The experimental study of the motion of fluids

In : Scientific American, 1902, February 1 destroyed by the Custom House authorities, who took them for bombs and infernal machines. Toward the end of that year he took out his first patent. During 1897 and 1898 he made wonderful strides in increasing the distances to which messages could be sent and received, and in March, 1899, succeeded in telegraphing without wires between France and England. On July 20, 1897, he floated the Marconi Wireless Telegraph Company, and in April, 1900, the Marconi International Marine Company, while to-day no fewer than forty-five ships of the British navy have been equipped with the Marconi apparatus, as well as all Lloyd's signaling stations and many of the lightships around the British coast.

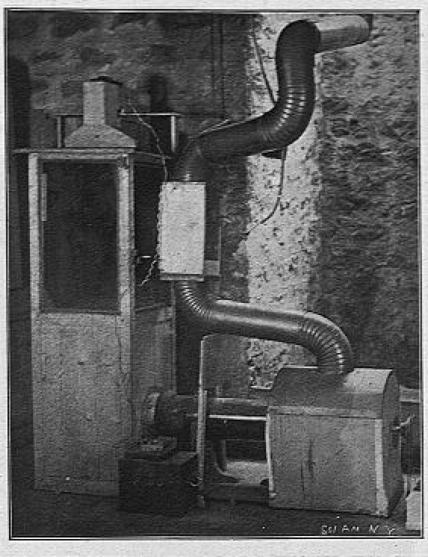
THE EXPERIMENTAL STUDY OF THE MOTION OF FLUIDS.

BY OUR PARIS CORRESPONDENT.

Mathematicians have developed certain interesting theories to explain the movement of a fluid in encountering obstacles. Unfortunately the results of such theoretical calculations have been of little value, because they were not based upon sufficient data obtained by actual observation, or because they applied only to non-existent perfect fluids, the molecules of which glide over each other without friction. If these mathematical theories could be verified experimentally much would be done both for hydrodynamics and aerial dynamics. Furthermore, it would be possible to devise a body which would encounter the least possible resistance in moving through water or air; for the laws underlying the movement of bodies around a stationary obstacle would apply conversely to a body moving through a fluid.

The first attempts to observe the movements of fluids directly by the eye, or indirectly by means of photography, were made some years ago by L. Mach. In these classic experiments of his, the warm and cold air was admitted into an observation chamber by way of numerous small openings. The threads of air streaming through these openings continued their movement in the observation chamber without intermingling. Although the eye could see nothing of this phenomenon, the photographic plate showed that differently heated currents did not mingle; for it is a well-known fact that light does not travel with the same speed in cold and warm air. Still another method of studying the current lines of fluids was adopted by an English physicist, Hele-Shaw. In 1897 he began to study the motion of water circling between the two parallel glass walls of a vessel and encountering various obstacles. Accidentally he found that a mixture of air and water, by reason of the division of the air into a number of globules, rendered it possible to follow the motion of the water with considerable accuracy. Photographs showed not only the places where vortices were produced by reason of the obstacles, but also proved the general law that in all cases, despite the violence of the current, the water is held to the obstacle by adhesion. The varying thickness of the layer thus retained furnishes a means for ascertaining to what extent the entire mass of water is affected by friction.

In order to study the movements of fluids, Hele-Shaw devised the apparatus shown in one of the accompanying engravings. The fluid, the movement of which he examines, is held in a glass box-like receptacle in a suitable stand. Water is allowed to enter the receptacle through a series of fine openings; and colored glycerine is pumped into the receptacle through another series of fine openings alternating with the first. A photographic camera is placed on one side of the stand, and a powerful source of light on the other.

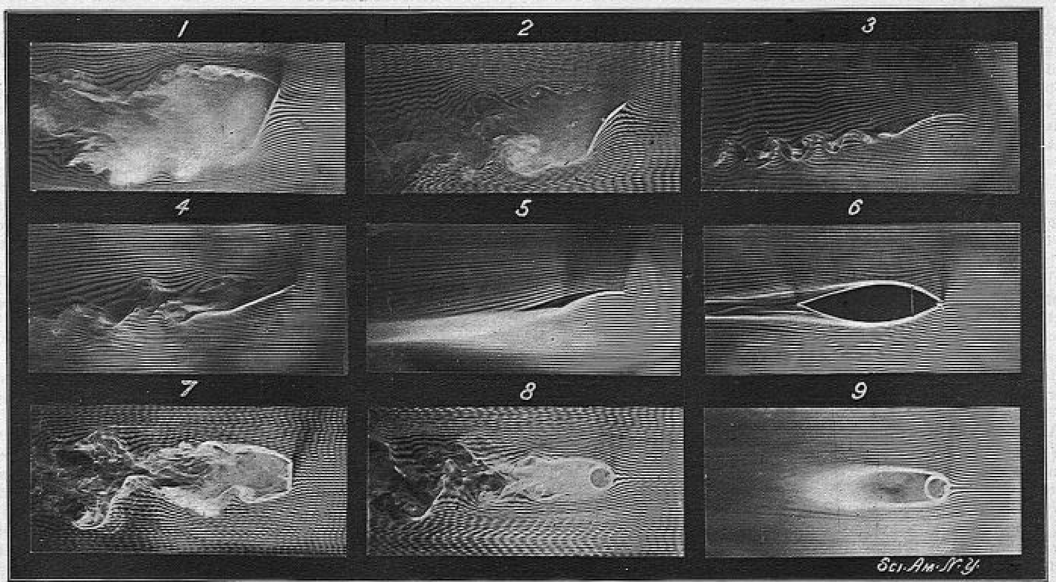


M. MAREY'S APPARATUS FOR STUDYING AIR CURRENTS.

By means of this apparatus Hele-Shaw was enabled to produce photographs corresponding exactly with the theoretical forms of current lines for fluids moving in narrow passages, pictured in Lamb's "Hydrodynamics." This mechanical method, however, is defective in so far as it shows only the direction of movement, and not the velocity at various obstacles.

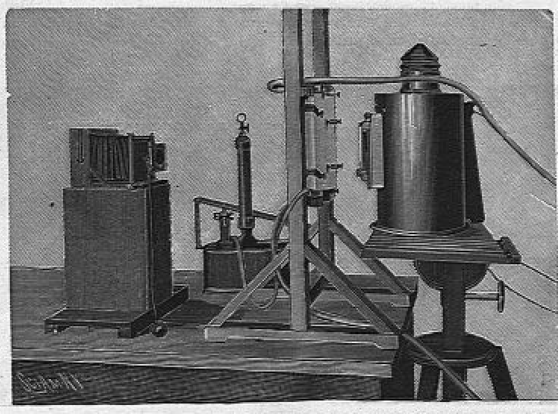
More accurate results have been obtained by Marey, an eminent French scientist, who has made the study of the movements of air his life work. His method is to form a series of parallel air-streams within a large chamber, then to charge them with smoke and thus make them visible. When an obstacle is placed in their path the movement of the air is clearly distinguished. To carry this out he uses the large chamber seen on the left of the engraving, 5 feet high and 2 feet in section. In the lower part is an orifice which is joined to the aspirating ventilator on the right, driven by a small electric motor. The air descends through an opening at the top of the chamber, which has stretched across it a frame covered with silk gauze whose meshes are very fine and regular. This serves to direct the air in a series of vertical streams and prevent the formation of vortices, and it thus descends parallel to the walls of the chamber. The smoke is fed into the air by a series of 60 tubes, ¼ inch in diameter and about the same distance apart. Back of the tubes is a small chamber in which the smoke-producing substance is burned, and the streams of smoke thus formed are easily observed and photographed. For this a glass-covered box in which magnesium is burned is placed in the path of the ventilating pipe as seen on the left and near the opening of the main chamber. An instantaneous flash is the best for showing the agitation of the air in the rear of an obstacle, while a prolonged exposure gives the resultant of different movements.

When the ventilator is set in motion the air is aspirated and draws with it the smoke, and the latter descends in a series of vertical cords which may reach as long as three feet if the air of the room is perfectly still. This is not always easy to realize, as often the movements of the operator are sufficient to cause a perceptible deflection of the air-currents. It only remains to interpose in the path of the air the obstacle whose influence is to be studied; this is fixed by very light supports placed against the rear wall. This wall is covered with black velvet so that the smoke-streams, when lighted by the magnesium, are observed as a brilliant white against a black background, and can be easily photographed. M. Marey has devised a very ingenious method of measuring the speed of each stream at different points of its path, and especially in front and in the rear of the obstacle. The smoke-tubes are connected with an electric vibrator whose period is generally regulated at 10 vibrations per second. In this way the smoke-streams assume a wave form which will be noticed on some of the figures. The distance apart of the waves gives a measure of the speed at each point. In the parts where the speed is slower the waves are closer together and *vice versa*. On the wall of the chamber is fixed a rod 8 inches long, parallel to the streams, which serves as a scale to measure the distance covered by the streams in each tenth of a second.



PHOTOGRAPHS OF THE AIR STREAMS UNDER VARYING CONDITIONS.

The accompanying figures show some of the most interesting results obtained by this method. In Fig. 1 the air encounters a plane surface inclined at about 70 degrees. It will be observed how the air-streams pass around the obstacle. Part of them mount on the left side, but the greater number follow the slope. In the rear is a region of agitated air which extends far back. The waves are closer together at the contact of the plane, showing a diminution of speed in Fig. 2, which represents a concave surface at an angle of about 45 deg. In Figs. 3 and 4 are shown the different manner in which the air acts in contact with concave and plane surfaces; the figures indicate that concave surfaces are more advantageous than plane surfaces as regards flying, a result which has been already proven by the aviators. In fact, in the rear of the concave surface the air is aspirated with energy and without much agitation, which is a very favorable condition, as this agitation represents a great expenditure of work. Fig. 5 is the same as Fig. 3, but with a different lighting; the former,



HELE-SHAW'S APPARATUS FOR PHOTOGRAPHING MOVING FLUIDS.

taken by an instantaneous flash, shows the agitated zone at a given moment; in the latter the light was continuous for several seconds, and gives the mean direction of the air. Here the agitated portion is represented by a white band. Fig. 6 is of especial interest as showing the resistance to the air which is offered by a body having the form of a boat or again of a dirigible balloon. In Figs. 7 and 8, two bodies, a plane and a cylinder having the same section, are compared in order to show how the streams curve in the rear of the obstacle and also the relative diminution of speed. Fig. 9 shows the same cylinder with a prolonged lighting, and here the zone of air in the rear of the cylinder is strikingly brought out.

As will be seen, the method of M. Marey is of great practical value in the study of the resistance which various bodies present to the air. It can be applied to great advantage in studying the best forms to be given to dirigible balloons. In the study of curved or plane surfaces it shows that the former are much more advantageous than the latter. The apparatus will also be useful to mathematicians in giving them figures which will facilitate the study of the laws of air-resistance.

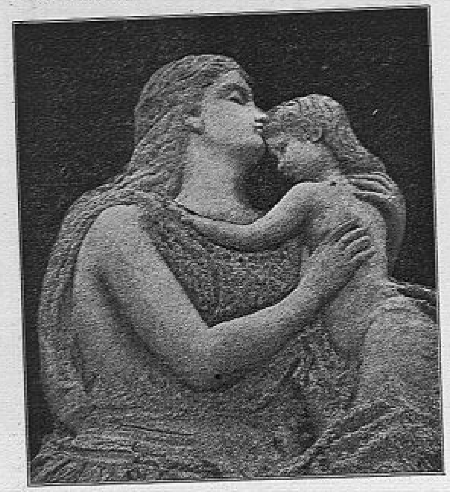
Barium: Its Preparation and Properties.

In a paper lately read before the Académie des Sciences, M. Guntz describes an interesting series of experiments in which he obtains the metal barium in a pure state by a special method of electric heating. It seems that pure barium has not been as yet obtained. Bunsen, Frey and others of the older chemists indicate that they have obtained the metal, but more recently others such as Limbs, of Paris, and Lengyel, of Germany, have been unable to obtain it in a pure state, and therefore its properties are but little known. The author uses a barium chloride solution, using a mercury cathode. The mercury is then driven off in an electric heating device. A porcelain tube is placed within an outer tube of refractory earth and the latter is surrounded by a coil of platinum wire through which the current passes. The iron vessel containing the amalgam is placed in the porcelain tube and the whole is heated very gradually by the current. The amalgam continues to lose mercury, and at about 850 deg. C. it contains 90 per cent of barium. The mercury seems to be completely driven off at 1,000 deg. If raised to 1,150 deg. the metal is seen to boil and vaporizes very rapidly. Contrary to Frey, barium is melted below 1,000 deg. C., and its solidifying point is even much lower. It is a very volatile body, and this property explains why it has not been obtained heretofore by heating its amalgam. To remove it from the iron vessel, to which it adheres strongly, it must be cut out and thus oxidizes somewhat. This explains the rather low percentage, 98, which the author finds on analysis. The barium thus obtained is quite free from mercury, and has a metallic luster of a silver-white appearance when freshly cut. It is almost as soft as lead when quite free from mercury, but in the contrary case it is brittle. It is fusible at a low red heat and very volatile at a bright red. Thus if a fragment of barium is thrown into a bath of melted chloride of barium at a red heat it is seen to descend in the liquid, then to vaporize, and greenish flames coming from the combustion of the metal are produced at the surface. Barium oxidizes rapidly in the air, giving baryta. It often takes fire on contact with air, and almost always when it is detached from the mass by a hard body. Like lithium and calcium, it gives with liquefied ammonia gas an ammonium compound of a golden yellow color, which is quite soluble in the liquefied gas, but is a rather unstable body.

The Pennsylvania Railroad system has placed orders with three car manufacturing companies for freight cars, the order amounting in value to about $10,000,000. It is understood that the company intends to obviate for several years the likelihood of a car shortage like the present one. The Pressed Steel Car Company has received an order for 9,000 of the 15,000 cars. Two thousand cars will be built by the Cambria Steel Company, controlled by the Pennsylvania Railroad Company, and 1,000 will be built by the American Car and Foundry Company. The order for the remaining 3,000 cars has not yet been placed. Five thousand of the cars ordered from the Pressed Steel Car Company will be hopper cars for the transportation of coal. The railroad company has now in commission on main line and branches 150,000 freight cars.

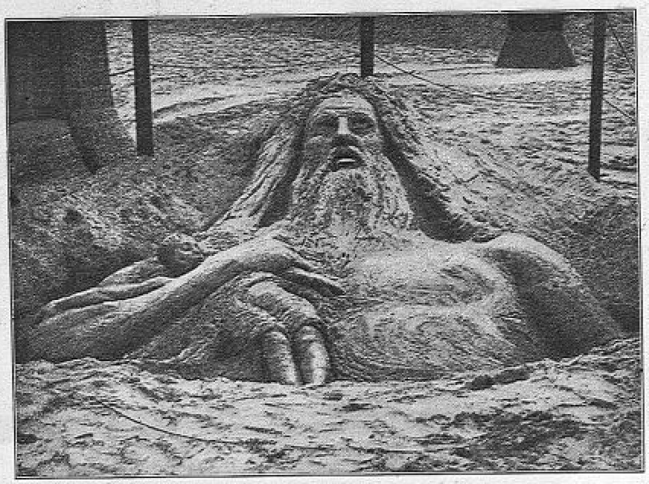
MODELING IN BEACH SAND.

According to the Illustrirte Zeitung, Eugen Boermel, a well-known sculptor of Berlin, created something of a sensation last summer in the little seaside resort of Nordeney. The sculptor modeled in the sand of the beach a number of figures which have aroused the admiration of the hotel habitués. It is difficult enough to infuse life into dead marble; and it may, indeed, be considered still more difficult, from a technical standpoint, to give shape to so refractory a medium as crumbling sand.



MOTHER AND CHILD.

Two years ago Boermel made a few experiments along the shores of the Baltic in order to determine the practicability of the use of white beach sand for modeling. The experience which he gathered in these early endeavors culminated in his Nordeney work. He was primarily actuated by charitable considerations; for he was interested in a plan for providing for the family of a fisherman who had lost his life. Surrounded by a crowd of curious and admiring spectators, Boermel modeled, without any design and without any preparation, the forms which we have reproduced in the accompanying illustrations.



ÆGIR AND SACRIFICIAL OFFERING.

Work is actively proceeding at Mr. Tesla's new laboratory at Wardenclyffe, L. I.

BRUNHILDE.

Painting the Forth Bridge.

According to the Mechanical Engineer, the Forth bridge is now in process of receiving its fourth coat of paint since it was erected. Ever since the bridge was opened—11 years ago—the painting process has gone on continuously. Beginning at the south end, the workmen take three years to cover the entire length of the bridge, and, as three years represents approximately the life of the paint, no sooner are they finished than the men have to begin again. In this way every square inch of steel comes under observation at least once in three years. The staff of men employed varies in number from the maximum of 35.

In order to obtain access to the various parts, Mr. Adam Hunter, the resident engineer, has devised an elaborate series of ladders and lifts, which form no part of the original design. Wherever practicable, ladders attached to the permanent structure are used, but in order to reach the higher parts it has been found necessary to provide lifts. There are three such lifts, worked by steam engines and winches placed almost out of sight a little below the level of the permanent way. At each hoist there is also a shelter house where the paint is mixed. In order to reach the parts below the rails, platforms are strung from wire ropes run along either side of the bridge, and the platforms being movable, they can be pushed along the steel ropes on the principle of an overhead railway. A squad of men precedes the painters, erecting the platforms and rigging up the tackle from which they are suspended. The work proceeds daily except on Sundays and in very stormy weather. It is a striking tribute to the ability of those engaged in maintaining the bridge in good order that in no case has any part required renewal.

Purity of Air in Tube Railways.

Dr. A. Wynter Blyth, President of the Incorporated Society of Medical Officers of Health, contributes an article to Public Health, in which he gives the results of his tests of the ventilation of the Two-penny Tube. "In front of each train," he says, "there is a distinct and measurable increase of barometric pressure, in the rear a diminution of pressure. As each train leaves a station it pushes a column of air in front of it, part of which, on reaching the station, rushes up the staircase into the open air, and as the train leaves the station air rushes down the staircase from the street. The downward or upward velocity varies with the position of the trains." Taking the whole results, they show that, so far as respiratory impurity goes, the tube railway gives better results than the Underground railway, and better results than in ordinary places of assembly. Even in a crowded lift the sojourn is too short to contaminate the air seriously, and since each lift when it ascends to the level of the street has the advantage of thorough ventilation, the transient contamination of air during the sojourn gets swept away. The amount of carbon dioxide on the platform of the stations appears to be from about 9 to nearly 11 per 1,000. The research clearly shows that, although there is so much movement of air, so much sucking in from above and blowing out from below, a good portion of the air must be driven backward and forward unchanged in the tubes; in other words, the tunnel air is diluted, but the whole of it is never swept out. The mere stoppage of trains would not so seriously interfere with the air supply as to render the supply incapable of supporting life.

Mr. Donald Murray has been carrying out a prolonged series of experiments with his long-distance, high-speed, page-printing telegraph system upon the trunk telegraph wire of the British post office between London and Glasgow. Although the conditions for the trials were distinctly unfavorable, he obtained a speed of 120 words per minute, which is only ten words less than the maximum he claims for his invention, so that the test was satisfactory. He found in the course of his experiments that although the automatic typewriting transcriber was capable of a speed of 110 words per minute, it evinced a tendency to drop letters while writing at that velocity, so he utilized two transcribers working at 70 words a minute, transcribing alternate batches of messages. By this means the apparatus was proved to work satisfactorily. Mr. Murray, at the conclusion of his experiments upon the English wires, is going to Vienna to carry out similar trials upon the telegraph systems of the Austrian government.