TEST OF A SIX-INCH EXPERIMENTAL KRUPP PLATE.

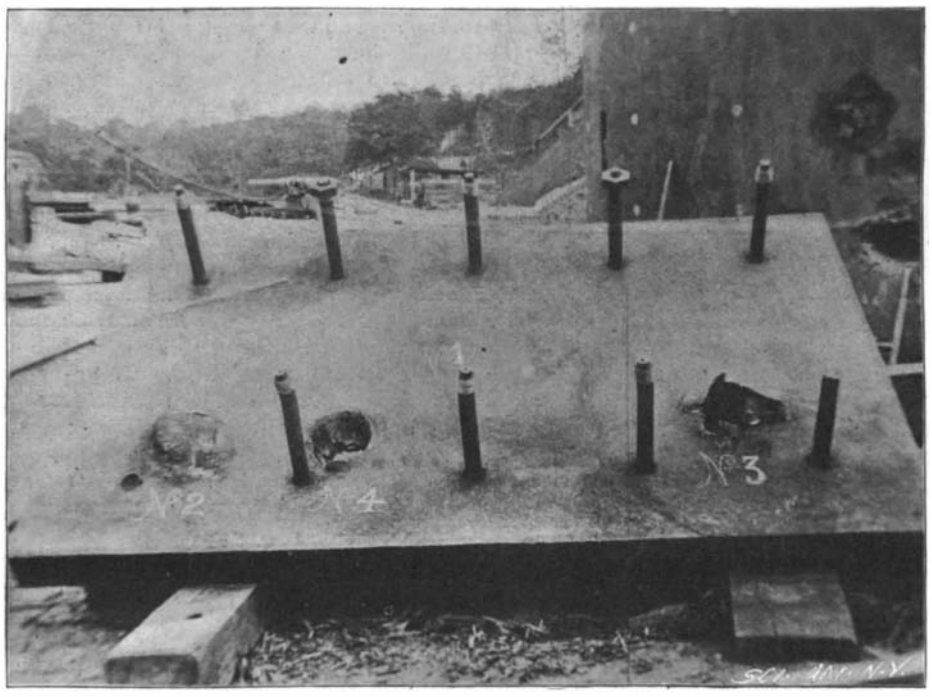
Our naval authorities are to be congratulated on their broadmindedness and enterprise in adopting a foreign process of armor-plate manufacture which has easily proved itself to be the very best in the world. The Krupp gas process has produced plates which are as superior to the Harvey and Corey plates as the latter plates were to the all-steel and compound plates of an earlier day. Its superiority, as shown by proving ground tests, was so marked that the English Admiralty at once adopted it in place of the Harveyized armor, and it is now being placed upon all the newer vessels of their navy; and after the very excellent results obtained at the Indian Head Proving Ground, and herewith illustrated, it was inevitable that the new armor should be chosen for all our future ships.

The supreme value of the ever increasing hardness and toughness which is being given to armor plates consists in the fact that the new plates enable the total weight of armor with which a ship is clothed to be greatly reduced, and the weight so saved may be appropriated to a more powerful armament, or engines and boilers of greater horse power. Proving-ground tests and experience in actual warfare have shown that the protection afforded by the 15 and 18-inch Harveyized armor of the "Oregon" is amply sufficient to resist modern high-powered rifles. Although the 18-inch belt or 15-inch turrets of the "Oregon" type of ship have never been penetrated in an actual engagement, the behavior of inferior heavy armor at the Yalu and at Santiago proves that the heavy Harveyized protection of our ships renders them practically impregnable against shell fired from the distances at which modern engagements will probably be carried on. This being the case, it follows that every improvement in the quality of the later armor enables us, taking the protection of the "Oregon" as a standard, to make a corresponding reduction in the thickness of the plates.

The improvements introduced under the Corey patents made it possible to increase the tensile strength about 12 per cent and the elongation about 15 per cent over that of the Harvey plates; and now the Krupp gas process enables us to produce a plate of such wonderful toughness and hardness that armor 10 and 11 inches in thickness has all the powers of resistance shown by the 15 to 18-inch armor of the earlier vessels.

Our readers who wish to follow the development of armor plate manufacture will find it treated at some length in the SCIENTIFIC AMERICAN ARMY AND COAST DEFENCE SUPPLEMENT. The Krupp gas process is the latest development in a long line of experiments which has successively provided the world with iron, compound iron and steel, all steel, Harveyized steel, nickel steel, Harveyized nickel steel, reforged Harveyized nickel steel, and Krupp steel. The rights have been purchased in this country by the Carnegie Company, and the second experimental plate recently tested at Indian Head proved to be of exceptionally high quality, even for a Krupp plate. Krupp armor shows remarkable toughness combined with all the hardness of the best face-hardened armor, and, unlike armor manufactured by other well known processes, the Krupp product maintains these qualities in the very thickest armor.

The plate tested at Indian Head measured 5 feet 8 inches by 9 feet by 6 inches. The backing consisted of 12-inch oak and two 5/8-inch skin plates secured to the plate by ten armor bolts. The plate and backing were secured to the normal target structure by four holding-in bolts 1·5 inches in diameter which passed through the backing, and by four similar bolts secured to the exposed vertical edge of the backing. The plate has a good surface and general appearance and was hard to a depth varying from 1·5 inches to 2 inches. The plate was so secured that "top" was the right vertical edge.



1.—REAR VIEW OF 6-INCH KRUPP PLATE AFTER TEST.

First Round.—The gun used was 6-inch rapid-fire. The charge of powder was 22·25 pounds of Dupont's S. P. F. G. 3; the striking velocity, by chronograph, was 2,021 foot-seconds and the striking energy 2,831 foot-tons. The projectile used was a 6-inch armor-piercing Carpenter, hardened to 3 inches below the bourrelet, without cap; weight, 100 pounds. The impact was at a point 39 inches from the bottom of the plate, 58·5 inches from the left edge and normal to the surface. The projectile smashed on the plate, only a small part of the point remaining welded in the plate, a large part of the body and base of the projectile being found in one piece in front of the plate. The estimated penetration was 2·5 inches. A back bulge 1·5 inches high was formed on the rear of the plate. The plate was dished in the vicinity of the impact 1/16 inch. The impact on the surface of the plate covered an area 12 inches in diameter. The plate was not cracked, nor was any injury done to the backing, bolts, or structure.

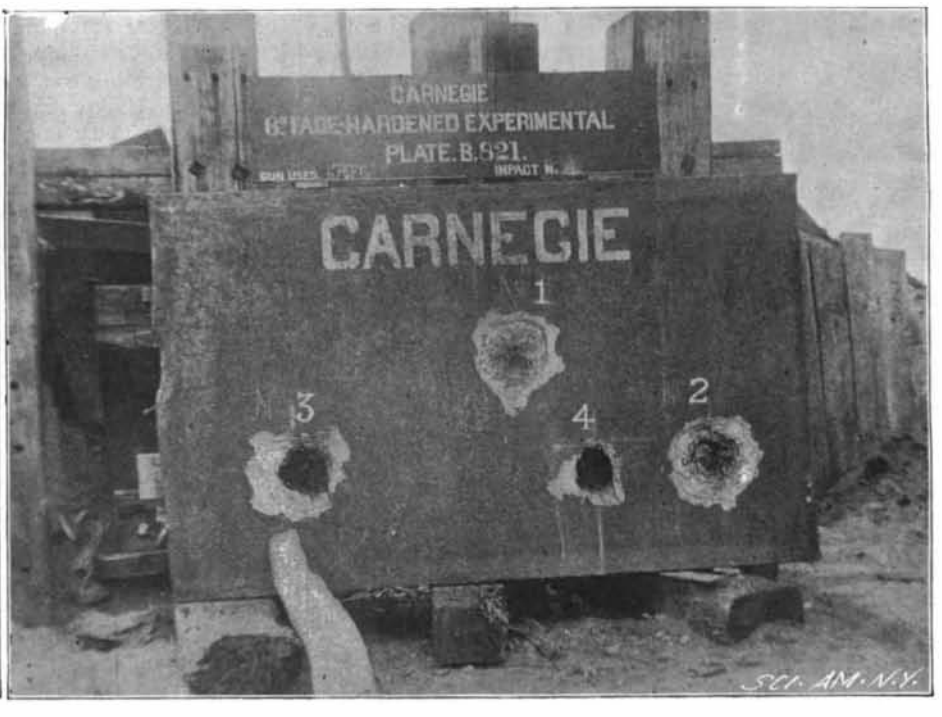
Second Round.—The same gun, 6-inch, was used. The charge of powder was 25·8 pounds of Dupont's S. P. F. G. 1. The striking velocity was, by chronograph, 2,237 foot-seconds and the striking energy was 3,469 foot-tons. The projectile used was a 6-inch armor-piercing Carpenter hardened to 2½ inches below the bourrelet, without cap, weight 100 pounds. The impact was at a point 19·4 inches from the bottom of the plate, 92 inches from the left edge, 39·5 inches from the previous impact, and normal to the surface. The projectile smashed on the plate. A large part of the projectile remained welded to the plate, judging from the smaller part of body and base found in front of the plate. The estimated penetration was 5 inches. A back bulge 4·5 inches high was formed on the rear of the plate. The plate was dished 1/8 inch in the vicinity of the impact. The impact on the surface of the plate covered an area 10·5 inches in diameter. The flaking extended around the impact to a diameter of 16·5 inches. The plate was not cracked, nor was injury done to the backing, bolts, or structure.

Third Round.—The same gun, 6-inch, was used. The charge of powder was 25 pounds of California S. P. perforated cylinder. The striking velocity was, by chronograph, 2,350 foot-seconds and the striking energy 3,828 foot-tons. The projectile used was a Carpenter 6-inch armor-piercer without cap, hardened to 2¾ inches below the bourrelet; weight 100 pounds. The impact was at a point 20·25 inches from the bottom of the plate, 21·5 inches from the left edge, 41 inches from the nearest previous impact, and normal to the surface.

The projectile perforated the plate and broke up all parts, going through the plate and the oak backing; but they were stopped by the skin plating without cracking the latter. The hole made in the plate was of an irregular oblong form, having greatest diameter of 8·5 inches at front and rear and no spur. A part of the plate of the same shape as the hole was driven ahead of the projectile in one piece, as though punched by a powerful punch. The plate was dished 0·3 inch in the vicinity of the impact. The flaking on the front face was 17·5 inches in diameter. The plate was not cracked, nor was any further injury done than that set forth above to the plate, backing, bolts, or structure.

Fourth Round.—The same gun, 6-inch, was used. The charge was 32·3 pounds of Dupont's S. P. F. G. 3. The striking velocity was, by chronograph, 1,984 foot-seconds and the striking energy 2,837 foot-tons. The projectile used was Carpenter 6-inch A. P., fitted with standard cap, hardened to 4 inches below the bourrelet, weight 104 pounds. The impact was at a point 18·25 inches from the bottom of the plate, 9·5 inches from the left edge, 21·25 inches from the nearest previous impact, and normal to the surface. The projectile perforated the plate and broke up, all parts going through the plate, backing, and skin plates, and barely entering the sand butt in the immediate rear of the structure. As in the previous round, the hole made was oblong in shape, with the greatest diameter of 6·75 inches, and practically the same on the front and rear faces. A spur 1·6 inch high was raised about the point of exit. There was no dish in the plate observable about the point of impact. The flaking on the front of the plate was 12 inches in diameter. No other injury than that noted above was done to the plate, bolts, backing, or structure. This plate showed great resisting power.

2.—KRUPP PLATE AFTER ATTACK BY THREE 6-INCH ARMOR-PIERCING SHELLS.



3.—SAME PLATE PENETRATED BY CAPPED SHELL DELIVERED WITH 1984 FOOT-SECONDS VELOCITY.

The notable features were the extreme toughness of the back of the plate and great thickness of the hard face, the comparatively small flaking on the front face, and the entire absence of coning on exit at the rear. The plate was of good appearance as regards surface, both front and rear.

Continued improvement in quality, peculiar to the American manufacturer, will no doubt result in the near future in armor plate manufactured by this process, and the result will no doubt be equally as superior to that manufactured in Europe as is our present ordinary face-hardened armor.

THE "AVION."

The problem of aerostation, that is to say, of aerial locomotion effected by means of an apparatus heavier than the air, is so attractive as to occupy the attention not only of the most extravagant inventors, but of the most conservative and conscientious scientists. How many strange conceptions, from the flying dove (a simple toy) of Architas of Tarentum (from the century before Christ) to the dirigible flying apparatus of Otto Lilienthal, which was much more dangerous, since, in 1896, it cost its inventor his life! How many laborious researches, from those of Roger Bacon and Leonardo da Vinci to those of Maxim, Langley, and Richet! How many disciples on both sides!

Is the "Avion," an apparatus devised and constructed by M. Ader, a French engineer, finally to permit man to realize the legendary dream of Icarus? Perhaps so.

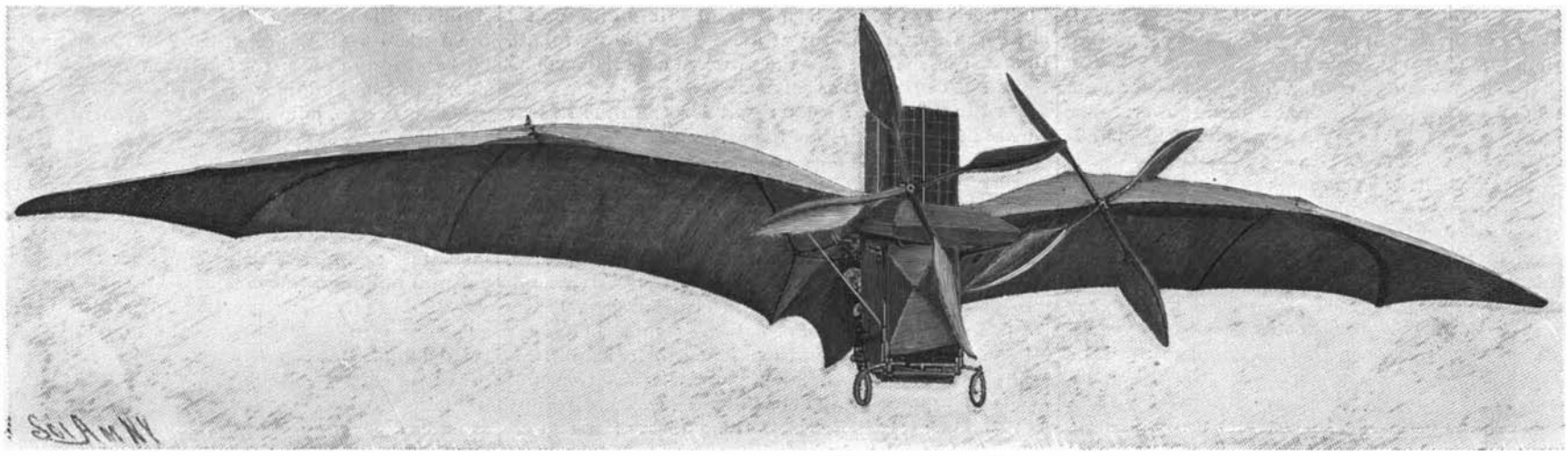
Upon an examination, and at first sight, this Avion is the most seductive flying machine that could be imagined. Will it fly? It is, unfortunately, difficult to be positive as to this essential point, since up to the present the machine has done so little flying!

M. Ader has been able to attempt an experiment but once. A fortuitous accident interrupted the experiment at the precise moment at which it was about to prove conclusive in one direction or the other, and the apparatus has therefore failed to show what it is capable of doing.

M. Ader, like all those who, before him, have conceived the idea of rising, moving, and steering themselves in the air, has for a long, very long time studied the flight of birds, and the organs of such flight, the wings. He has doubtless brought to this study more shrewdness than was possessed by his predecessors and his rivals, since he has made one discovery that did not enter their heads. He has observed that for the organs by which birds are sustained in the air Nature has adopted a well defined, special geometrical curve, developing from front to rear in the direction of the motion. Each feather taken separately obeys the same law. The curve is more or less pronounced according to the charge of the wings, but the spiral is found always and everywhere in the wing of all birds—in that of bats, in that of insects, and in the structure of everything that sustains itself in the air. There is here a principle from which Nature never departs, and which, according to M. Ader, constitutes the basis of aerostation.

In order to sustain his mechanical bird upon the atmospheric strata, M. Ader has, therefore, deliberately abandoned the plane surfaces of the Maxim and Richet apparatus and substituted therefor incurved surfaces —true wings, characterized, like the mysterious boomerang of the Australian aborigines, by the indispensable spiral.

With such a starting point, the Avion should certainly offer a general resemblance to the body of a bird with outspread wings. Such resemblance will certainly be objected to on the score of not being very scientific and of giving the machine the aspect of a gigantic and puerile plaything. But M. Ader makes no concealment of his intentions; it is really a mechanical bird that he has desired to construct (just as was done by the Franconian astronomer J. Muller in the fifteenth century), but with all the means placed at his disposal by modern science and industry.



THE "AVION" IN ITS POSITION OF FLIGHT.

THE "AVION" WITH THE WINGS FOLDED.

As may well be imagined, the copy of the bird is not servile. The wings of the Avion are not composed of artificial feathers. They reproduce those of the bird especially by the distribution of resistances. The frame, which is made of sized bamboo fibers, is hollow and of extreme lightness and rigidity. Ribs of steel wire (true tendons) hold them in position. The sails or membranes that serve as a support in the air are of silk. These wings, jointed in all their parts, are capable of being folded up compactly. They serve for sustentation merely, and do not flap. They are movable at the shoulder only from front to rear, in order to permit of modifying the center of gravity of the apparatus. The propeller of the Avion is a screw, which, in the air, replaces the flapping wing of the bird, as in water it replaces the fin of the fish. The four-bladed screws constructed by M. Ader are of bamboo fiber, light and rigid, two in number, and situated in front. They revolve in opposite directions, in nearly the same plane, and are entirely independent. The motor that drives each of them is a marvel of power condensed into small bulk and feeble weight. The motive power is furnished by steam. The