of a fast cruiser of the enemy, the "Pennsylvania" would be able to follow the chase for 50 per cent longer time than her consort. In other words, by virtue of her higher economy, her radius of action, on the same amount of coal, when using forced draft, is just 50 per cent greater than that of the sister ship.

In the popular mind, the speed trials of a United States warship are associated with much that is spectacular, both in the event and in the preparations for it. Although the editor boarded the ship at the New York navy yard, under the impression that the reality would prove considerably less lurid than its oft-repeated descriptions might lead the layman to expect, he was not altogether prepared to find such a cool, matter-of-fact, everyday air prevailing both above decks and below. There were no chunks of unburned coal, "big as a man's fist," being thrown crater-like from the "belching" smokestacks, nor were there any exhausted firemen brought up and laid on deck to be revived before plunging again into that "inferno" below. Everything was orderly, methodical, and highly scientific. The trial was simply the accomplishment of results that had been carefully planned and confidently predicted months and years before they happened. Indeed, just as the vessel swept over the line at the start, her builder predicted her speed to the writer, with an accuracy which proved, when the trial was over, to be only one-tenth of a knot too low.

The Cape Ann course is selected mainly because it affords deep water—an important element in obtaining estimated speeds—and because the course is sufficiently near to the shore to admit of the buoys by which it is marked off being accurately located by triangulation from the shore. The total length of 44 knots is divided into seven approximately equal lengths of about 6 knots each. Near each buoy, and on the landward side of it, is anchored a United States warship, which does the double duty of affording a large, conspicuous object to assist the captain of the vessel on trial in steering a true course, and also affording a means of gaging the speed of the tide at each particular mark at the time when the ship passes. The vessel runs the full length of the course, then makes a wide turn, and steams back over the same course. In estimating her average speed over each leg of the course, the speeds of the tide at the two buoys are taken, and their mean is added or deducted, according as the tide is adverse or favorable, to the speed of the vessel over that leg. The average of the fourteen speeds thus arrived at gives the average speed of the ship for the whole 88 knots.

In a case where deductions at the rate of $25,000 for every quarter of a knot that the vessel falls below contract speed, are involved, great accuracy is necessary. The time is taken by means of two vertical sighting rods placed transversely to the axis of the ship on the upper, forward bridge. At the instant that the particular buoy is in line with these two sights, the timing officer calls out "Mark," and the time is accurately taken with a chronometer. It is not generally understood how greatly the speed of the ship depends upon the steersman; for if she veers ever so little from her course, it means not only that she travels a proportionately greater distance, but that the retarding effect of the helm in bringing her back to her course pulls down the speed very materially.

Upon entering the engine room, the conditions did not strike the writer as varying greatly from those that obtained when he made a chance visit to the engine room of the "Deutschland," during a passage across the Atlantic. Each engineer and oiler was at his particular post and, of course, was closely attentive to his duties. Perhaps the only difference that one could note was the large amount of saponified lubricating oil (looking for all the world like soapsuds) that was spattered over the moving parts, frames, and bed plate. This was inevitable in a case like the present, where the engines, although they were fresh from the builders' yard, were being pushed to their maximum power. Passing through the airlock that leads into the boiler rooms, one was struck with the same quiet orderliness and utter absence of excitement or nervous tension. The coal was being brought by a couple of men from the bunker door at the end of the foot plate, a sack at a time, and emptied into a long heap athwartships, and midway between the twelve fire doors of the four boilers in the compartment. The fire doors were numbered in pairs, the doors having the same number being on opposite boilers and diagonal to each other. At one end of the foot plate stood a group of firemen, with a boy in their midst who was holding a watch. At two-minute intervals he would call out a number, and instantly two firemen would come out upon the floor plate, coal the fires corresponding to the numbers called, throwing on a half dozen shovelfuls, and then step back to join the quiet little group at the end of the floor plate. This method was followed in all the compartments, and it meant that each furnace received a thin layer of coal once in every twelve minutes. Previous experience had shown that this rate of firing would provide the thin, evenly-spread bed of coal necessary to maintain a full head of steam at 300 pounds boiler pressure.

With a view to determining the actual coal consumption, the coal, before the trial, was sacked and weighed; and many of our readers will be astonished to learn that the coal used was the straight run of the mine, and cost only $2.75 a ton—thus disposing of another of the little fictions that have grown up around warship speed trials, to the effect that the coal was picked by hand and cost something over $10 per ton.

Our observations of the whole trial confirm the statement that there is no reason why such a ship as the "Pennsylvania," after being turned over to the navy, should not for years to come, repeat, or even exceed, her trial performance. It is true the trial crew was a special one, well trained to its work; but the navy is also paying special attention to its fire-room staff, and it has some very efficient crews in the service. Moreover, the engines on this trial were perfectly new, and no doubt after several months of service they will limber up and show as good, or better results.

THE HEAVENS IN DECEMBER.

BY PROF. W. M. REED.

On December 31, at midnight, the earth is at perihelion, and therefore nearest to the sun of any time during the year. But how far we are at this time from our source of heat is still doubtful by perhaps 100,000 miles. Since B. C. 270 many attempts have been made to determine this most important of all distances in the solar system. By other means the relative distances of all the heavenly bodies can be found. But to ascertain the dimensions of the solar system in miles, we must know the distance from the earth to the sun. Mr. Arthur R. Hinks has just made a discussion in the Monthly Notices of the Royal Astronomical Society, of the parallax of the sun, as deduced from photographs of Eros, taken during the last opposition of November 7 to 15, 1900; 295 plates were exposed at observatories in the following places: Algiers, Lick Observatory, Cal., Northfield, Minn., Tacubaya, Mexico, Cambridge, Minneapolis, Oxford, and Paris.

The measurement of these plates gives a value of the parallax of 8.7966 sec. ± 0.0047 sec., which corresponds to a distance of about 92,861,000 miles ± 50,000 miles, which places the sun about 36,000 miles further away than it was formerly supposed to be. Aristarchus in B. C. 270 obtained a parallax of 180 sec. by observations on the moon when its elongation was 90 deg. from the sun, or one-half phase. In 136 A. D. Ptolemy, from observations on the earth's shadow, made the parallax 170 sec. The Hindoos about 1100 A. D. got 240 sec. Corpernicus in 1543, also from observations of the earth's shadow, got 240 sec. Kepler, from the diurnal parallax of Mars, obtained 60 sec. in 1620. By the same kind of observations, Flamsteed, in 1672, reduced the parallax to 10 sec. Since 1850 over fifty determinations of the solar parallax have been made. They all lie between 8 sec. and 9 sec. Until quite recently the accepted parallax was 8.80 sec.

On December 20 Aldebaran is occulted by the moon. As seen from Washington, the star disappears behind the moon at 8h. 25m. Eastern standard time, and reappears at 9h. 46m. But on account of the parallax of the moon, this time must be considerably altered to suit conditions at other places. On December 2 Mars is also occulted. The Washington time of disappearance is 2h. 15m. A. M. Eastern standard time, and 3h. 16m. A. M. for reappearance.

The disappearance of a bright star behind the moon is an extremely interesting phenomenon to watch. It gives many people their first impression of how rapidly the moon is moving among the stars. Then the very sudden extinction of the star is an impressive sight. At first the moon will appear to gain rapidly on Aldebaran. Finally this speck of light will seem to be fastened to the edge of the moon, and to stay in this position longer than the observer expects. But suddenly the star will be gone. Its reappearance from the other side will be equally startling. This phenomenon is one of our strongest arguments that the moon has either no atmosphere or an extremely trifling one. Even in a small telescope it is obvious that there can be no very great gaseous envelop to our satellite. For the mountains are just as distinctly seen at the edge of the disk as they are at the center. In 1792 Schröter thought he perceived a twilight band on the moon, and argued from that, that the moon must have an atmosphere about one-thirtieth as dense as ours. But such an atmosphere should so bend the light of occulted stars as to make the time from disappearance to reappearance much less than we should expect from the measured diameter of the moon. Sir George Airy found only 4 sec. for the difference in the diameter of the moon as deduced from direct measurement and from occultations of stars. Also from this 4 sec. must be subtracted the effect of irradiation, which is far from a negligible quantity. From these observations he concluded that the moon's atmosphere, if it has any, must be at least two thousand times less dense than our own at sea level. Furthermore, as the star approaches the lunar disk, certain rays of its light should first be absorbed by the lunar atmosphere. Such an example of selective absorption is noticed on every clear day when the sun sets. The absorption in this case is so great, on account of the greater mass of air through which the sunlight must travel, that its color is perceptibly changed. To test this effect of a possible lunar atmosphere, Sir William Huggins watched the spectrum of the star Epsilon Piscium during occultation, but found that the whole spectrum disappeared as quickly as the star itself. Prof. Comstock has recently come to the conclusion from occultation of stars that the lunar atmosphere cannot have a density exceeding one five-thousandth that of the earth's. Prof. W. H. Pickering took photographs of Jupiter during an occultation in 1892. He concluded that the disk was slightly flattened as it approached the moon's limb, on account of the effect of the lunar atmosphere. These measurements gave a maximum density of the refracting medium of one four-thousandth of our atmosphere. It is interesting that during this month both kinds of occultations can be observed.

On December 16, at midnight, Jupiter is in conjunction with the moon. The sun is at the winter solstice, which marks the beginning of winter, on December 22 at 1 A. M.

On December 20 at 6 P. M. Venus is in the southwest at an altitude of 15 deg. The planet will continue to grow more brilliant throughout the month. At the same time Saturn will be in the same quarter of the heavens at an altitude of 22 deg. At 6 A. M. Mars will be seen in the S. S. E. at an altitude of 40 deg. It will be a short distance above the bright star Spica, in the constellation of Virgo.

During the evening Jupiter will be a very prominent object. At about 8 P. M. it will be in the direction S. S. W. at an altitude of 57 deg. It will be easily distinguished by its great brilliancy.

Mercury is at greatest elongation on December 13, when it is 20 deg. from the sun. It will then be close to the horizon just after sunset. But at this season of the year the ecliptic makes such an acute angle with the horizon at sunset that it is very difficult to see Mercury unless the weather is exceptionally clear.

At 8 P. M. on December 20, Orion is S. S. E. at an altitude of about 30 deg. The three stars that form the belt are almost vertical to the horizon.

Farther to the north, in a direction about E. N. E., are the Twins—Castor and Pollux. They will be about the same distance above the horizon as Orion's Belt. A line connecting these two stars is also nearly vertical to the horizon. Directly above Orion's Belt is the red star Aldebaran, and around it the group of faint stars known as the Hyades. Still further toward the zenith, 65 deg. from the horizon, is the famous group of the Pleiades, consisting of six stars easily seen and six others that are seen with difficulty. Below Orion's Belt and close to the horizon is the dog star Sirius—the brightest of the fixed stars.

Princeton University Observatory.

SCIENCE NOTES.

Only 14,995,272 acres, or 15.7 per cent of the whole area of Japan, exclusive of Formosa, consists of arable land, and 55 per cent of the agricultural families cultivate less than two acres each; 30 per cent cultivate 2 acres or more up to 1½ cho, or a little less than 3¾ acres, leaving 15 per cent of the farmers who cultivate the farms of 3¾ acres or more.

An important and valuable discovery relative to the deadly sleeping sickness has been made by the Liverpool School of Tropical Medicine. The cause of this disease, according to the results of elaborate diagnoses that have been made, is attributable to "trypanosomiasis," i. e., the presence in the blood, and in the fluids of the brain and spinal cord, of some form of the microscopic parasite known as "trypanosoma," which is propagated by the tsetse fly in South Africa. From the close observations that have been made upon the afflicted patients, the symptoms and the danger bear some relation to the greater or less abundance of the parasites, and develop seriously when they have entered the cerebro-spinal fluid. The parasites may be present in the blood of deeply-seated organs, when they are not to be found in that which is drawn from a skin puncture, and their frequent temporary disappearances from this surface blood renders it difficult sometimes to be certain of their presence in the system. The expedition organized by the school also discovered a blood-sucking larva, which thrives in many parts of the Congo. During the daytime this larva conceals itself in the cracks of the native floors, and only attacks its victims during the night. When dug up they are found to be full of bright red blood, thereby testifying to the severity of their attack during the previous night. It is the larva of the Glossina fly which is apparently harmless in the imago state. This discovery is of great value, and systematic measures to combat its injurious nature will at once be inaugurated.

A LOCOMOTIVE IN SERVICE SIXTY YEARS.

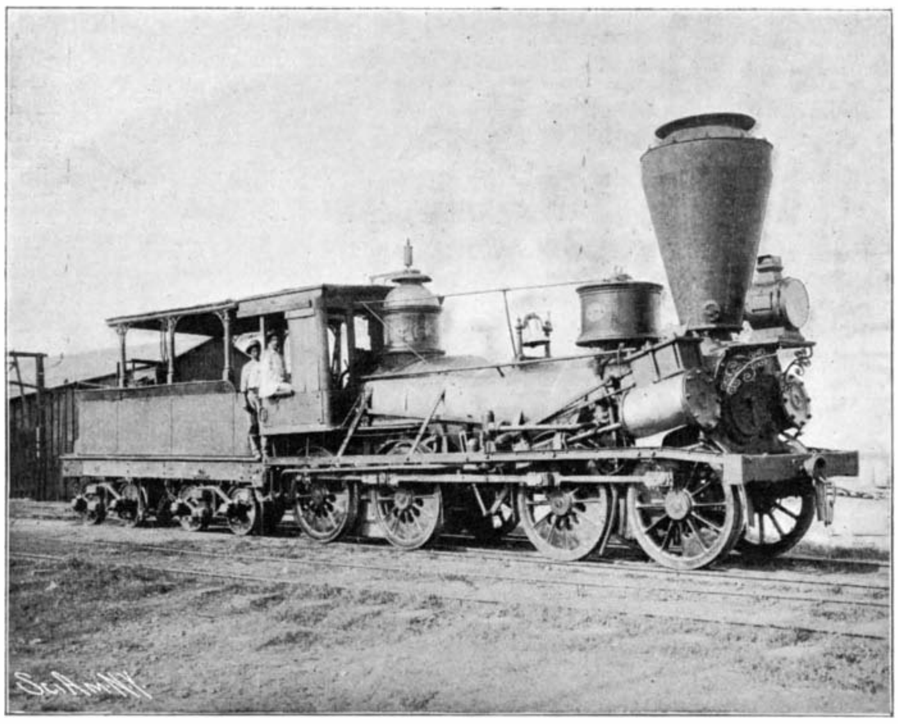
BY HERBERT T. WALKER.

In the earlier days of railroads, the life of a locomotive engine was longer than it is now, for even within the last decade many engines built under the personal supervision of Stephenson, Bury, Baldwin, and Rogers were in active service on the railroads of the United States and Great Britain, as well as on those of other countries that depended on us and the British locomotive builders for their supply of railway motive power.

During say the first forty years of railroad history, the engines were not, as a rule, worked to their fullest capacity; but as time went on, the requirements of railroad work became more exacting, and the period during which an engine was in the roundhouse grew gradually shorter, until to-day a locomotive, especially if it is in freight service, is almost constantly at work, the only intervals being the time necessary for oiling, inspection, and repairs.

As a consequence of these present conditions, one seldom sees a really old locomotive in service; but a notable exception is illustrated in the accompanying engraving, showing an engine which has been in constant use for nearly sixty years on a branch railroad in Santiago de Cuba.

This locomotive was built by M. W. Baldwin, and, by the courtesy of Messrs. Burnham, Williams & Co., who have, at the writer's request, referred to their old records, we are able to publish some interesting details of a design of engine originated by one of the most celebrated of the pioneer locomotive builders of the United States.



ONE OF THE OLDEST LOCOMOTIVES IN USE.

It has been running on a Cuban branch railroad out of Santiago for over sixty years.

It appears that in the years 1847 and 1848 two locomotives of the type illustrated were built for the Havana & Guines Railroad, and one of them is doubtless the engine forming the subject of this notice. The cylinders were inside-connected and were 14½ inches diameter by 18 inches stroke. The engines weighed somewhere about 18 tons.

The leading feature of this design is in the wheel arrangement. All the wheels are drivers, and from the engraving it would appear that the engine is without a truck; but in reality the four front wheels have inside journals running in boxes held by two deep wrought-iron beams, one on each side. These beams are unconnected and entirely independent of each other, and their pedestals are bored out cylindrically to receive cylindrical journal boxes. The main engine frame on each side is directly over each beam, and a spherical pin, running down from the frame, bears in a socket in the beam midway between the two axles. Each beam can thus independently turn, horizontally or vertically, under the spherical pin, and the cylindrical boxes can also turn in the pedestals, so that in passing over a curve, the front pair of wheels can move laterally in one direction—say to the right—while the next pair moves in the opposite direction, or to the left, the two axles always remaining parallel to each other and to the two rear axles, which latter are mounted rigidly in the main frames, as in ordinary locomotives.

The operation of these beams is therefore like that of a parallel ruler, and the spherical pins allowing them to move in a vertical as well as a horizontal plane, they act as equalizers, and so permit the four wheels to accommodate themselves to a rough, uneven track.

It should be explained that the coupling rods are made with ball and socket joints, to enable them to conform to the lateral movements of the wheels. This invention of Baldwin's was known as the "flexible beam truck," for which he secured a patent August 25, 1842; it solved the problem of producing a locomotive with a flexible wheel base, in which the total weight of the engine was available for adhesive purposes.

Other details of this engine may also be noted. It will be observed that the valve chest has two valve stems. The explanation of this is that the chest has two compartments, with a separate slide valve in each chamber. One valve cuts the steam off at full stroke, and the other at an intermediate portion thereof. By suitable levers these valves can be worked either separately or together. This device was one of many invented by Baldwin to take the place of the Stephenson link motion, which he did not consider to be a satisfactory valve gear.

The large smokestack indicates that this locomotive is a wood burner, which fuel requires special provision for preventing an excessive discharge of sparks from the chimney when the engine is under way. Even with the most approved stacks, wood-burning engines throw much fire, and many of us can recall an early day, when we watched the night express as it speeded by, sending showers of bright sparks flying over the dark landscape.

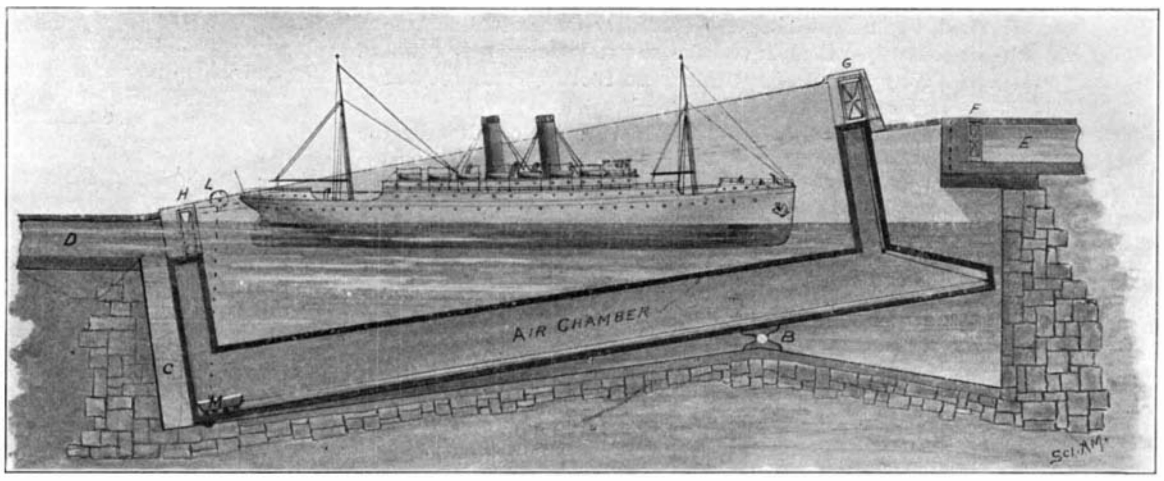
A TILTING LOCK-CHAMBER.

A peculiar form of canal-lock, indeed perhaps more peculiar than serviceable, has been invented by Charles A. Cardot, of Paris, who hopes by means of this device to raise or lower a ship of any size from the upper level to the lower, or *vice versa*, without losing a drop of water.

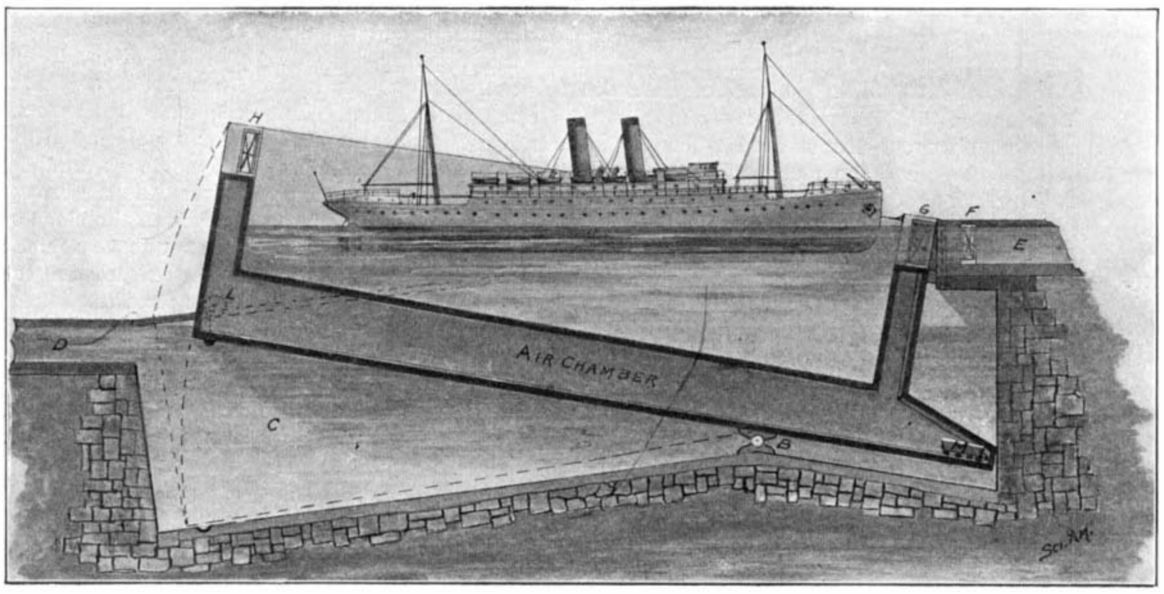
The invention, as the two accompanying illustrations clearly show, comprises essentially a lock-chamber, *C*, permanently in communication with the water, *D*, of the lower level. It will be observed that the bottom of this chamber is formed with two inclines of unequal length, so that the highest point will lie nearer the upper level, *E*, to permit the raising and lowering of the vessel. At this highest point a ridge, as it were, is formed, which constitutes the fulcrum for a floating-chamber mounted to rock on the shaft, *B*.

This floating-chamber is constructed with double walls, constituting an air-chamber, and comprises in itself a water-compartment, the ends of which are closed by gates *G* and *H*. At the bottom of the air-chamber a track is laid, on which a weight, *M*, is mounted to travel. The weight, *M*, is connected, by means of a cable passing over a pulley, with a float, *L*.

In order to tilt the floating chamber down to the lower level, the weight, *M*, is caused to travel in the direction of the lower level, whereupon the corresponding end of the floating chamber descends. When the lower level has been reached, the gates, *H*, are opened, and the vessel continues on its journey. In order to raise a vessel from the lower to the upper level, it is obvious that the reverse operation must be gone through.



The Lock-Chamber Tilted Down to the Lower Level.



The Lock-Chamber Rocked to the Upper Level.

A TILTING LOCK-CHAMBER.

New Bread-Making Process.

United States Consul Mahin, at Nottingham, England, says in a recent report:

"A journalist, Mr. W. Pickering, whose address is not given, though it is presumably London, is credited in a current newspaper item with an invention which entirely dispenses with the customary night work in bread making. The preparation of the dough takes most of the time required in the ordinary baking process, as, after mixing and kneading, it must be left to rise, which requires from four to twelve hours. Mr. Pickering's invention reduces this time to about one hour. No additional plant is required and no extra ingredient is put into the bread. 'The effect is produced by the action of temperatures,' explains the descriptive article.

"At a practical demonstration recently given, it is said that the flour was made up into dough ready for the oven in fifty-nine minutes, and the batch of twenty-five loaves was produced from the raw flour in two hours and thirty-five minutes. The flour was weighed and the number of loaves compared with the number produced by the ordinary process, and it was found that eight more quartern loaves than usual are produced from a sack of flour."

Cement production in the United States in 1903 amounted to 28,454,140 barrels, according to the United States Geological Survey. Of this amount 20,897,973 barrels were Portland cement, 7,030,271 barrels were natural cement, and 525,896 barrels were slag cement. The amount made in 1903 was about 2,700,000 barrels more than in 1902, the output in the preceding year.

NEW FORM OF LIQUID RHEOSTAT FOR STARTING ELECTRIC MOTORS.

BY OUR BELGIAN CORRESPONDENT.

When circuits into which artificial resistances are introduced are traversed by heavy currents, coarse resistance wires, straight or coiled, and stretched upon insulators in the open air, ordinarily are employed. But it is possible, also, to use a solution of a metallic salt in which are immersed plates of the same metal as that of the dissolved salt. The resistance of the bath is modified at will by varying the distance apart of the plates. When it is unnecessary to pay any attention to the electromotive force of polarization, wrought iron electrodes and a solution of carbonate of soda are employed.

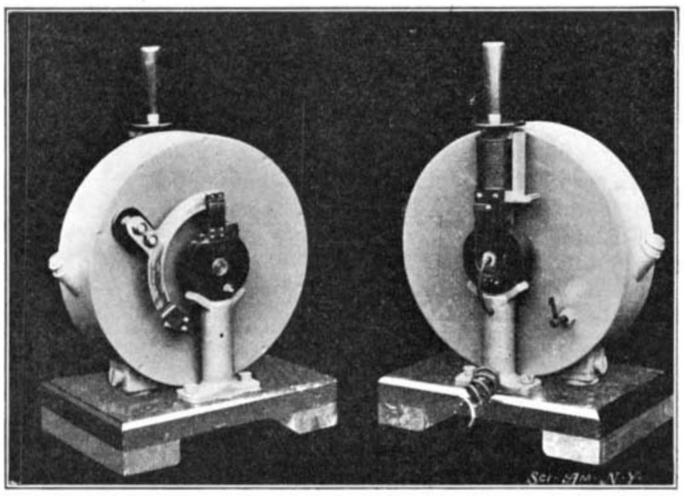


Fig. 1.—New Type of Electric-Motor-Starting Rheostat with Automatic "No Voltage" and Overload Releases.

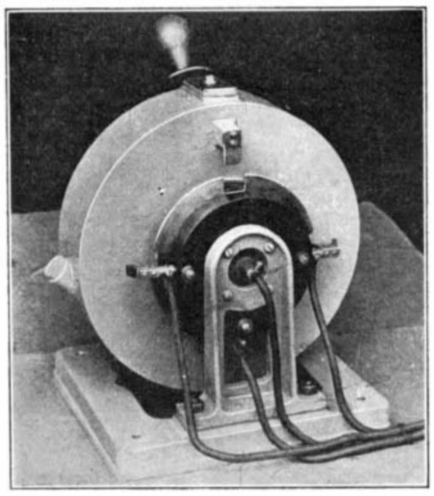


Fig. 2.—Reversing Switch for 5-Horse-power Electric Motor.

The use of liquid resistances offers certain advantages. The superheating that not only damages metallic resistances, but, under certain circumstances, constitutes a danger, cannot occur when liquid resistances are employed. Moreover, the putting of metallic resistances out of circuit, which is usually effected by a switch moving over a series of contacts, destroys the contacts and necessitates expensive repairs. Liquid resistances are, therefore, superior to the others, and they would certainly have been more widely used were it not for certain disadvantages inherent in them. These may be summed up as follows: (1) the creeping of the salts of the liquid, and, consequently, a diminution in the insulation of the apparatus; (2) evaporation, which ruins the terminals, the contacts, and the conductors of the resistance box; (3) the adherence of the oil and air valves; (4) the absence of "overload" and "no voltage" releases (maximum and minimum).

A new rheostat, designed to remedy these inconveniences, has been invented by Mr. Woolliscroft and has been put on the market by the Sandycroft Foundry Co., Limited, of Chester, England. It consists of a cast-iron drum, hermetically closed and filled half full of a solution of soda and water. The drum is provided externally with contacts and terminals, and internally with electrodes. In Fig. 1, on the left, is shown the friction contact segment insulated from the drum, and just beneath the "no resistance" contact, or the one with which the resistance is all cut out. The distance that separates them is such that it can be completely bridged by the forked current collector, which is seen mounted on top of one of the supporting posts of the drum.

The drum is mounted on two of these insulated posts, and has on its side a hole for filling it with liquid. The hole is closed by a screw plug containing a small hole that acts as a safety valve and gives vent to the gases engendered by electrolysis. Since this aperture is never submerged, no losses of liquid can occur.

A minimum release magnet (see Fig. 1 on the right), connected with the shunt winding of the motor, is mounted, together with a handle, on a lever that revolves upon the same axis as the drum. When this magnet is energized, if the handle is placed in a horizontal position, a catch on the armature of the magnet engages with another on the side of the drum. Then, as the handle is raised, the drum, being locked to it, moves along with it. The effect of this movement is to plunge the two electrodes attached to the drum into the liquid. The more they are submerged, the less the resistance in the circuit becomes, until the drum finally reaches the end of its travel, and the resistance is all cut out by means of the special contact already mentioned.

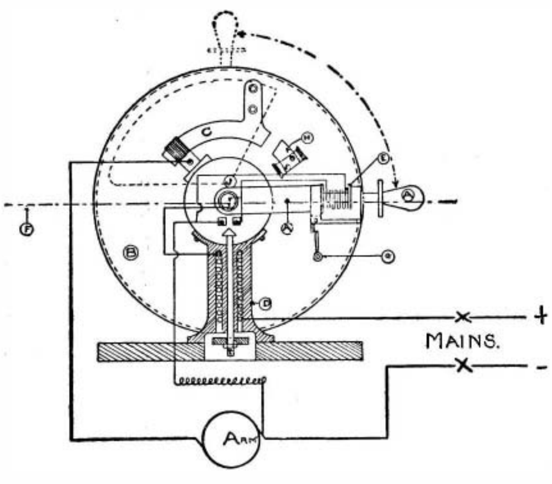


Fig. 3.—Diagram Showing Circuits of "No Voltage" and Overload Release Magnets.

LIQUID RHEOSTAT FOR STARTING ELECTRIC MOTORS.

A "maximum" release magnet is contained in one of the cast-iron supports. This release magnet, in case the current that is passing should be excessive during the operation of starting or during the running, short-circuits the minimum release magnet, causing it to let go the drum, which immediately returns, by gravity, since it is suitably weighted, to the position of interruption.

The diagram, Fig. 3, shows the electrical connections clearly. The current, entering from the mains, passes through the heavy wire of the overload magnet in the supporting post of the drum, and then in through the axis to one resistance plate of the drum. The other resistance plate is connected with the insulated segment on the outside, and the current passes from this segment through the collecting forked contact and back to the mains, thus completing the circuit. The connections of the "no voltage," or underload, magnet are indicated in lighter lines, running from the shunt coil around the magnet and back to the wire in the axis of the drum, which connects with the other side of the armature and shunt coil, as above stated. When an overload occurs, the armature of the large magnet rises, and the plunger on its upper end completes the circuit through the two points shown, which, being a path of less resistance for the current, is taken by the latter in preference to that through the magnet, thus causing the latter to release its armature.

The same company is also constructing a special type of reversing switch based upon the same principle. Fig. 2 shows one for 5 horse-power. It is particularly adapted for elevators, cranes, etc., in which motors requiring a reversal of the current are employed. The house also adapts the system to use with polyphase currents, for which it is particularly well fitted.

The advantages claimed for the system are the following: Simplicity of construction, absolute efficiency in its operation, and absence of sparks. The motor cannot be set in operation too rapidly and may be stopped either through a bipolar apparatus or a liquid resistance. There is no limit of maximum time for the starting, and it is impossible for the resistance to burn. A motor may be stopped at any moment by pressing a button. The apparatus requires scarcely any attention. By varying the density of the solution, the resistances may be adapted to voltages of as high as 700. The apparatus can be easily carried without loss of liquid, and is always ready for operation.

The reduction of fire risks makes these apparatus recommendable for mines, flour mills, powder mills, oil manufactories, and, in general, for all industrial exploitations in which risks are run from the presence of inflammable materials, dust, or gas.

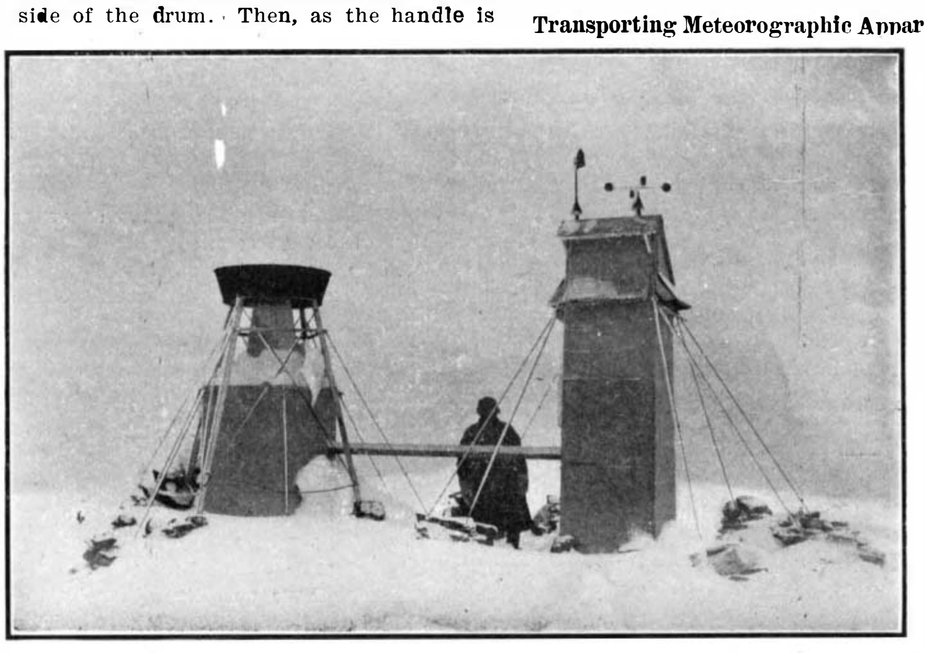
These resistances, moreover, have already been widely sold and, in every case, have given entire satisfaction. In many cases in which metallic resistances had not proved a success, as a consequence of the difficult conditions in which they had to operate, this system has surmounted all difficulties.—Translated for the SCIENTIFIC AMERICAN.

THE REGISTRATION OF METEOROLOGICAL PHENOMENA IN LAPLAND.

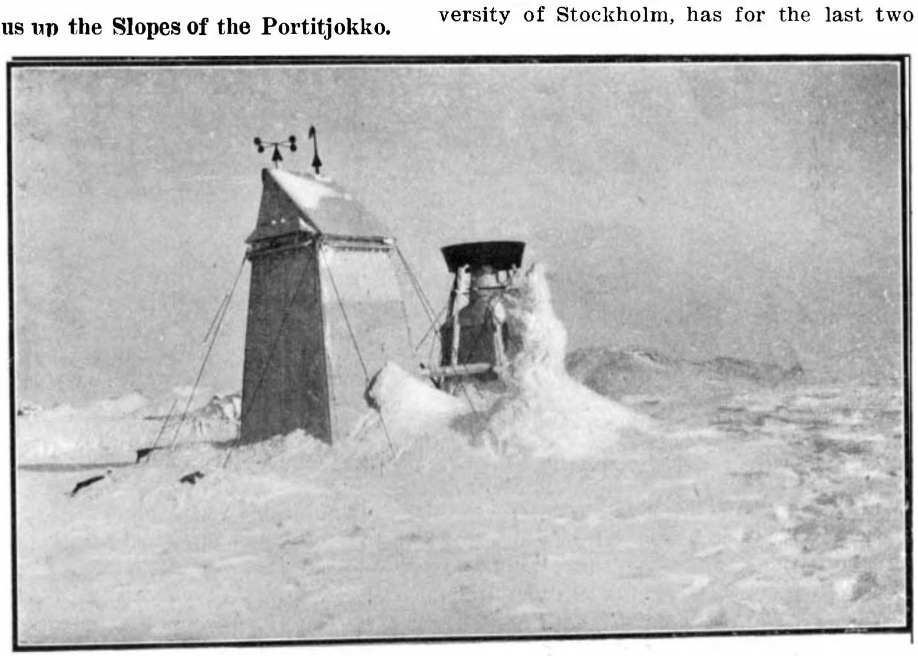
BY EMILE GUARINI.

M. Axel Hamberg, instructor at the University of Stockholm, has for the last two

Transporting Meteorographic Apparatus up the Slopes of the Portitjokko.



The Meteorographic Station upon the "Sahkok" at an Altitude of 8,500 Feet.



The Meteorographic Station upon the Portitjokko from the Southwest.

THE REGISTRATION OF METEOROLOGICAL PHENOMENA IN LAPLAND.

years been engaged in establishing upon the Alps of Swedish Lapland an automatic meteorological observatory something like the one installed with so little success upon the summit of Mont Blanc by M. Janssen of the Institute of France.

Up to the present, two stations have been established, one upon Sähkok Mountain at about 3,500 feet above the level of the sea, and the other upon the Portitjokko at an altitude of 6,560 feet.

The first apparatus stopped for the first time after running for a month, and had to be taken to Stockholm for reconstruction. Each apparatus is calculated for an uninterrupted operation of one year, and weighs about 2,200 pounds. In order to facilitate carriage, the instruments are constructed in parts that can be transported by reindeer. The weights of the clockwork movement weigh 660 pounds, and are divided into parts, each weighing 35 pounds.

The second experiment gave good results. The registration is obtained by means of a bar, which, three times an hour, falls across needles and produces in the paper perforations corresponding to each of them. The great difficulty to be surmounted is the hoar frost. The Portitjokko station, for example, was, after a few months, completely surrounded by a stratum of frost of at least three feet in thickness, and the apparatus very naturally ceased to operate. The instruments were then taken down to 500 feet from the summit, but, even at this altitude, the formation of frost interfered with their operation, especially in autumn. It is then almost impossible to prevent interruptions in the registration of the velocity and direction of the wind. In order to obviate this inconvenience, M. Hamberg has the summit apparatus cleaned from time to time by a Laplander, and after this the running proceeds uninterruptedly till the succeeding autumn.

Not only the frost, but the fine snow, also, which it is very difficult to exclude, causes serious trouble. On the other hand, in order to assure the proper operation of the apparatus, the air that surrounds them in the hut must be kept as dry as possible, else the paper will wrinkle and the pieces of iron will rust, and, at every variation of temperature, the frost will deposit upon the clockwork movement and stop it.

In order to dry the air to as great a degree as possible, it became necessary to place paper cylinders around the clockwork movement, and, around the registering apparatus, an iron plate casing containing cups filled with chloride of calcium. It was owing only to such precautions that the running of the apparatus became uniform during the entire winter. The apparatus installed at 3,500 feet altitude has operated almost continuously for two summers, and the second, placed at 6,000, has operated equally as well. The anemometer and the weather vane, however, have sometimes been stopped by the autumnal frost.

The winding up of the clockwork and the changing of the paper bands of the registering apparatus are effected but once a year. The registration during the year requires the use of 65 feet of paper. The weight that actuates the clockwork movement descends but 60 inches a year. This movement was constructed by M. G. W. Linderoth, a Swedish horologist.

A complete station comprises two huts, one containing the paper-cylinders, the clockwork, and the registering apparatus, and the other the rain and snow registering apparatus. This latter is suspended from spiral springs in a large cask. When there is a fall of rain or snow, the cask descends according to the greater or less quantity of material that it receives, and thus causes the registration. The huts are constructed of wood and iron plate.

The problem of the meteorography of high altitudes is therefore solved, or at least will be ere long. From now on the curves obtained will probably teach us much upon this subject, for it is to be anticipated that M. Hamberg's experiment will not remain isolated, and that analogous observatories will be installed at numerous points of the globe. Perhaps it will even be possible to resume M. Janssen's experiment upon Mont Blanc.

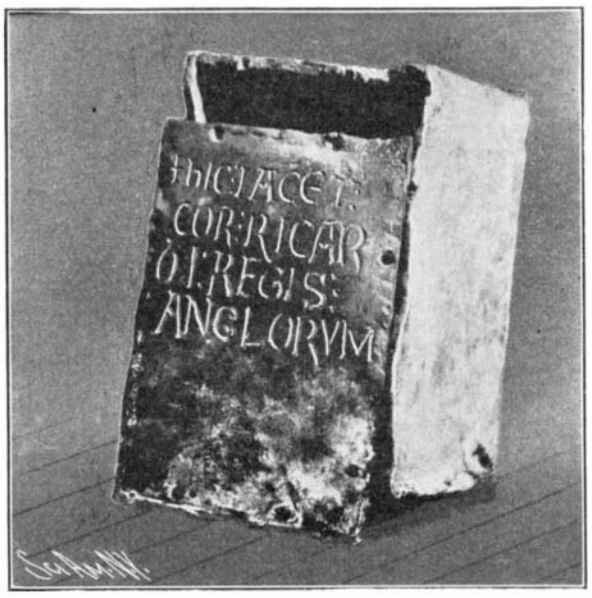
Death of Gen. Di Cesnola.

Gen. Luigi Palma di Cesnola, soldier, archæologist, director of the Metropolitan Museum of Art, died November 22, 1904. General di Cesnola's career was picturesque. Born in 1832, in Piedmont, Italy, he entered the army at the age of seventeen, served through the Italian war against Austria, and was decorated on the field of battle for bravery. Later he went through the entire Crimean war and was present at the fall of Sebastopol. His fighting career did not end there. He came to this country in 1860, taught languages for a while, and entered the United States service as an instructor in tactics and cavalry drill. When the civil war broke out he raised a company and fought in many important battles. He was captured by the Confederates and spent nine months in Libby Prison. At the close of the war President Lincoln promised him a promotion to the grade of brigadier-general. Although the President's untimely death prevented him from carrying out this promise, Di Cesnola always was known as a general.

It was as consul to Larnica, Cyprus, to which post he had been appointed by Lincoln, that Gen. Di Cesnola began his famous archæological investigations. For twelve years he thoroughly explored Cyprus, made excavations in which he gathered thousands of relics, which he afterward catalogued and described in his book "Cyprus: Its Ancient Cities, Tombs and Temples." This Cyprus collection may be regarded as the nucleus of the present Metropolitan Museum of Art. Gen. Di Cesnola became a trustee of the museum in 1877 and was later made its director. The museum as we know it to-day may be regarded as a monument to his energy, enterprise, and rare executive skill. In his death the museum has lost a director whose place it will be very difficult to fill.

AN INTERESTING RELIC.

In the splendid cathedral church of Rouen is a suite of three or four rooms containing what is known as the "Trèsor." This is a collection of very valuable and interesting relics, forming quite a little museum, to which admission may be obtained for the modest fee of 25 centimes. To an Anglo-Saxon quite the most interesting article in the collection is the plain leaden casket in which was buried the heart of the famous King Richard Cœur-de-Lion, who, it will be remembered, was slain by a bolt from the crossbow of Bertrand de Gourdon at the siege of the castle of Chaluz. His body was buried at the feet of his father at Fontrevault near Tours, but his heart was incased in two leaden caskets and buried in the cathedral of Rouen, "the faithful city."



THE CASKET THAT CONTAINED THE HEART OF RICHARD COEUR-DE-LION.

The exact place of its burial seems to have been forgotten, but it was re-discovered in 1840, placed in a new receptacle, and reburied in the choir. The old leaden cases, the outer one of which was in a most dilapidated condition, were placed in the "Trèsor," with the following inscription:

Cercueil
et
Boite de plomb
ou fût renfermé
lors de sa sepulture en 1199
la Cœur de
Richard Cœur-de-Lion.
Trouvés en 1840
dans le sanctuaire de la Cathedral
de Rouen.

The inner case is in comparatively good condition, the inscription being perfectly legible after all these hundreds of years. The Latin is somewhat peculiar, and it is curious to find that at a period when the art of working in metals was at an advanced stage, the engraver of the inscription on the coffer which was to contain the heart of such a high and mighty potentate did not take the trouble to ascertain what space he required for the king's name, so that he had to carry over the terminal letter to the next line. It is noteworthy, too, that Richard is styled "Regis Anglorum," "King of the English"—not of "England"—while no reference at all is made to Normandy or Aquitaine. The box is about a foot long, eight inches wide, and five deep.

The Current Supplement.

The current Supplement, No. 1509, opens with an excellently illustrated article by the St. Louis correspondent of the Scientific American, in which some interesting models at the Fair are described. One of the finest of these shows the methods of anthracite coal mining as carried out in the State of Pennsylvania. Another represents naval warfare on a mimic scale. Mr. A. A. Campbell Swinton recently read before the British Association an instructive paper on the development of electricity from water power. The paper is published in the current Supplement. The Supplement will hereafter publish every two weeks an article by Prof. N. Monroe Hopkins on experimental electro-chemistry. When completed the series will constitute a splendid student's manual. The articles are noteworthy for their practical character, the many clear drawings of easily-constructed apparatus that are used as illustrations, and the intelligible exposition of the subject. "A Chemist in the Days of the Stuarts" is the title of a contribution in which much curious historical information is given. The Navy Department exhibit in the Government Building at St. Louis is fully described and illustrated. The same applies to the exhibit of rolled and flanged steel plate. Douglas W. Freshfield's paper on "Mountains and Mankind" is concluded.

Electrical Notes.

The British Admiralty has obtained the exclusive use of a new apparatus, which is to be employed in connection with wireless telegraphy. Precisely what the invention comprises is not known, as it is a jealously-guarded secret. It is called a cryptogram, and is the invention of a Swiss mechanic. Its purpose is to prevent the interception of wireless messages, except by a person or station provided with the same device. The apparatus is stated by the English naval authorities to be perfect in operation, since when five of these instruments were submitted by them to a series of exacting tests, they proved so successful that the device was procured by them outright.

Mr. L. R. Lee, of the electricity station of the Manchester, England, corporation, has invented an apparatus for the ventilation of watertight-incased transformers used in underground stations, which are liable to flooding. In this invention discriminating valves are fixed to the case or tank containing the transformer, thereby enabling a continual supply of air to enter and leave the tank. One advantage of this device is that any water that may be left in the transformers during the process of manufacture can make its escape, by condensation on the underside of the cover, and then running out of the inclosing tank, the cover being formed in such a way that the water cannot remain inside. No apprehension need be entertained regarding the safety of a tank fitted with these valves in the event of flooding, for even if the water rises completely over the transformer, none can enter the case, and as soon as the water is drained away or removed, ventilation is at once automatically resumed.

A new method of wireless telephony is being developed by Prof. Quirino Majorana, of Rome. This system, according to reports in the Italian technical press, seems to be based essentially on the Marconi wireless telegraphy. In the latter, as is well known, a series of shocks corresponding to the various sparks is produced at the receiver, when the sparks are made to jump at the transmitting station. The receiver designed by Marconi enables the operator to decipher the telegrams acoustically, listening to the series of sparks. The number of sparks, however, does not exceed 10 per second in the Marconi apparatus, whereas Majorana has increased this number up to 10,000 per second, though the various sparks are evidently weaker than those used in wireless telegraphy. Persons placed at the receiving station will, therefore, not note anything, the succession of sparks being too rapid and the sparks themselves too similar to one another. As soon, however, as the uniformity of these sparks is interrupted artificially by the oscillations of the human voice, every word will be transmitted truly to the receiver. The Cologne Gazette, in a recent issue, points out the similarity of Majorana's endeavors to the scheme outlined by Prof. H. Th. Simon and Dr. Reich. According to the researches of these experimenters, the problem of wireless telephony by means of Hertzian waves has been solved at least theoretically. Transmitters so far used in wireless telegraphy yield trains of waves interrupted by relatively long pauses, and corresponding to the various spark discharges. Though the interval between the passage of a group of waves and the production of the subsequent group is only a minimal fraction of a second, this short interruption in the series of oscillations will be quite sufficient to render any transmission of acoustic waves of the human voice to a distance impossible. Wireless telephony requires continuous wave currents. These are obtained by Prof. Simon by the aid of an Arons-Hewitt mercury lamp as vacuum spark gap, when the discharge potential between the spark electrode exceeded 50,000 volts, and the frequency of the spark discharge 10,000,000 per second, that is much more than according to Majorana. In wireless telephony the intensity of the spark wave will have to be adapted to that of the acoustic waves. This will be possible either by the wave lengths or by the intensity being altered. The first scheme has been chosen by Prof. Fessenden, whereas Majorana seems to have adopted the second alternative.

Correspondence.

German Bells at St. Louis.

To the Editor of the SCIENTIFIC AMERICAN:

I was much interested in your description and illustrations of the German national pavilion at the St. Louis Exposition, especially in your reference to the bells. You are in error, however, in saying they were purchased by an eastern city, as they were purchased for St. John's German Lutheran Church, of Reading, Pa., the Rev. Dr. J. J. Kuendig, pastor. F. S. WERTZ.

Reading, Pa., November 18, 1904.

◆

Indian Summer.

To the Editor of the SCIENTIFIC AMERICAN:

The author of the article on Indian summer in the SCIENTIFIC AMERICAN is in error when he supposes the Northern States and Canada have a monopoly of that delightful phenomenon. Earth has no more beautiful scenes than are beheld in the Southern and Gulf States in the Indian summer periods, especially in the region of the Blue Ridge Mountains. As I write this in a Southern Gulf town, the indescribable Indian summer haze hangs over town, prairie, and bay, although summer verdure is still unscathed.

ALEX WILLIAMS.

Port Lavaca, Texas, November 17, 1904.

HENRI BECQUEREL.

BY DANIEL BELLET.

Henri Becquerel first came prominently before the public when he began the investigation of phosphorescent and fluorescent substances shortly after the discovery of the X-rays, for the purpose of ascertaining whether their phenomena might not be attributed to causes similar to those which give rise to the properties of the Crookes tube. He found that they projected emanations entirely different in character—emanations which have been fittingly named "Becquerel rays."

Prof. Henri Becquerel is the grandson of a celebrated physicist, Antoine César Becquerel, and the son of an equally illustrious physicist, Alexandre Edmonde Becquerel. At present Henri Becquerel is professor of applied physics. When he first began his course of lectures in 1892, at the Museum, with characteristic modesty he never once referred to his own name in passing in review work of his predecessors, despite the fact that these predecessors were his father and his grandfather. His educational activities are not confined to the Museum, for he is actively engaged at the Conservatoire des Arts et Métiers, and is also one of the Chief Engineers of the Department des Ponts et Chaussées.

Born in 1852, Henri Becquerel entered the Ecole Polytechnique at the age of 20. The three years from 1874 to 1877 were spent at the Ecole des Ponts et Chaussées, a preparatory school in which the construction of roads and bridges and civil engineering in general is taught. Although an engineer by training, Becquerel was soon attracted to the study of pure science, following in the footsteps of his eminent grandfather and father. In 1878 he entered the Museum of Natural History, an institution with which the name of Becquerel will be ever linked. Since 1895 he has filled a professor's chair at the Ecole Polytechnique. He has been a member of the Academy of Sciences since 1889.

I did not have the pleasure of knowing Prof. Becquerel personally when I received the commission of interviewing him for the SCIENTIFIC AMERICAN. What struck me most when I first met him was his charming personality. He lives in one of the most aristocratic streets of Paris, in the Quartier des Champs Elysées, quite near the Arc de Triomphe et de l'Etoile. When I stepped into the reception room of his house, I marveled not a little at the artistic surroundings in which I found myself. And the reception room is but a counterpart of every room in the house. Every chamber through which I was conducted by Prof. Becquerel had its old furniture, its quaint bric-a-brac, its walls covered with pictures—many of them heirlooms and family relics handed down by Antoine César Becquerel. Although a scientist to his finger tips, Prof. Becquerel assured me that he takes a lively interest in the beautiful surroundings of his home, and the contemplation of pictures and statues is a diversion and a rest from the arduous work of the laboratory.

In person Becquerel is short. His face is wonderfully expressive and mobile. His diction is choice. Every word is selected with the care habitually given by a man of culture to literary form.

His laboratory work is admirably systematic. For weeks he experiments and observes the results of his experiments in accordance with a well-defined plan. Probably it would not be impossible for him to state far in advance what particular phase of scientific research would receive his attention on a certain day a year hence. And this systematic plan, which he has followed more or less throughout his entire career, may be considered a continuation of the work of his father and grandfather. Despite the fact that there is hardly a branch of pure science in which he has not made some important discovery, he has occupied himself chiefly with the problem of those mysterious luminous phenomena which his father before him had studied, and the solution of which his grandfather had dimly foreseen. It is this continuity of scientific purpose and investigation that lends so peculiar an interest to the labors of the Becquerel dynasty.

Henri Becquerel labored long and faithfully in the fields of electricity, magnetism, optics and meteorology; but the researches which he has carried on in these fields are really part of a well-defined system having for its object the study of electro-optic phenomena such as the invisible infra-red spectrum and the absorption of light. All his investigations have been carried on in the physical laboratory of the Museum of Natural History which was the scene of the labors of his father and grandfather before him. Starting with Faraday's splendid discovery of the relation of electro-magnetism to light, Becquerel succeeded in showing the existence of a fundamental relation between the rotary magnetic power of bodies and a very simple function of their index of refraction. The limitations of this article prevent me from following in detail the interesting development of Becquerel's theories. Hundreds of observations were made which lead to the conclusion that the phenomena of electro-magnetism are intimately connected with the speed of propagation of luminous waves, and to an inter-molecular magnetic action. Negative rotations in the plane of rotation of light were studied minutely, and clearly and simply explained. The Faraday phenomena were discovered in gases, an entirely new domain, by means of wonderfully ingenious and sensitive apparatus. The magnetic influence of the earth as part of this systematic plan of investigation was likewise studied, and the results obtained have fully confirmed the conclusions which have been inductively drawn by scientists. So far, indeed, were these investigations carried, that a method was devised for determining the rotary magnetic power of a body, and of ascertaining by simple optical measurements the absolute intensity of terrestrial magnetism. Naturally Becquerel was ready to approach from an entirely new standpoint the phenomena of atmospheric polarization, with the result that he had made discoveries that are ill described by the simple word "startling."

Becquerel's study of invisible infra-red radiations is not the least interesting work which he has accomplished. Here he followed directly in the footsteps of his father, who had discovered that these thermo-rays cause the phosphorescence of a substance which has been previously rendered luminous. This may be said in a measure to be the starting-point of the discovery of the radio-activity of matter. By projecting on a phosphorescent surface discontinuous spectra of incandescent metallic vapors, he discovered a series of rays, the existence of which had never been suspected. He was thus led to examine the invisible vapors of different metals. This opened up an entirely new field in spectroscopy.

Becquerel's interesting investigations of the absorption of light by various bodies brings us nearer to the subject of radio-activity; for the compounds of uranium were used in studying the phenomena of phosphorescence. He proved the variability of the spectra with the direction of the luminous vibrations by which they were traversed. All these researches led to a new method of spectrum analysis, based on the independence of the various substances of which a single crystal is composed, and rendering it possible to determine the structure of the crystal without fracture. It was this work that earned for him a place among the members of the Academy of Sciences. While continuing his studies of phosphorescence and light, he still found time to investigate fluorine.

Each discovery that he made seemed to foreshadow the next; for he seemed to sow the scientific fruit which he was to garner at a later day. Although in 1896 he began his interesting communications to the Academy of Sciences on the radiant properties of the salts of uranium, and although for two years he patiently made experiments on the emanations of uranium and its salts, it is somewhat remarkable that at the beginning of 1898 not a word is published in the reports of the Academy of his labors. The reason is to be found in the fact that he did not wish to publish immediately the discovery of phenomena which formed but a part of still vaster discoveries—discoveries which are now in course of publication, and which are concerned chiefly with Faraday and Zeeman phenomena.

It is impossible in the brief space at my disposal to enumerate all the discoveries which have been made by Prof. Becquerel. A modern scientific bibliography, however, would be very largely composed of studies bearing his name; they would include monographs of all kinds on radio-active substances and radio-activity.

It must not be forgotten that the work of M. and Mme. Curie, strikingly original though it may be, was nevertheless suggested by, and may be said to be an outgrowth of, Becquerel's investigations of uranium. Prof. Becquerel himself has only very recently published a voluminous treatise on the spontaneous radio-activity of matter, to which he has given the suggestive title "Researches on a New Property of Matter."

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Results of the Annual Automobile Hill-Climbing Contest at Eagle Rock.

The fourth annual hill-climbing contest of the Automobile Club of New Jersey was held on Thanksgiving Day, November 24, at Eagle Rock hill in Orange. The cars were classified according to selling price, and also by weight. The fastest time was made by Bernin, who, on W. Gould Brokaw's 60-horse-power Renault racer, covered the mile up an average grade of about 12 per cent in 1 minute, 20 seconds, or at a speed of 45 miles an hour. William K. Vanderbilt, Jr., on his 90-horse-power Mercedes car, made the climb in 1 minute, 20 3-5 seconds; and two 90-horse-power Fiat racers, driven by William Wallace and Paul Sartori, secured third and fourth places in 1:22 and 1:22 1-5 respectively. These records were made in the contest for cars weighing from 1,432 to 2,204 pounds. In the contest for light cars, weighing between 851 and 1,432 pounds, Guy Vaughn, on a 40-horse-power Decauville, took first place in 1 minute, 37 1-5 seconds; while a 7½-horse-power Prescott steamer and a 15-horse-power White steamer made the second and third best times in 1:37 3-5 and 1:48 respectively. The same White machine made the best time in the contest for stock steam cars, this time being 1:23 3-5.

In the contests for gasoline machines of various prices, an Oldsmobile made the best time (3:06 1-5) for machines selling under $850, a Cadillac coming second in 4:33 2-5. The winner in the $850 to $1,250 class was a 22-horse-power Buick car, which made the climb in 2:18 2-5, and was followed by a 12-horse-power Duryea in 2:33 2-5 and two 15-horse power Elmores in 2:41 4-5 and 2:45 3-5. In the $1,250 to $2,000 class, first, second, and third places were secured by a 14-horse-power Columbia, a 12-horse-power Franklin, and a 16-horse-power Rambler in 3:14 2-5, 4:03 3-5, and 4:13 2-5. A 40-horse-power Thomas, representing machines in the $2,000 to $3,000 class, covered the mile in 2:42 4-5; while in the $3,000 to $5,000 class a 24 to 30-horse-power Walter car secured first in 1:54 2-5, and 24-horse-power Pope-Toledo and Matheson cars second and third in 2:15 4-5 and 2:21 4-5. It can thus be seen that some of the moderate-priced cars are just as good or even better hill-climbers than those of the larger and more expensive type. Of the cars valued at over $5,000, the best times were those stated above for heavy machines. It will be noted that all of these are foreign machines. The records for electrics were 4:22 3-5 by a 3-horse-power Torbensen machine and 5:23 2-5 by a Columbia. In the 551 to 851-pound class for gasoline cars, a Franklin did the climb in 2:26, and a Cameron in 3:07 1-5, both of these machines being of the air-cooled-motor type. The hill climb was the most successful one ever held at Eagle Rock, and it furnished an ample demonstration of the climbing ability of both American and foreign stock cars.

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The Oldest Self-Striking Clock in the World.

In the north transept of Wells Cathedral, England, may be seen the oldest self-striking clock with a count-wheel in the world, having been constructed by Peter Lightfoot about 1320. This timepiece contains many devices which testify to the ancient horologist's ingenuity. Several celestial and terrestrial bodies are incorporated in interesting movement and relationship. They indicate the hours of the day, the age of the moon, and the position of the planets and the tides. When the clock strikes the hour, horsemen fully armed dash out of two gateways in opposite directions, and charge furiously. They strike with their lances as they pass, as many times as corresponds with the number of the hour. A little distance away is seated upon a high perch a quaint figure, which kicks the quarters on two bells placed beneath his feet, and strikes the hours on a bell. The dial of the clock is divided into twenty-four hours, and indicates the phases of the moon and a map of the heavens. Outside the transept is another large dial and two bells, on which two armored knights strike the quarters, each with his halbert, and are said to be actuated by the mechanism of the clock inside.

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The National Mosquito Extermination Society.

The second annual convention of the above society is to be held on December 15 and 16 next in New York and Brooklyn. There are to be participants from abroad and all over the United States. Important measures are to be considered in reference to the extermination of the mosquito in the various States, and much interesting information is promised.

The society has recently issued its first annual Bulletin, which is full of useful facts and historical data relating to the work done during the past year.

THE CALIFORNIA REDWOOD IN MODERN ENGINEERING.

BY H. A. CRAFTS.

The California redwood (*Sequoia sempervirens*) has been chiefly celebrated in its primitive form of gigantic trees; its place in modern mechanics has not been so extensively dwelt upon. Yet at the same time the wood occupies an important position in the industries of the country, especially those of the Pacific slope.

While the use of redwood is large and increasing, the supply is limited. The principal field of supply extends along the Pacific coast from the northern boundary of California nearly to San Francisco Bay, and reaches inland only from ten to twelve miles. There is a limited area of redwoods south of San Francisco, but it does not count much in the general supply of lumber. Humboldt County in the north, which contains the larger redwood forests, has cut 52,000 acres of the wood, but still has left 486,000 acres. It is estimated that this acreage contains 49,000,000,000 feet of redwood lumber, which at the present rate of consumption, about 250,000,000 feet annually, would last about two centuries. More conservative estimates, based upon a broader knowledge of supply and demand and the probable increase in consumption, give only one century for the final exhaustion of the country's supply of redwood. As no measures are being employed with an idea of conserving the supply, this estimate will doubtless prove to have been pretty nearly correct.

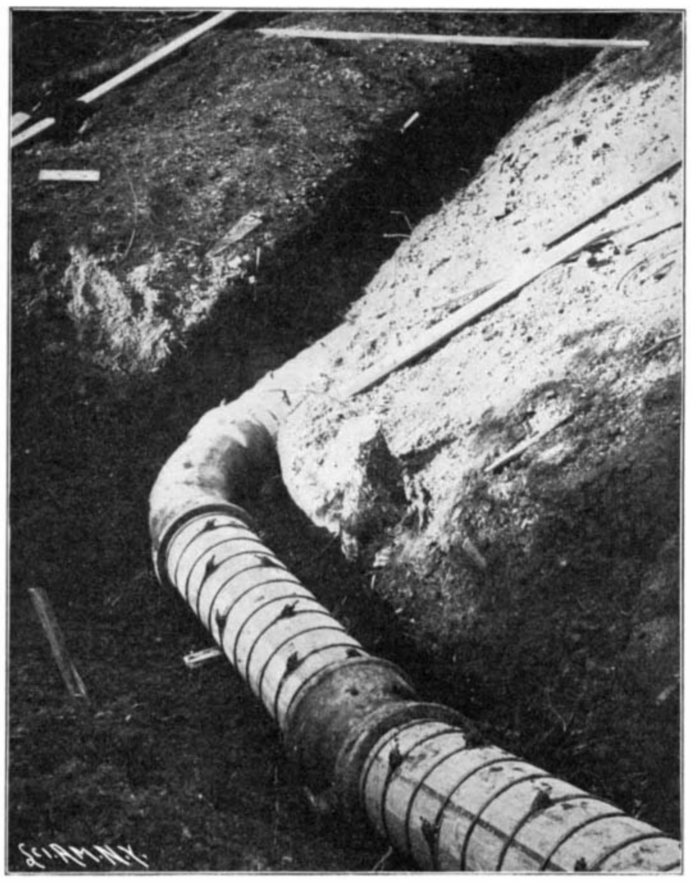
The demand for redwood in the lumber trade is increasing. Its use is at present almost wholly confined to the Pacific slope, but the millmen of the coast are exerting themselves to push the material into the eastern markets, especially the market of Chicago. The redwood in a manufactured state has thus far been used in the East in the shape of shingles; but its adaptability to the manufacture of doors, sash, blinds, mantels, as well as to making of both exterior and interior finish, stave pipe, etc., will be demonstrated.

The uses to which the redwood is put in California are almost innumerable; but its employment in the manufacture and use in stave pipe and tanks is of special interest. The principal uses to which redwood stave-pipe are put include domestic water supply, irrigation, water power, and outfall sewers. The pipe is slowly finding its way even into the more extreme East, the Excelsior Wooden Pipe Company, of San Francisco, having just secured the contract for installing a system of domestic water supply in Lynchburg, Va., which includes twenty miles of pipe of 30-inch internal diameter. The same company not long since installed a section of water-power pipe of the same wood at Cornell University, New York, of an internal diameter of 60 inches.

But it is in the great mining, irrigation, and domestic water supply operations of the Pacific slope that the more striking features of the use of redwood stave pipes and tanks are observable. The stave pipes vary in size from an internal diameter of eight inches to nine feet; while one manufacturing company has in contemplation the construction of a pipe to have an internal diameter of ten feet. The redwood tanks are used principally for the holding of water, but at the same time many are used for the storing of oil and wine, while they enter largely into the construction of cyanide plants for the separating of ores. In the construction of this class of tanks it is interesting to note that a former custom of building them larger at the bottom than at the top has become almost entirely obsolete, the modern tank being built in the shape of a perfect cylinder.

The larger stock tank has a capacity of 100,000 gallons. A tank of this capacity would have an outside diameter of 31 feet 9 inches and a height of 18 feet.

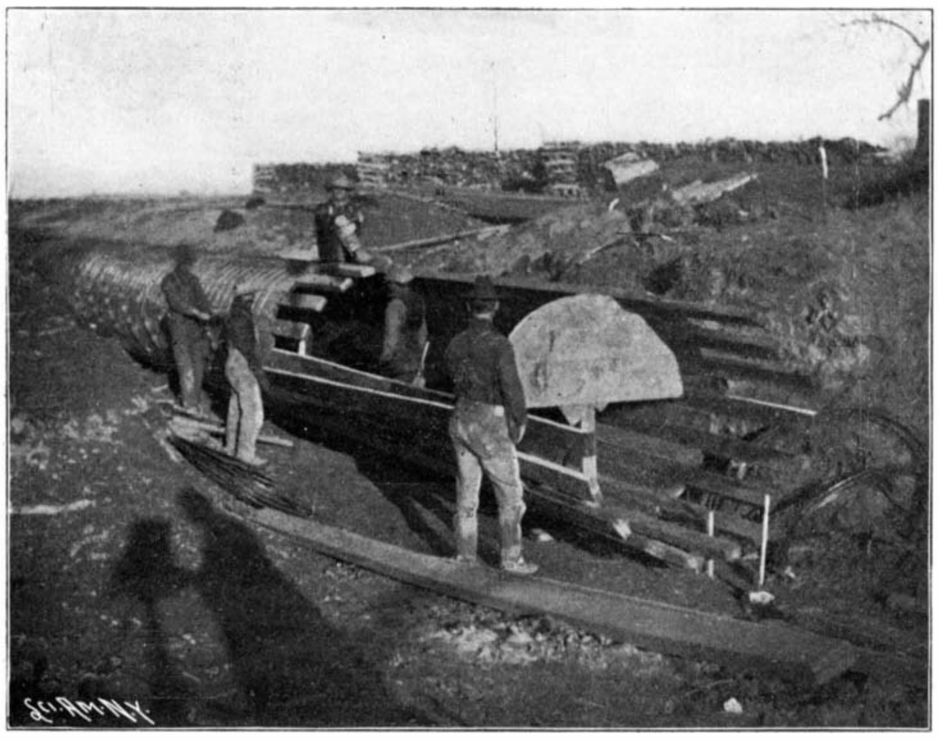
The larger-sized redwood stave is made in short sections, and the radii of the curves in the completed pipe lines are necessarily long. The radius of the ordinary curve in a ten-inch pipe is about 125 feet, while that of a nine-foot pipe is about 800 feet. In meeting sharp curves it is found necessary to introduce riveted steel elbows. In the smaller pipes, however, it is found pos-



Redwood Pipe with Steel and Iron Elbows.

Redwood Stave Pipe that has Supplanted an Irrigation Flume.

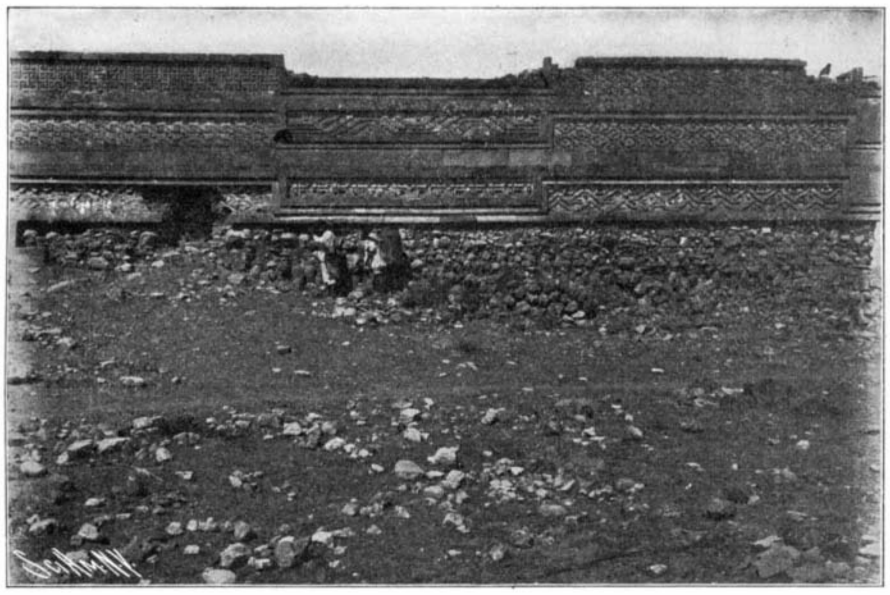
Two-foot Domestic Water Service Redwood Stave Pipe Showing Two-foot Gate.



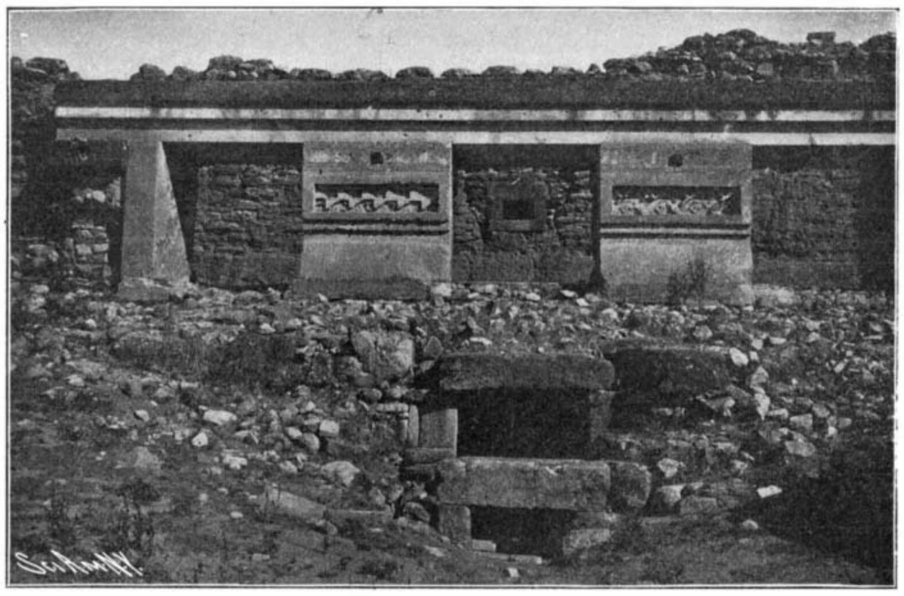
Laying a Redwood Stave Water Pipe.

Three 54-inch Redwood Stave Pipes Used for Power Purposes.

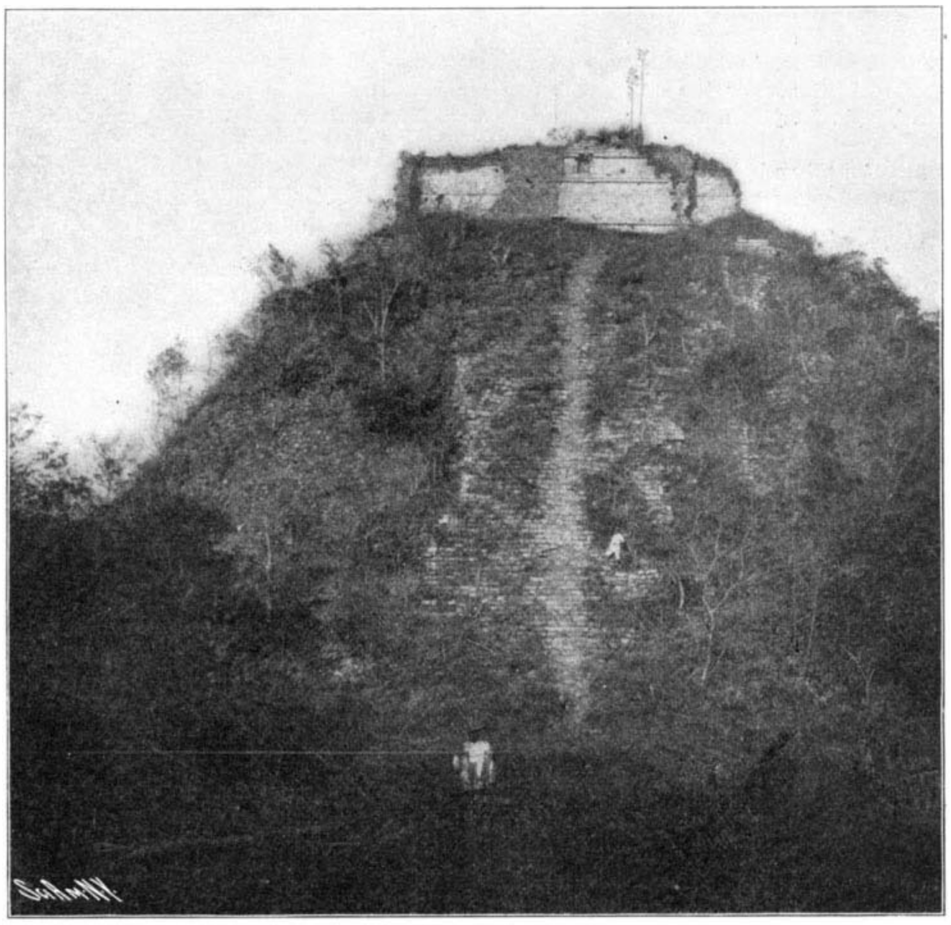
CALIFORNIA REDWOOD IN MODERN ENGINEERING.



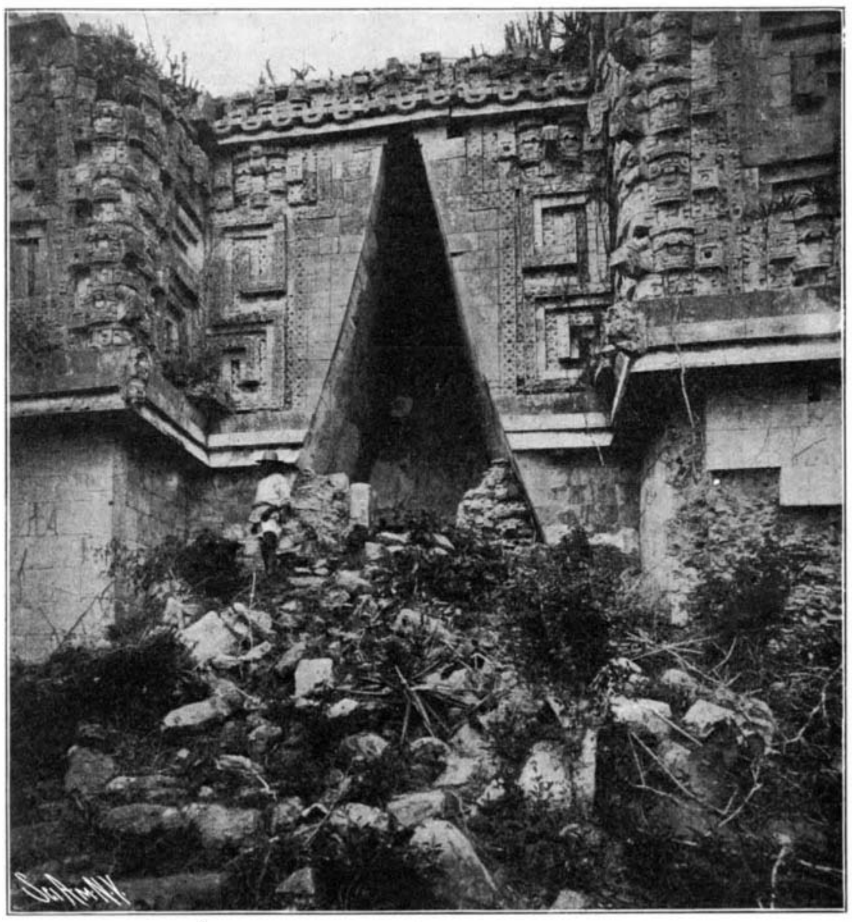
Exterior View of the Temple of the Columns, Mitla, Oaxaca, Mexico.



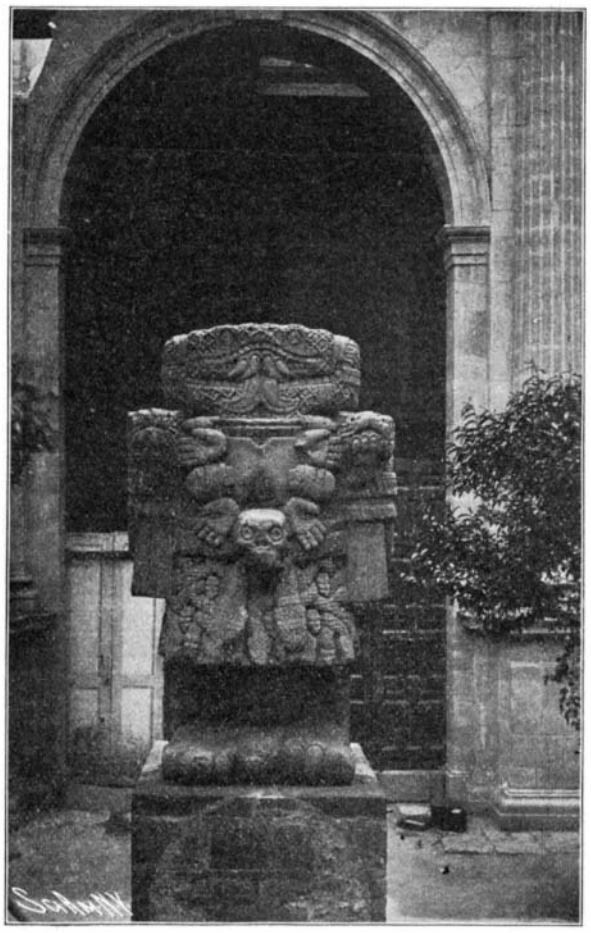
Facade of the Temple at Mitla. Below Appears the Obstructed Opening Leading into the Subterranean Chambers.



Ruins of the Great Pyramid Temple Called the "House of the Magician," Uxmal, Yucatan.

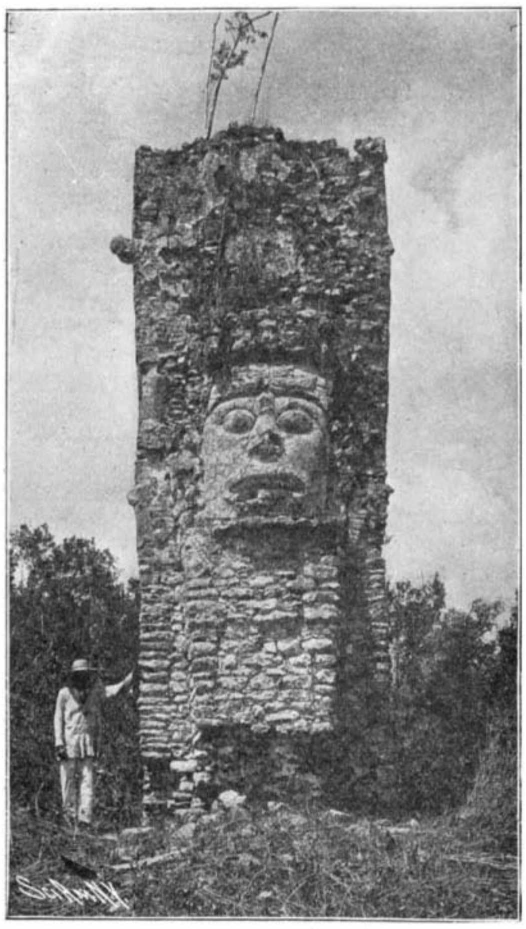


One of the Great Arched Doorways of the House of the Governor, Uxmal, Yucatan.



Aztec Sculpture Representing Two or More Deities of the Aztec Pantheon. Height, 10 Feet; Weight, 12 Tons.

The Ruin of a Small Temple on Cozumel Island, Eastern Yucatan.



Ruin of the Building Showing Remains of a Great Stucco Face, Nocuchich, Northern Yucatan.

THE ANCIENT RUINS OF YUCATAN AND MEXICO.—[See next page.]

sible to use cast-iron elbows. In constructing wood stave pipe around a curve, the staves are fitted together, partially banded, and then, by applying such power as the surrounding conditions will permit, the pipe is made to assume its desired shape. During the application of the power the staves are driven endwise, in order to close the butt joints. To bring the larger-sized pipe into proper curve, it is usually the custom to employ jack screws.

The use of the redwood stave pipe has been found especially favorable to hydraulic engineering in the West, because of its lightness and ease of transportation. For the construction of pipe lines in mountainous countries, remote from railroad transportation facilities, it fills the bill almost completely, for the reason that it can be carried in the "knocked-down" shape. If need be, the staves may be lashed to the backs of burros, and thus carried into places absolutely inaccessible to a vehicle of any kind. When thoroughly seasoned, the California redwood has a lighter specific gravity than almost any other known wood, weighing only about two and a half pounds to the board foot. The wood also possesses a great power of resisting decay, for the reason that it is very free from knots, seams, and pitch.

In the irrigated districts of the Pacific slope the use of redwood stave pipe is being largely employed in the conducting of water across deep canyons and gulches, taking the place of the old-fashioned trestled flume. Pipe thus employed usually does its work in the shape of an inverted siphon.

The manufacture of stave pipe is quite a simple process, the staves being turned out by an ordinary machine called a "sticker." The edges of the staves are of course cut on radial lines, and the sides on concentric circles that conform to the inside and outside radii of the pipe or tank under construction.

THE ANCIENT RACES OF YUCATAN AND MEXICO.—II.

BY RANDOLPH I. GEARE.

The number of ruined cities in Yucatan, and the State of Chiapas to the southeast, is very large. Two explorers alone discovered the remains of fifty-four ancient cities, including in Chiapas the wonderful remains at Ocozingo and Palenque, and in Yucatan the monumental ruins at Maxcanu, Uxmal, Sacbey, Izamal, Chichen, and a host of others, in the interior; and at Tuloom, Tancar, and on the island of Cozumel on its eastern coast. Among these the ruins of Palenque, Uxmal, and Chichen are among the most remarkable for their architectural forms and ornamentation, but they, as well as others represented by the illustrations, have been made so well known in these columns that it seems unnecessary to dwell on their characteristics in this article, which, as already indicated, is intended to deal rather with the people than with their buildings.

The men who built these cities were, as has been pointed out, far removed from the condition of nomadic tribes. Taste and luxury had long been grafted on the mere wants of the natives. They had learned to build, not only for protection against the elements, but for permanent residence. Here, however, as in Egypt, the remains are chiefly of temples, palaces, and tombs. The worship of God, the safety of the body after death, and obedience to authority, are demonstrated by the temple, tomb, and rock-built palace.

The country of the Aztecs, now called Mexico, was formerly known as Anahuac, a Toltec word signifying "situated near the water." At first this name was applied only to the Valley of Mexico, on account of its numerous lakes. When Grijalva in 1518 discovered the shores of Anahuac, the country was divided into four kingdoms, three republics, and a host of small states. Mexico was the chief kingdom; then came Colhuacan, Tlacopan, and Michoacan. The republics were Tlaxcala—whose citizens, for centuries enemies of the Aztecs, made common cause with Cortez—Cholula, and Huexotzinco.

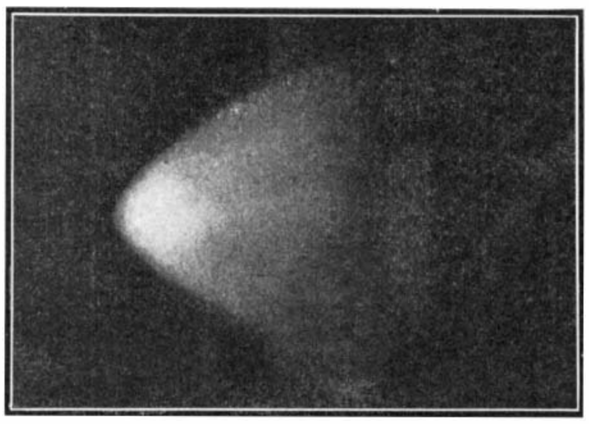
When Europeans first landed in Mexico, they found a numerous race of people called Nahuas, or Aztecs, who had developed a civilization at once astounding and incomprehensible to the adventurers. Their industrial attainments were fully evidenced by their spacious temples and other large and elaborate structures, which to-day, in part at least, testify to their former greatness. Their principal community was at that time in the Valley of Mexico, although, according to tradition, the original home of the Aztecs was Aztlan, in or near the Gulf of California.

About the year 648 A. D., seven of the principal tribes of the great nation of the Nahuatlacs left their homes, advanced toward the valley of Anahuac, and subsequently returned. Many years later they set out again, crossed the modern province of Xalisco, following the course of the Tolotlan River, and stopped at Culiacan. Here Huitzilipochtli, the terrible god of war, demanded that they should build him a tabernacle, and that the priests should carry it. The Aztecs, special *protégés* of this god, were commanded to separate from their companions and to take the name of Mexi, in honor of their being favorite sons of Mexitli, which was another name of this war god.

The Aztecs for a long time led a sedentary life, while the Nahuan natives spread over Anahuac, and covered it with kingdoms. Thus divided and subdivided, the Nahuas were for centuries engaged in conflict with one another, resulting in the smaller states being annihilated by the larger, which in turn would perhaps have been absorbed by the Aztecs, had it not been for the advent of the Spaniards. Then leaving Culiacan, the Aztecs entered Colima, and went as far east as Tollan. Wandering ever in search of a final resting-place, they reached Tzompango ("place of bones"), a large city of the valley to which they were destined afterward to give their name of Mexicatls, and from which the word Mexico was later formed. Here they were sorely persecuted by one of the generals of the Chichimec king Xolotl, and they therefore sought refuge at Chapultepec, which belonged to the Colhuas. The Colhuas soon declared war against them, and the Aztecs were reduced to a state of slavery. After fighting successfully for their masters against the Xochimilcos, in the hope of regaining their liberty, they were treated worse than ever, and were finally ordered to leave the country. Their wanderings began again, and finally they settled (and this time permanently) near the lakes Tezcoco, Xochimilco, Chalco, and Xaltocan. Here in 1325 they founded the great city of Tenochtitlan, now the city of Mexico, where they reared huge temples and other buildings.

In appearance the Aztec was of medium height, thick-set and well-proportioned. He had a narrow forehead, flat nose, black eyes, large mouth, thick purple lips, short regular teeth, well set in rose-colored gums. His hair was black, thick, and coarse, and his beard scanty. His skin was of a dull copper color.

South of Vera Cruz lies the State of Oaxaca, a region which also seems to have once been the seat of an advanced civilization. Interesting remains, including tumuli, are known to exist at Tachila, at Monte Alban, six miles from the city of Oaxaca, where there are tumuli and pyramids, at Coyúla, at San Juan de los Cũes, at Guengola, at Quiotepec, and at Mitla. Most of these ruins present pyramidal shapes in combination with the vertical. The ruins of Mitla are perhaps the most interesting of all, with their monuments and palaces, which excite universal wonder and admiration for the power of this ancient people, giants in the art of building and decorating edifices of stupendous dimensions and of exceedingly ornate decoration. There it was that the Aztecs in 1494 finally subdued the natives, and it is supposed that large numbers of the unfortunate Zapotec inhabitants of Mitla and Huaxaca (or Oaxaca), who had previously become prisoners of Aheutzotl, swelled the splendid but brutal sacrifice of human victims with which the great temple of Mexico was dedicated in 1487.



COMET "1904 A" AS SEEN MAY 19, 1904. 10 H. 19 M.

The cruelty of the Mexican sacrifices of human beings has always been one of the principal arguments against the civilization theory of the Aztec race; but all religion includes the idea of sacrifice, and the Aztec sacrifice arose probably from a blended motive of propitiation and policy. The human sacrifices by that people were perhaps founded on the idea that the best way of getting rid of culprits, dangerous people, and prisoners of war taken in large numbers, and whom it was impracticable to support or retain in subjection, was to offer them to the gods. Viewed only in the light of their idolatry, it is difficult to account for their intellectual advancement in architecture and other industrial and artistic pursuits; but as the latter are readily demonstrated, it must be held that these manifestations of a system of advanced civilization prove their social condition to have been much more refined than their religion, from which we may conclude that the Valley of Anahuac, although a hotbed of priestcraft and superstition, was also the center of a cultivated society.

According to the reports of explorers, the chief object sought in the erection of the grand edifices at Mitla and elsewhere, was to preserve the remains of their princes; and it is alleged that at the death of a son or brother, the sovereign retired to this place, and taking up his residence in a portion of the building, performed religious services and indulged in ceremonious grief. Other reports say that these spacious though solitary abodes were inhabited by an association of priests who devoted their lives to expiatory services for the dead. Their isolated sites are certainly well adapted for any purpose of a gloomy nature; for, according to travelers, the silence of the lovely valleys is unbroken even by the songs of birds. A large portion of the valley, overlooked by a noble group of mountains, is said to be still covered with heaps indicating the sites of ancient architecture; but as most of the ground is under cultivation, every relic of the architecture at this point is destroyed, and even the ground-plans have become so indistinct as to make research useless. There is another lot of ruins at Mitla, however, consisting of four connected or nearly connected buildings, each fronting a cardinal point, and the whole inclosing a square court. They have been described in detail by several explorers, and the reader is referred to the literature for the facts concerning the ruins at this place and others, some of which are illustrated in this article from photographs secured by Mr. William H. Holmes in connection with his explorations of this highly interesting region in 1894-95.

Many accounts of the peopling of Mexico by the Aztecs have been written, most of which seem to agree in the main essentials, namely, that Yucatan and the territory of the Zapotecs were once inhabited by a refined people, who were later subordinated to the Aztecs by conquest; that regarding the settling of the Vale of Anahuac, the original inhabitants came from some unknown place "at the north," and in the fifth or eighth century, settled at Tollan or Tula, in the neighborhood of the Mexican Valley; that this spot became the parent hive of an industrious and progressive people, whose northern frames and characters were civilized and not emasculated by the more genial climate to which they migrated; that they cultivated the soil, built extensive cities, conquered their neighbors, and after performing their allotted task in the development of the continent, wasted away in the tenth or eleventh century under the desolation of famine and unsuccessful wars, the Toltec remnant emigrating southward; that during the next hundred years, the valleys and mountains of this beautiful region were nearly abandoned, until a rude tribe known as the Chichimecas came from the north, and settled among the ruins abandoned by the Toltecs; and that some years afterward several tribes of the Nahuatlacs reached the valley, announcing the approach of another band from the north, known as the Aztecs.

Thus it will be seen that wave after wave of population poured from the north into the valley till it was reached by the Aztecs, who about the year 1160 left their mysterious and unknown site at Aztlan. After one hundred and sixty-five years of wanderings they descried an eagle grasping in a claw a writhing serpent, and resting on a cactus which sprang from a rock in the Lake of Tezcoco. This had been designated by the Aztec oracles as the spot where the tribe should settle after its long and weary migration; and accordingly the city of Tenochtitlan (now the city of Mexico) was founded on the sacred rock, and like another Venice rose from the bosom of the placid waters.

COMET "1904 A."

M. L. Rudaux, who for some time past has been making some interesting discoveries and observations at his private observatory at Douville, France, has recently succeeded in photographing the new comet called "1904 A."

From the viewpoint of the discovery of this comet, the utility of astronomical photographs is clearly shown, since it was in a photograph enlarged eight and a half times that the discovery was made. On the other hand, this discovery brings into prominence the advantages to be gained by the use of simple portrait lenses for this kind of photography. The comet 1904 A was very faint and of about the 9th magnitude, and yet owing to the rapidity of the objective, it required a short exposure of but half an hour for the star to make a sharp impression upon the plate. Contrary to what usually occurs, the negative reveals scarcely any trace of tail, while direct observation shows a short fan-shaped one.

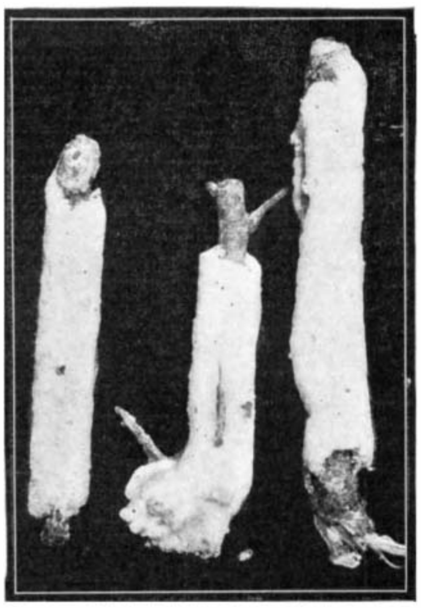
In the 4½-inch equatorial provided with a magnifying power of 45 diameters, the comet was difficult to see. At the outset, nothing was distinguished but a small nebulous mass and a brilliant nucleus. Afterward, there was perceived a wide fan-shaped appendage. The nucleus occupied internally the apex of a triangle formed by the fan, so that the front of the comet appeared to be pointed. The luminous intensity of the tail was seemingly produced by different sectors or, better, trains provided with a coma. Finally, the nucleus appeared to be multiple, but at instants solely, because of the great difficulty of observing it.

WAX FARMING IN CHINA—A STRANGE INDUSTRY.

BY WALTER L. BEASLEY.

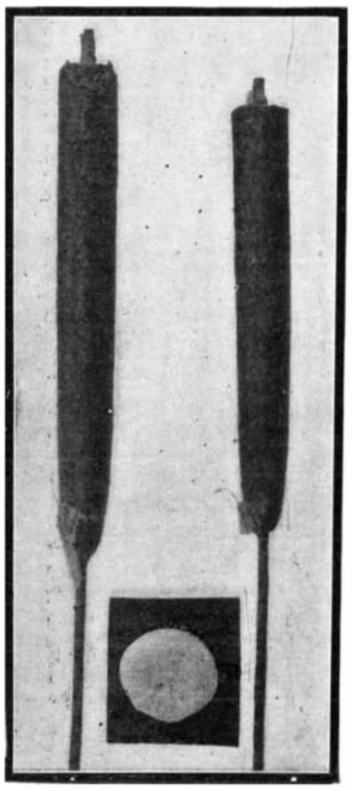
Among the novel occupations in China but little known, if at all, to the outside world, is that of the wax farmer. The most remarkable feature in connection with this industry is that the owner's entire crop is produced by the free labor of myriads of little insects, whose eggs or cocoons deposited on the limbs and branches yield a rich harvest, which is transformed into pure white wax and marketed at a fair price. Equally odd and fantastic are the midnight journeys of the agile and sure-footed porters, who are forced to hurry along as fast as possible with their loads of insects on their backs hundreds of miles across steep and rocky mountain passes, ascending and descending precipitous places which no animal or conveyance could traverse with safety, in order to land their cargoes in proper time for the hatching-out season. The American Museum of Natural History has just received some specimens of the wax-covered branches taken from the field, and the only ones to reach this country so far. Photographs of the strange creature itself and other characteristic views are shown and described here for the first time.

Comparatively little is known of this peculiar and valuable insect. Prof. C. Saski, of the Agricultural College of the Imperial University of Japan, has just reported in a bulletin on the life habits of the wax-producing coccid (*Ericerus pela*, Westwood). He gives much detailed information as to the size, appearance, and breeding habits of the creature, the salient points of which are here incorporated to supplement the general narrative. Through the kindness of Prof. William Beutenmüller, of the Entomological Department, this has been placed at the disposal of the writer. The insect is more common in China, though it is also found in Japan. In both countries it selects different trees to feed upon. The food plant in China is *Fraxinus Chinensis*, while in Japan it is *Fraxinus pubentrois* and *Ligustrum ibata*.



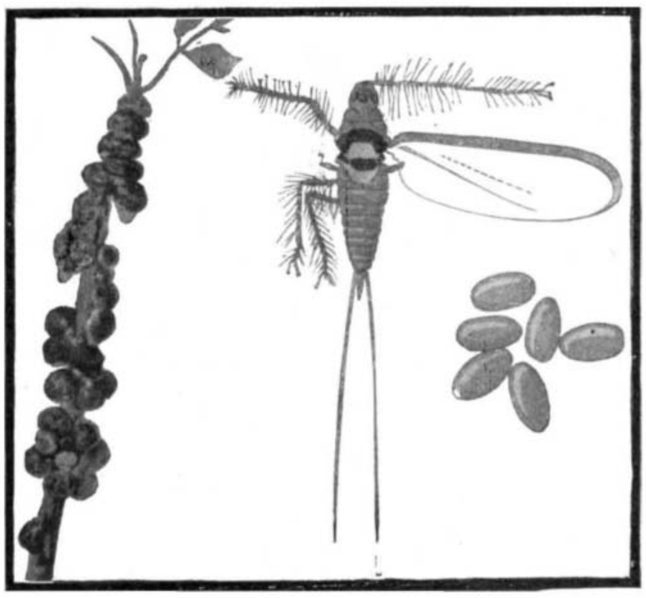
Layers of Wax as Deposited by the Insect on the Branch.

The male has a head nearly triangular and of a light orange color; the dorsal surface is marked with a broad grayish-brown band. The antennæ are long and composed of ten segments, covered with hairs. The segments are long, except the two basal ones, which are shorter and stouter than the rest. The last segment has on its tip three digitules. The thorax is large, elongated, and broader than the head. The legs are comparatively long, light brown, and covered with grayish hairs. The first pair lie far apart from the others. The four wings are long oval, and quite transparent. The abdomen is of nearly equal length to the thorax, and its anterior segment is closely attached to the thorax by its entire breadth. From the side of the last abdominal segments there protrude two slender white filaments, which are much longer than the body. The length of these is 3 millimeters. The female is globular in form and 11 millimeters in diameter, and when found in aggregations is slightly deformed from mutual pressure. The dorsal part, which forms the larger portion of the body, is dark reddish brown in color. The ventral flattened surface is almost oval in shape, but its large central portion becomes gradually concave, as the eggs are deposited, and finally gets deeper and deeper, so as to form a large hollow space, wide enough to protect many thousand eggs. If the insect is removed from the stem, the eggs fall freely off. These are elongated oval, light yellow, with diameters of 0.432 millimeter and 0.216 millimeter. The female begins to lay eggs about May 1, and the young larvæ commence to hatch out at the beginning of June. They are long oval, of an orange yellow color. The larvæ distribute by crawling about over every branch, and after molting pass to the second stage of growth. In the last part of August the male larvæ of the second stage are completely imprisoned within an oval cocoon, formed by snowy-white filaments, secreted by the dermal glands. Usually large numbers of the oval flattened cocoons completely surround the stems and branches. Within these the larvæ pass from the second to the third stage. At this period the antennæ, wings, and legs are all free, and the length of the body is 2.2 millimeters. A few days after remaining in this state, the winged insect appears through a slit-like opening at the free edge of the cocoon. The females go through the same stages of molting, and vary but slightly in structure and size from the male. The males appear about the last of September or beginning of October, and flit around the young females, who are already attached to the stems and branches.



Temple Candles made from White Wax.

The tree (*Ligustrum lucidum*) which produces the white wax insect grows in the Chien Chang valley in the western part of China, which is some 5,000 feet above the level of the sea. In March round brown forms are seen attached to the limbs and branches. If one of these should be opened, it would be found to contain innumerable white insects. By a strange law the insect will not flourish or produce wax in its birthplace, and if allowed to remain will drop off in a dead mass. The Chinese, with clever instinct, have discovered the exact locality where they will flourish to the best advantage, and have started breeding the insect and cultivating the particular food plant upon which it thrives and deposits the wax-making cocoons. Transporting the females to the various farming places some two to four hundred miles distant in the Province of Sze-Chuan gives employment during the season to thousands of porters. One of these wax-making centers is Kiating. About the first of May the female is nearly grown, and the body is almost conical, with a round base. Later on it becomes mature, and begins to deposit eggs. At this time the operation of removing the females from the limbs and branches to which they are attached and getting them ready to turn over to the porter for transit is commenced. They are thereafter carried hundreds of miles distant, to where the wax farmers have rows of the special food plant—a species of flowering ash five or six feet high (*Fraxinus chinensis*) upon which the insects feed and deposit their layers of wax. The insects are first tied up in a leaf of the wood-oil tree. A number are then placed in a gourd-like receptacle. These are then packed into two large bamboo baskets, and carried suspended on the shoulders. Many thousands of insects are taken in this way by each man on a trip. The porters have to travel entirely at night with their delicate and precious loads, for the mid-day heat would be dangerous to the lives of the inmates, as it would have a tendency to develop them too fast. It is customary, as the season approaches when the wax messengers are due, for the various cities and villages along the route to leave the gates open, so as to afford free and unobstructed passageway to the carriers. Seen at night running with all their might, dressed in most cases in rainproof straw, their flickering lanterns swaying to and fro with the motion of their bodies, they form a weird and picturesque sight. On they go, traversing rocky paths and lofty ascents of the Sze-Chuan Mountains, never stopping until the break of day, when they huddle up under cover of a shady retreat, where their baskets can be protected from the heat. They then prepare their meals, and await the coming of the night to continue their lonely and tiresome journey. On reaching their destination they immediately go to their masters or other agents, who have been awaiting their arrival. The baskets of insects are forthwith distributed to the respective farmers, who proceed at once to place them upon the food plant. They are tied on the branches in small bags made of leaves, where the heat of the sun hatches them. Holes are made in the leaves of the bags in which they are enveloped with a blunt needle, so that the insects may find their way out. When first hatched they creep rapidly up to the leaves of the food plant, where they nestle for nearly two weeks. After this they begin to scatter, and crawl along the branches.



Female Wax-making Insect and Eggs.

Night Porter Carrying Wax-making Insects to Breeding Place.

WAX FARMING IN CHINA—A STRANGE INDUSTRY.

The females, after a short period, begin to lay their eggs, and the males deposit white cocoons, which in time completely coat every branch and stem. It is the cocoon of the male which yields the wax. By the first of September the whole tree is literally covered with layers of pure white wax a quarter of an inch thick. This is a beautiful sight, and were it not for the temperature of the air, one might readily imagine there had been a recent snowstorm in the vicinity. The farmers cut off the branches, and scrape them. The material is heated, strained, and turned into molds of different sizes, becoming pure, white, and hard. The cultivation and preparation for market furnishes employment for a large number of industrial workers, who convert the wax into candles for house and street lanterns, also for the making of temple images and other articles connected with ceremonial worship. It is also used as a polish for furniture and for imparting gloss to silk. A tax tribute of this white wax from the Province of Sze-Chuan is sent every year to Peking. The whole output of the various wax farmers is estimated to amount to about $200,000 annually. It is said that the process is very old, over six hundred years or more, being handed down from one of the ancient dynasties.

RECENTLY PATENTED INVENTIONS.

Of General Interest.

SHIELD TUNNEL CONSTRUCTION.—W. I. AIMS, New York, N. Y. The invention relates to tunnel construction in the bed of waterways and other places, the object being to provide a construction arranged to permit of driving the shield readily through sand, gravel, and other loose material, to protect the workmen in the shield in case of a sudden inflow of water or loose material by closing doors in the shield, and to allow of conveniently and quickly placing the sections of metal lining for tunnel in position.

MANUFACTURE OF PLATES FOR PRINTING.—E. A. NEBEN, New York, N. Y. The invention relates to the art of preparing relief-plates for printing typographically therefrom. The object is to provide certain improvements in the manufacture of plates, whereby zinc or copper plates are produced for receiving any desired design in half-tone effects, together with the necessary contrasts of high lights, solids, and shades to allow of using the plates for reproduction of color-work for fine color-printing.

TRUCK.—H. C. HARRINGTON and W. M. TOWERS, Rome, Ga. It is a very difficult matter to handle sacks of grain or heavy casks of merchandise with the ordinary truck from the fact that in loading material the pressure backward is very great, and unless the truck is held in position by an extra hand it will often slip backward, dumping the load and causing reloading. The improvement seeks to prevent any backward movement of wheels when truck is in position to receive load until the truck is adjusted out of such position toward a position for carrying the load.

Machines and Mechanical Devices.

BREAD-MAKING APPARATUS.—E. D. LYNDS, Newman, Ill. One object of this invention, among others, is to provide a novel construction for mixing flour and milk, water, or other liquid constituent through the aid of a rapidly-revolving disk, from which the liquid element will be discharged in a finely-divided state into the flour, and thoroughly mixed with the flour in the mixing-chamber.

MUSIC-LEAF TURNER.—N. P. JENSEN, Ephraim, Utah. The object here is to provide a turner for use on pianos, organs, music-racks, and the like, and arranged to permit of conveniently turning the leaves successively over in either direction to permit of operating the device either by hand or foot, and in the latter case to render the device especially serviceable for use on portable racks such as used by band-musicians.

Pertaining to Vehicles.

BRICK-ELEVATING ATTACHMENT FOR TRUCKS.—S. P. HEDGES, Greenport, N. Y. The invention relates to an attachment for trucks, especially trucks for carrying brick and other material to be burned, stacked, stored, or dried. The purpose is to provide stationary uprights and a movable frame mounted between them and adapted to carry pallets on which material is placed and to so construct the truck and carrying-frame that they will be more substantial than ordinary, being built with the least number of posts and posts not liable to bend or get out of shape.

Prime Movers and Their Accessories.

WIND-WHEEL.—E. PAVÓN Y MORALEDA, Madrid, Spain. The object of the inventor is to provide a construction whereby the wheel will not be bound or locked at any time by the action of the wind, as when one blade is in position to receive the pressure of the wind the blade in front will be free to spill the wind, thus preventing the wheel from remaining stationary by reason of the wind blowing in an angular pocket having fixed walls.

Railways and Their Accessories.

CAR-COUPLING.—R. REARDON, Savannah, Ga. This improvement relates to automatic double-knuckle car-couplers. The objects are to provide for insuring the certainty of action of a coupling of the type mentioned, for providing an absolutely secure coupling, and for providing means for quickly and easily uncoupling the device by automatic action when the locking device is operated to unlock the knuckle. The invention is an improvement upon a previous patent granted to Mr. Reardon, and it has been successfully used on the Atlantic Coast Line R. R.

RAIL-JOINT FASTENER.—J. A. GOSSARD, JR., South Solon, Ohio. The object in this instance is to provide details of construction for a fastener which are adapted to be placed in position for securing together two meeting ends of track-rails under spring tension of parts of the fastener by use of suitable tools or be removed by the same means, as occasion may require, a further object being to provide a fastener that is held in place for connection of the rail ends and their lateral support at joint by spring tension of its parts only and is devoid of bolts and nuts usually employed.

MONORAIL TRACTION.—C. E. FAROUX, 106 Rue de Courcelles, Levallois-Perret, Seine, France. This invention has for its object a method of and means for monorail traction whereby high speeds may be attained under good economical and practical conditions. The device comprises a single rail of suitable section, upon which travels the locomotor-vehicle, which rests upon a truck. The invention comprises a vehicle including a body, flanged wheels supporting the body, a rail having inclined sides with which the wheel-flanges engage at two points only, guide-wheels bearing on the upper edge of the rail, a track above the vehicle, and wheels carried by the vehicle and engaging the opposite sides of the last-named rail.

Designs.

DESIGN FOR A CULINARY VESSEL.—F. H. GRISWOLD, Springfield, Mass. The design is applied to an open kettle or vessel for cooking fruits, meats, and vegetables. The body enlarges from the bottom up, and on the same near the bottom, is a series of like figures, in low relief or intaglio, each comprising a series of rays radiating upward from a common point where the capital letter X is located, the whole indicating "X rays."

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. In every case it is necessary to give the number of the inquiry.

MUNN & CO.

Inquiry No. 6242.—For parties to manufacture, on contract, small machines weighing 6 pounds.

Inquiry No. 6243.—For the address of the manufacturers of the wire-wound wooden pipe, in the United States and Canada.

Inquiry No. 6244.—For makers of round, woven wire belting or round chain belting, sizes from ¼ inch to ⅛ inch diameter.

Inquiry No. 6245.—Wanted, to purchase a good patent or novelty suitable for mail order business.

Inquiry No. 6246.—For information as to process of making rubber stamps without steam heat.

Inquiry No. 6247.—For makers of high-grade tools for school use,

Inquiry No. 6248.—For parties controlling the sale of the Belden trip hammers, or for the makers thereof.

Inquiry No. 6249.—For makers of hydraulic presses with surface about 36 x 56 with moving stroke of about 2 inches or 3 inches only.

Inquiry No. 6250.—For small, simple machines for ginning, spinning and weaving cotton.

Inquiry No. 6251.—For the makers of the Cheeseman roller gin, or any other make of roller gin.

Inquiry No. 6252.—For makers of vane cutters and other machinery for manufacturing baskets and berry boxes.

Inquiry No. 6253.—For manufacturers of dynamos.

Inquiry No. 6254.—For makers of simple, up-to-date machines for boring iron pump cylinders.

Inquiry No. 6255.—For parties engaged in all kinds of spring work.

Inquiry No. 6256.—For the address of the manufacturers of the Hadfield apparatus for treating disease by vacuum.

Inquiry No. 6257.—For parties making machinery for manufacturing wood alcohol.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.
References to former articles or answers should give date of paper and page or number of question.
Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.
Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.
Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.
Scientific American Supplements referred to may be had at the office. Price 10 cents each.
Books referred to promptly supplied on receipt of price.
Minerals sent for examination should be distinctly marked or labeled.

(9486) A. H. S. asks: Theoretically, a rifle ball (or any body) fired vertically should return with exactly the same force. Practically, anyone who has tried, knows that a ball capable of a penetration of say four inches of wood at the muzzle will hardly more than dent the same wood on return. Please explain. A. The resistance of the air, which is very great in a body with a high velocity, prevents a rifle ball from rising as high into the air as it otherwise would, and hence it does not have as far to fall as its velocity on leaving the gun would indicate. The air also retards its fall, hence it does not acquire as great a velocity in falling as the height from which it falls would require. Both in ascending and descending its velocity is reduced, and hence its force on reaching the ground is much less than the velocity with which it left the muzzle of the gun.

(9487) H. H. asks: 1. Is the horse-power of a motor calculated the same as the horse-power of a steam engine? A. The horse-power of an electric motor is calculated by multiplying the volts and amperes together, and dividing the product by 746. 2. We have a circuit carrying 100 volts through 5,000 ohms resistance; if we add 1,000 ohms more to the circuit, how much more voltage will we have to have in order to have the same results at the end of the circuit? A. If you have 100 volts acting through 5,000 ohms resistance, you have 1-50 ampere flowing. To have the same through 6,000 ohms you will require 120 volts pressure. First case: $C = E \div R$; or $100 \div 5{,}000 = 1\text{-}50$. Second case: $E = C\ R$; or $1\text{-}50 \times 6{,}000 = 120$.

(9488) G. A. B. asks: We should like to get your valued opinion on a discussion with reference to sharp turns made by *vehicles in general*, and shall feel greatly obliged if you will submit your answer in the next issue of your paper. A contends that when an automobile makes a sharp turn, the outer wheels leave the ground, and the weight is all on the inner wheels; whereas B claims the inner wheels rise, and the weight is on the outer wheels; as proof, he offers as example the toboggan slide, where a person is thrown toward the outer end when it makes many turns. A. The centrifugal force developed by a vehicle in turning a corner causes the wheels to press outward, and the vehicle to overturn if the velocity is sufficient to throw it over. It is inconceivable that a force directed *outward* should cause the vehicle to be upset *inward*, or toward the center of the curve. To offset the outward pressure of a train, the outside rail is raised on curves in building railroads, as can be easily seen by looking at the elevated tracks in the city. The elevation is calculated to be sufficient to render the pressure on the inner rail again equal to that upon the outer rail; to tip the train in again, enough to balance the effect of the centrifugal force in tipping the train outward, and tending to upset the cars toward the outside of the curve. In bicycle tracks, where the vehicles often take the curves at high speeds, this elevation of the outer side of the track is very great, and in addition to this the rider finds it necessary to lean in a great deal, to balance the tendency to upset toward the outside.

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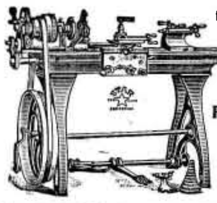

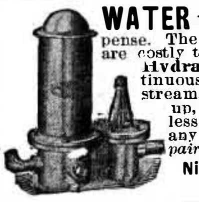

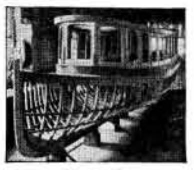

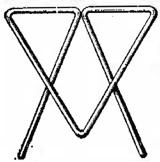

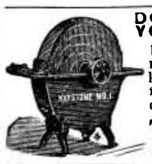

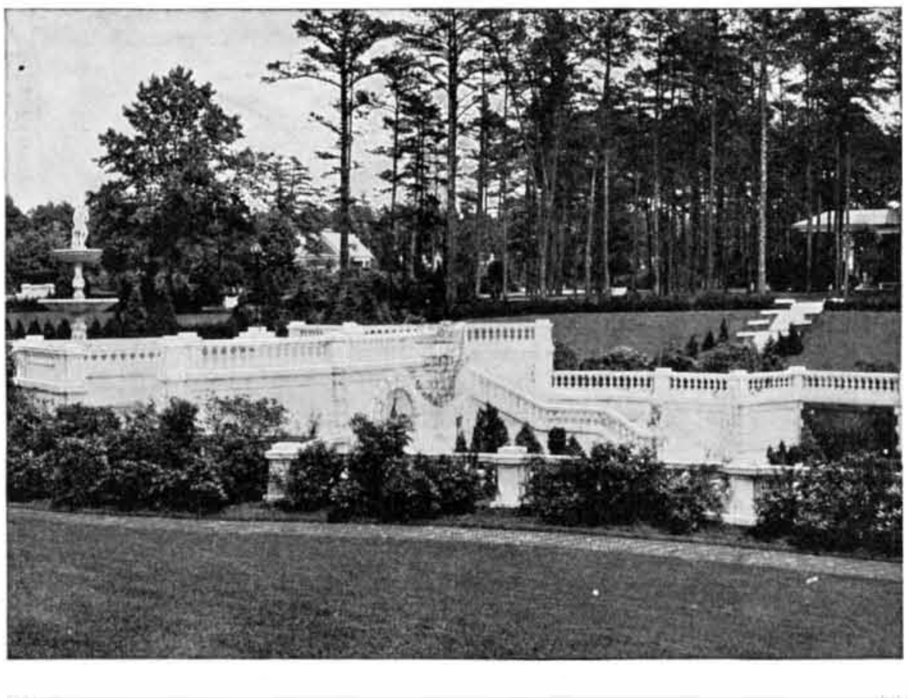

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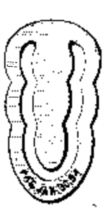

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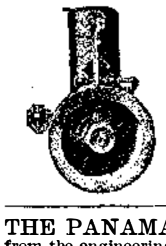

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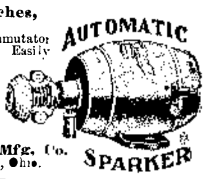

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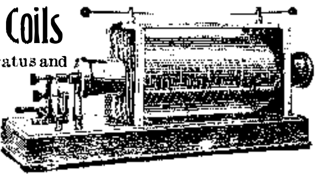

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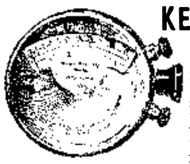

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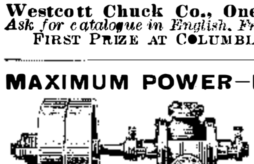

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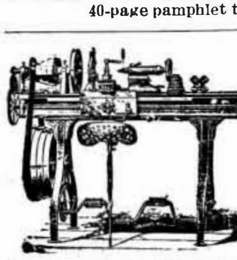

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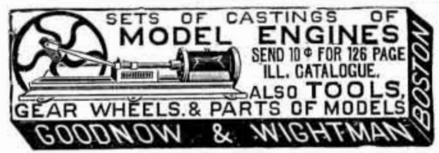

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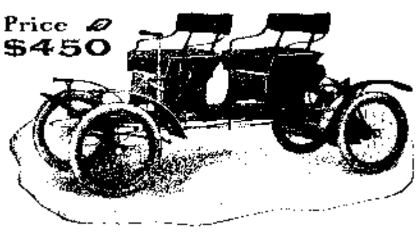

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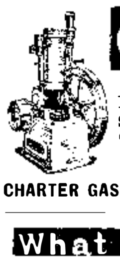

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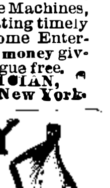

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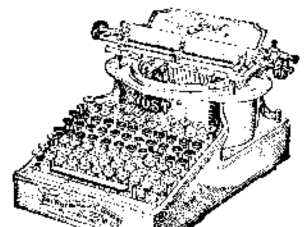

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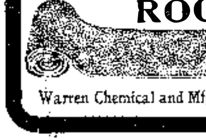

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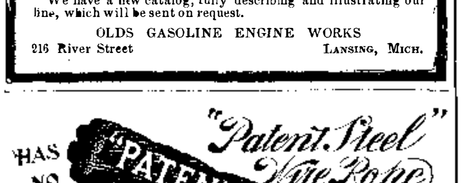

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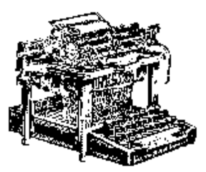

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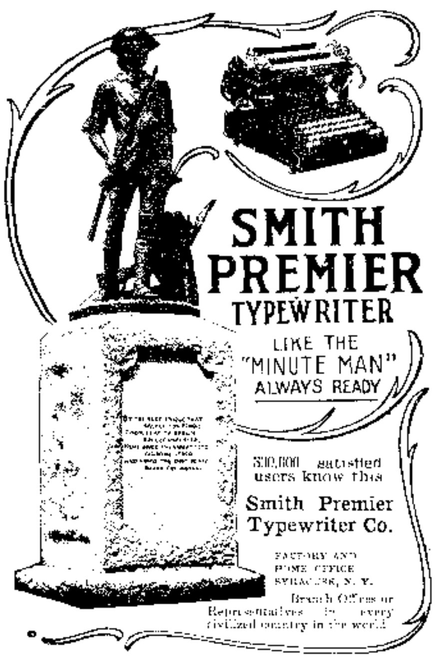

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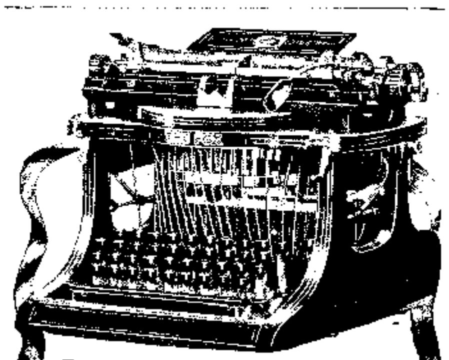

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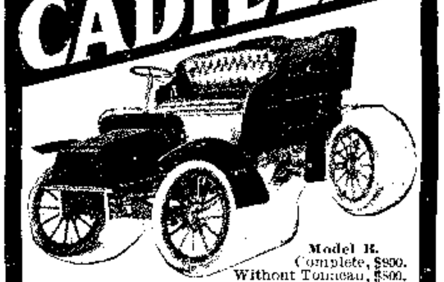

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