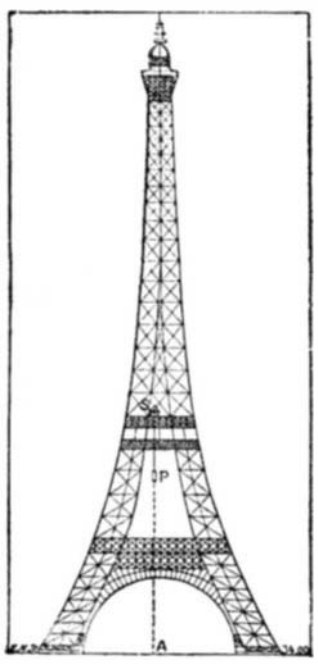
THE FALL OF BODIES AND THE RESISTANCE OF THE AIR.

An exceedingly interesting series of experiments is now being carried on in Paris, by MM. Cailletet and Colardeau, in which they are seeking to verify the law of falling bodies and at the same time those of the resistance of the air to the passage of bodies. Now that high-speed electric railway work is seriously contemplated, the results of these experiments cannot fail to be of the highest interest. In order to carry out their work, the investigators have installed their laboratory on the second landing of the Eiffel tower, which gives them a free fall of 120 meters, or about 370 feet.

In carrying out their experiments MM. Cailletet and Colardeau have employed a very ingenious electrical method of timing the fall of the variously shaped objects experimented with, and particularly with the view of knowing at every instant the position of the falling body. The laboratory itself is shown, says the *Electrical Engineer*, in the accompanying engraving, Fig. 1, taken from *La Nature*. Fig. 2 shows an enlarged view of the principal apparatus. The falling body is attached to a very fine light thread, which is divided into sections of 20 meters each. Each one of these sections is wound on a wooden cone, C^1 C^2 C^3, etc., all fixed vertically with their points facing downward. so that the thread is very easily unwound. When each of the sections of 20 meters is unrolled, an electric contact actuates a registering pen upon which an electric tuning fork chronograph indicates the instant with a precision of 1-100 of a second. Thus at the end of every 20, 40, and 60 meters, etc., a time record is automatically made.

The electric contact is accomplished as follows: In passing from one cone, C^1, to the following, C^2, the thread is looped around a contact, M N O, Fig. 2, the contacts being separated by an insulating block, I, and supported by two springs, L L', which press the contacts together very lightly. The falling body pulls the thread through the contacts, and thus for an instant breaks the circuits and allows the pen to register. Experiments have shown that the retardation to the fall of a body weighing 1 kilogramme through 20 meters caused by the separation of the spring contacts is less than 0·2 millimeter per second; that is, less than 1 one-hundred-thousandth. The retardation due to the resistance offered to the unrolling of the thread on the cone has been shown to be about 1 per cent.



Up to the present the experimenters have confined themselves to investigation to ascertain if the resistance opposed hy the air to plane surfaces of equal area, moving in a direction normal to these surfaces, was dependent upon their form. Thus they have employed circular, square, triangular, etc., surfaces. They have found that the time of fall differs only by insignificant amounts, as indicated in the record reproduced in Fig. 3. This figure is a production of the chart obtained by means of the apparatus above described. No. 1 is the theoretical record of a body falling freely in vacuum. No. 2 is an experimental record obtained of the fall of a long wooden arrow, weighted by a metallic mass at its point No. 3 is the record of the fall of a square surface (0·0225 cm. sq.) pulled by a weight of 800 grammes. No. 4 is the record of a triangular surface of the same area as the preceding, pulled by the same weight. The lowest curve in Fig. 3 is the record of the tuning fork,

Messrs. Cailletet and Colardeau have also investigated whether the resistance encountered by a flat surface moving through the air is proportional to this area.

For that purpose they employed two square surfaces the areas of which were in the ratio of 1 to 2, and pulled by weights of like proportion. The corrected time of fall was respectively 6·92 and 6·96 seconds. These figures being practically identical, confirm the strict proportionality.

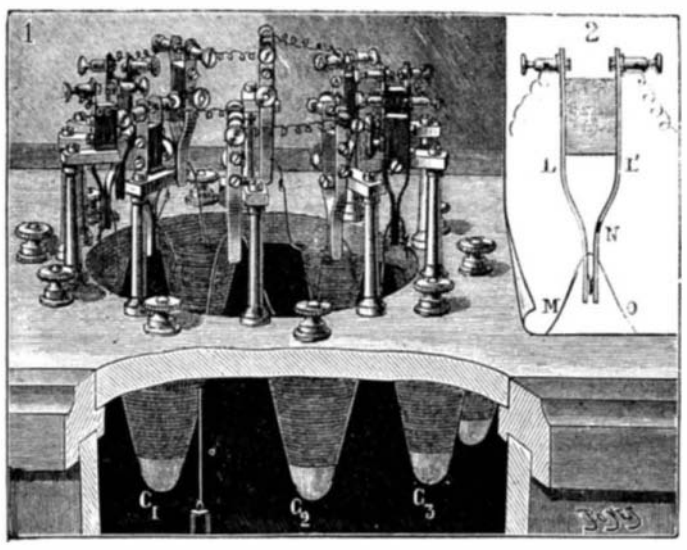


Fig. 2.—APPARATUS FOR EXPERIMENTS WITH FALLING BODIES AND AIR RESISTANCE.

Satisfactory Progress of American Armor.

The New York *Sun* makes the following remarks: The recent trials at Indian Head and at Bethlehem of two 10½ inch nickel-steel plates, treated by the Harvey process, have carried still further forward the high standard of American ship armor.

During the last two years American armor tests have surpassed in the severity of their methods and the importance of their results those of the most renowned ordnance-proving grounds of Europe. In 1890 trials at Annapolis destroyed the prestige of Sheffield compound armor, and made it evident that the ship plates of the future should be steel or nickel-steel. The next great series of experiments showed the superiority of nickel-steel plates over steel without the alloy, and also gave a forecast of the gain to be made through hardening the surface of the plate by the Harvey carbonizing process. Now we have the full demonstration of the value of this process, under certain notable improvements effected since the trials of last November.

The plate in the experiment of July 23 was of the same dimensions as those used in September, 1890, and November, 1891; but the test to which the Chief of Ordnance subjected it was far more severe. On the two former occasions he had attacked each of the competing plates with one 8 inch and four 6 inch projectiles; but on July 23 he fired five 8 inch shells, each with the velocity of the single 8 inch round of November, 1891. All the shells were made by Holtzer, which is a sufficient guarantee of their excellence; yet three of them broke up in small fragments on the Harvey face, and although the other two succeeded in getting through the Harvey crust, their points reaching the rear surface of the 10½ inch plate, not one of the five got into the wood backing behind.

The plate, therefore, came off victorious from this tremendous battering. It was only slightly cracked in the right hand upper corner, and at the conclusion of the test was in much better condition than the best plates of the November trials, some of which had shown better results than any in the world under equivalent circumstances.

The weight of each projectile was 250 pounds, and it was propelled with a striking velocity of 1,700 feet a second. The simplest statement of the difference between the trial of November, 1891, and that of Saturday, July 23, is that the aggregate energy of the five shots on the former occasion was 16,900 foot tons, while on the latter it was 25,040. The Harvey process of case-hardening, which has been so successfully applied to giving a hard surface to armor plates, is concisely described by the *Railway Review* as follows: The plate to be treated is made out of mild steel containing, say, 0·10 per cent to 0·35 per cent carbon, and after being formed to its final shape is laid flatwise on a bed of finely powdered dry clay or sand, which is deposited upon the bottom of a fire-brick cell or compartment erected within the heating chamber of a suitable furnace. The upper surface of the plate is then covered with powdered carbonaceous material, which is tightly packed. Above this is a layer of sand, and over the sand is laid a heavy covering of fire bricks. The furnace is then lighted and then raised to a temperature sufficient to melt cast iron, and this heat is maintained for a greater or lesser period according to the amount of carbonizing to be effected. About 120 hours are said to be required for a plate 10½ inches thick. On removal from the furnace such a plate is found to have had the composition of its upper surface changed. At a depth of about three inches from the surface the percentage of carbon has been raised by about 0·1 per cent, which increases progressively as the outer surface is neared, when the amount of carbon may rise to 1 per cent. It is said that this process, though, as will be seen, it resembles the ordinary cementation process, does not cause any blistering of the surface of the plate. This the inventor attributes to the high temperature at which it is carried out; but it is also suggested that the absence of blisters may be due to the homogeneity of the metal used, which, unlike the wrought iron bars used in the cementation process, is free from cinders.

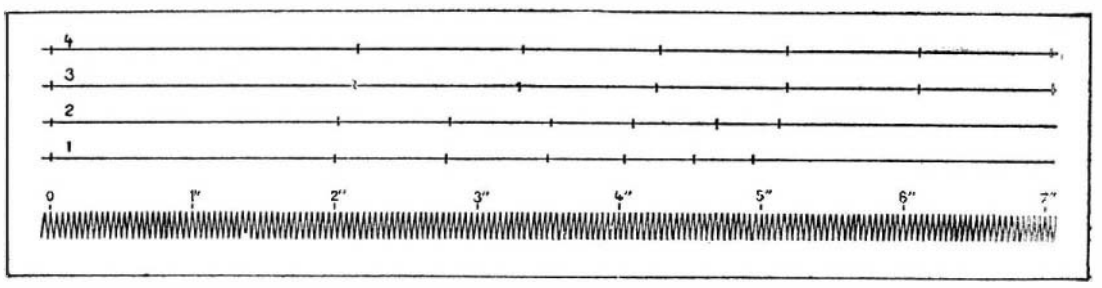


Fig. 3.—RECORD OF FALLING BODIES.

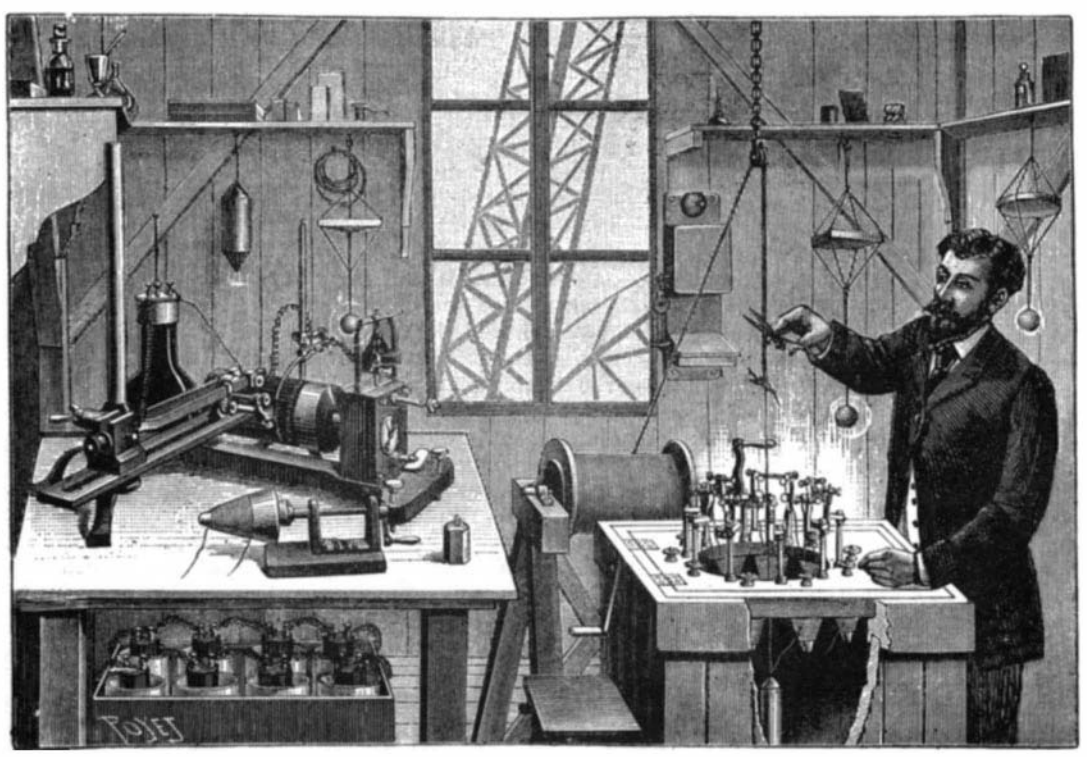


Fig. 1.—LABORATORY IN THE EIFFEL TOWER, PARIS.

FLIES have long been accused of spreading disease; but it is asserted now from Havana that mosquitoes have a use, for if they inoculate any one after biting a yellow-fever patient, the disease which follows is so mild that fatal results are rare.—*English Mechanic.*