TURRET OF THE BATTLESHIP MASSACHUSETTS UNDER FIRE.

An experimental turret, representing similar structures on the United States battleship Massachusetts, was tested last spring under conditions such as will obtain in an actual sea fight, and we are now enabled to present our readers with photographic reproductions which show how it stood the ordeal.

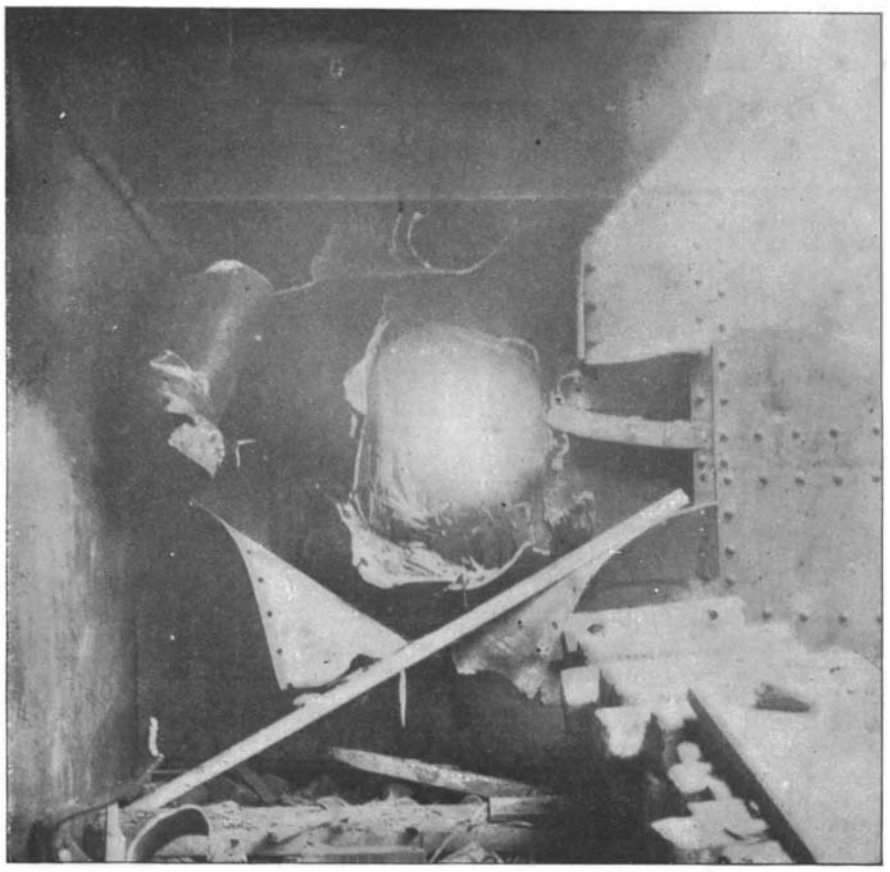
The ballistic tests which are continually being made upon armor plate furnish very complete information regarding its ability to keep out projectiles. There is not a battleship in any of the navies of the world regarding which a naval expert could not tell us the powers of resistance possessed by its armor. There are other questions, however, to be considered in addition to that of the mere resistance of armor to penetration. The plate would afford but little protection unless it were well supported or "backed" by the framing of the ship itself. Even if a shell should fail to get through, there is a possibility that it will drive the plates bodily within the structure of the ship, racking and distorting the skeleton framework to which the armor is bolted. Our readers will remember the test made late last year of a structure representing the sides of the battleship Iowa, which was illustrated in the SCIENTIFIC AMERICAN of November 9. The results showed that the framing had ample strength to hold the plate up against the heaviest shells.

It was felt by the Bureau of Ordnance, however, that the experiments would not be complete until a test had been made of the armored turrets of our battleships. The fact that the framework of the ship itself could stand the impact of heavy projectiles was no proof that the revolving turrets, which carry the big guns, would be equally secure. A slight deformation of the plates and beams of the backing, which would be of but little consequence in the fixed sides of the ship, might interfere with the working of a huge turret, rotating as it does on a circle of steel rollers, and having clearances of only a few inches between itself and the walls of the barbette. Even if the structure of the turret itself were not distorted, it was possible that it might be moved bodily upon its supports, in which event the elaborate gear, hydraulic or otherwise, for turning the turret would be disabled, and the whole mass, with its two big guns, constituting one-half the main fighting power of the ship, become wedged in its seat and rendered all but useless.

It was determined to make a test of an experimental turret which should be practically, at least for the purposes of the test, a facsimile of the turret of the battleship Massachusetts. A solid foundation of piling covered with heavy timber was built, and upon this was laid a circular track of wrought iron plates, answering to the roller track of the Massachusetts. The experimental turret was about 27 feet interior diameter and 11 feet high. Its framework, consisting of vertical angle frames and horizontal channel irons, carried ten cast iron plates, 15 inches thick, and one steel test plate representing the turret armor of the Massachusetts. Interior girders, similar to those used for carrying the gun, were built in place, and 180 tons of pig iron were so disposed within the turret as to represent the actual weights of the gun and gear. The weight of the complete structure was 450 tons, and it was carried on twenty cylindrical rollers of steel, which were prevented from transverse movement by means of wrought iron wedges. The experimental steel plate was one which had already been used in experimental tests, and had successfully resisted two heavy armor piercing shells, the points of which were embedded within it. In the present experiment three rounds were fired, as per the accompanying table:

	Round 1.	Round 2.	Round 3.
Gun.....	10 inch.	12 inch.	12 inch.
Projectile. ...	500 pounds.	850 pounds.	851 pounds.
Velocity	1,633 foot secs.	1,701 foot secs.	2,000 foot secs.
Energy	9,829 foot tons.	17,069 foot tons.	23,626 foot tons.

The first shell, a 10 inch Wheeler-Sterling, broke upon the plate with a penetration of 9½ inches. The point of impact was 14½ inches from the top of the plate and 2 feet to the left of the second of the points of impact above mentioned. A piece of the plate above the point of impact, 33 inches wide, was carried away, and the roof plates of the turret were wrenched upward to a height of 1 inch. The armor bolts were uninjured and there was no movement of the plates on the turret. The whole turret was moved backward on its rollers for a distance of 1¾ inches.



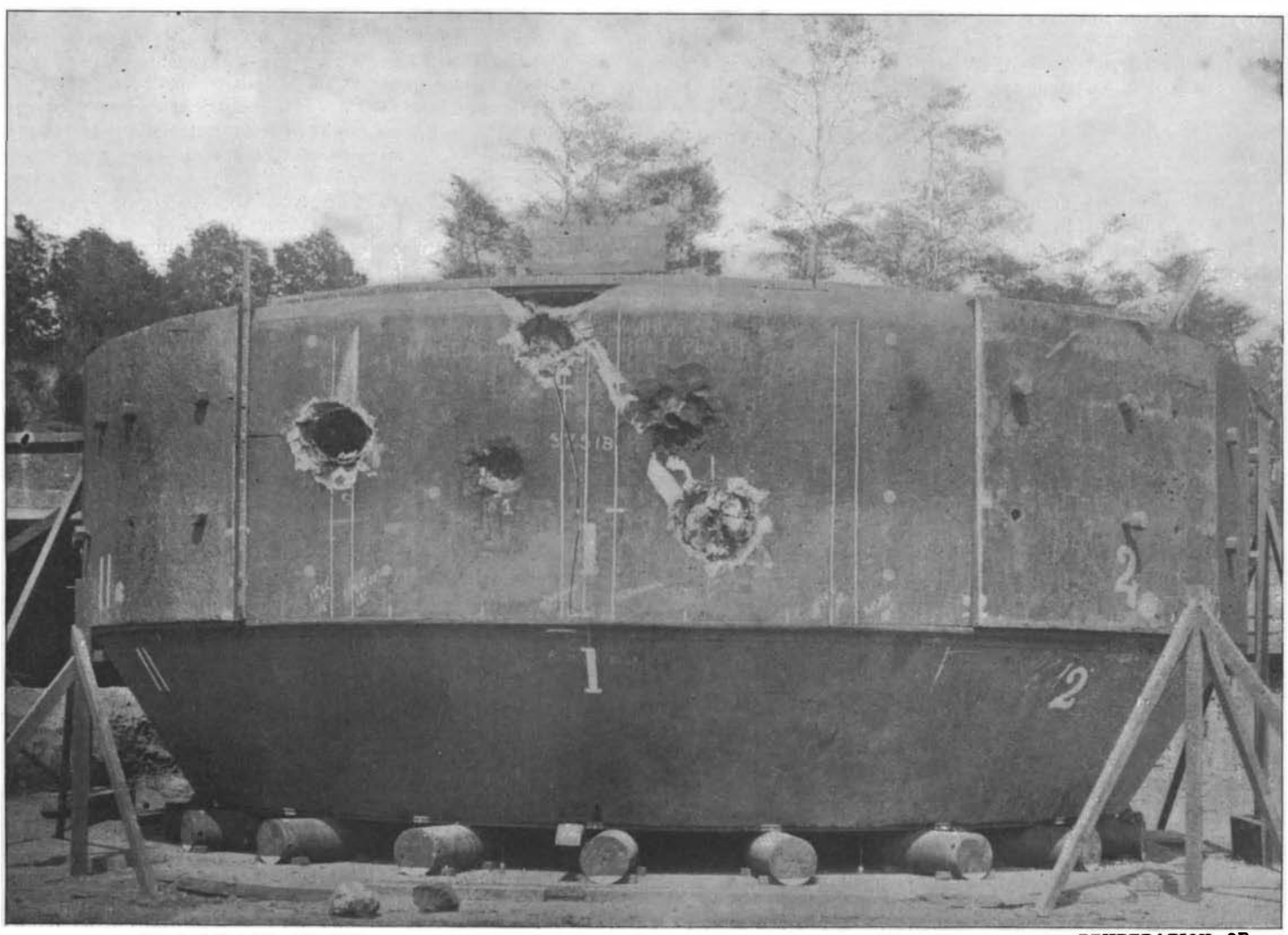
INTERNAL VIEW OF SHOT HOLE SHOWING DESTRUCTION OF BACKING, FRAMEWORK, AND COVERING PLATES.

The second shell struck the turret at an angle of 7½° from the normal. This projectile penetrated 11½ inches and broke up, the head remaining welded to the plate. The plate was cracked diagonally through the last shot hole and through one of the old points of impact to the bottom of the plate. One armor bolt was broken and driven into the turret. The adjoining cast iron plate to the right was slightly displaced. The horizontal channel irons of the framework were buckled to the extent of one inch. The splinter bulkhead to the left was buckled to the extent of 3 inches. The turret itself was carried to the rear a distance of 7¼ inches, and was also turned about its axis slightly. There was no distortion of the structure considered as a whole.

The third shot was a Johnson fluid compressed steel armor piercing shot, similar to that shown in our last week's issue, but 12 inches in diameter. It carried a soft steel cap and weighed 851 pounds. It struck the plate at an angle of 21° from the normal, at a point about 3 feet from the left edge and 3 feet from the top of the plate. It will be noticed that the angle of impact was very large, and when the shot struck the plate, instead of following the line of fire, it turned sharply to the right and passed entirely through the plate on a line nearly normal to its surface.

The shot broke up in forcing its way through, the larger pieces going through the covering plate on the rear side of the turret, piercing the backing, smashing off a large portion of the rear cast iron plate, and finally going into the woods behind the target.

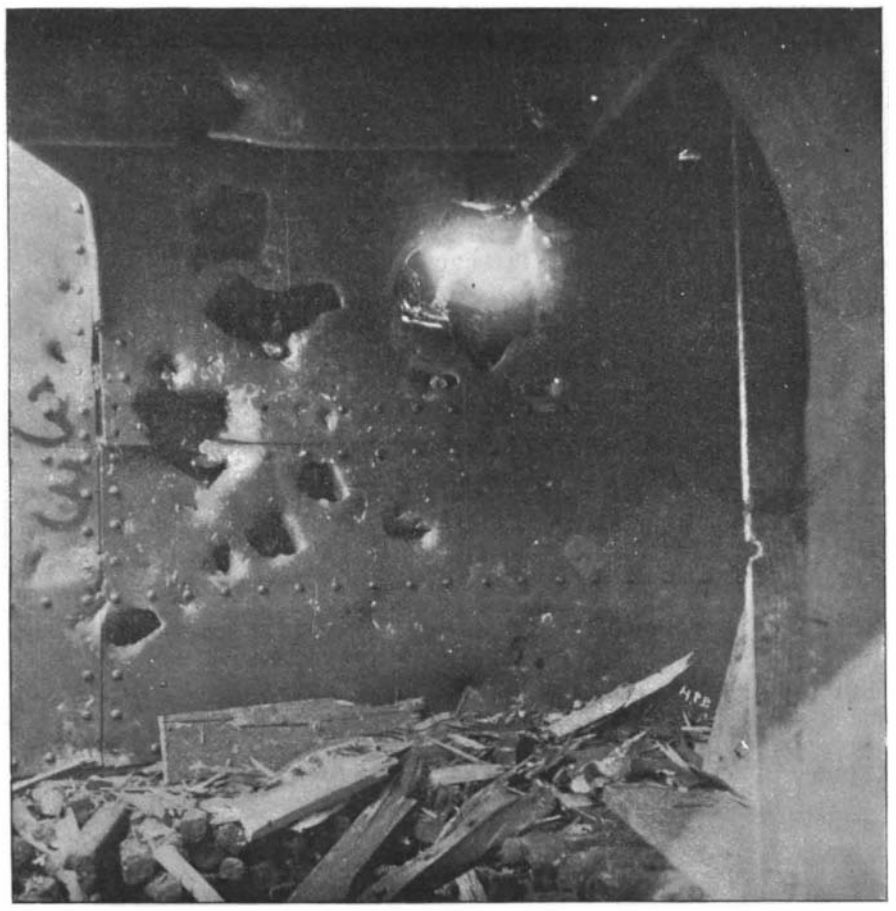
The destructive effect of the shot is shown very graphically in the accompanying illustrations. The back of the ballistic armor plate was broken out for a diameter of two feet around the hole; pieces of the steel being driven through the turret and scattering in all directions. The backing was carried away and splintered; the plating behind the backing being folded back and wrecked over an area of 3½ feet square. Rivets were sheared and flew all over the turret, leaving their marks on the interior. The channel beam at the rear of the shot hole was ripped off and thrown across the turret. A jagged hole, 7 inches in diameter, was torn through an adjoining deck beam. The interior vertical covering plates on the opposite side of the turret were pierced with eighteen holes and showed numerous deep gouges and scars caused by the flying fragments. The turret structure over an area of 4 square feet where the shot struck was badly wrecked. The backing on the rear side was wrecked and splintered and the 15 inch cast iron plate badly cracked, two large pieces of the latter being thrown to the rear, leaving



EXPERIMENTAL TURRET OF THE BATTLESHIP MASSACHUSETTS—EXTERNAL VIEW, SHOWING COMPLETE PENETRATION OF 15 INCH HARVEYIZED NICKEL STEEL PLATE.

a triangular hole 4 feet high and 4 feet wide. All six of the armor bolts holding these plates were broken, and the plate itself was forced to the rear 9 inches on one edge and 2 inches on the other. This impact moved the turret 9 inches to the rear in a direction making an angle of nearly 8° with the line of the movement in the two previous impacts. It also revolved around its center to the left through an angle of 2°. The result of the test proves that the framing of the turret has ample strength to resist the heaviest strains that could come upon it under fire. The fact that the turret as a whole moved as much as 9 inches under the energy of the shot raises the question of the sufficiency of the means adopted to hold the turrets of our battleships in place. As at present constructed, the tendency to translation of the turret is resisted by the flanges of the steel rollers upon which it revolves, and it is estimated by Commodore W. T. Sampson that these flanges present an ample margin of strength to resist the shearing action to which they are subjected. When the 33,000 foot tons of energy of a 13 inch shot is communicated to the turret, a part of it is expended in piercing or breaking up the plate and part of it causes the whole turret to move until the roller flanges take hold of the edges of the roller track. According to the last authority, the pressure of a 13 inch gun against its recoil cylinders when it is fired brings a strain upon the roller bearings far greater than they can ever experience under the momentum of a heavy shot. Altogether this very interesting test establishes the excellence of the system of turret construction as carried out in our new battleships.

Referring again to the photographs showing the destruction wrought in the interior of the turret by the flying fragments of the successful shot, it is evident that had the turret been occupied by actual guns and gun crew, the gun itself and the larger part of the crew would have been disabled. It is also noteworthy that successful penetration was effected in spite of the fact that the shot struck at a high angle of incidence, and there is no doubt but what it was largely due to the action of the soft steel cap, as explained in our last issue.



INTERNAL VIEW SHOWING PENETRATION AND DESTRUCTION OF REAR WALL OF TURRET BY FLYING FRAGMENTS OF THE SHOT AND ARMOR.

Plans for the Proposed Zoological Park in New York.

Last spring the plans of the New York Zoological Society reached a point where it became necessary to take up the many questions involved in the design and construction of buildings and other inclosures for animals, and also their arrangement in the proposed Zoological Park. The executive committee realized the necessity of a thorough examination and study of the best zoological gardens of Europe.

Accordingly, says Science, Mr. William T. Hornaday, the director, was instructed to visit all the large gardens of Europe, examine them carefully, and bring back photographs and designs of their most valuable and interesting features. He left New York in June, and visited the zoological gardens of the following cities, in the order named: London, Antwerp, Rotterdam, The Hague, Amsterdam, Hanover, Hamburg, Berlin, Dresden, Leipsic, Frankfort, Cologne, and Paris. Altogether fifteen gardens were inspected, and their best features were photographed, sketched and studied throughout. Without an exception, the directors, superintendents and inspectors of the gardens visited were very cordial. Every fact asked for was cheerfully furnished, without the slightest hesitation or reservation. Not only were good features pointed out as being worthy of special attention, but some officers very kindly indicated the mistakes that had been made in their gardens in the early days when everything had to be determined by experiment, thus showing what to avoid.

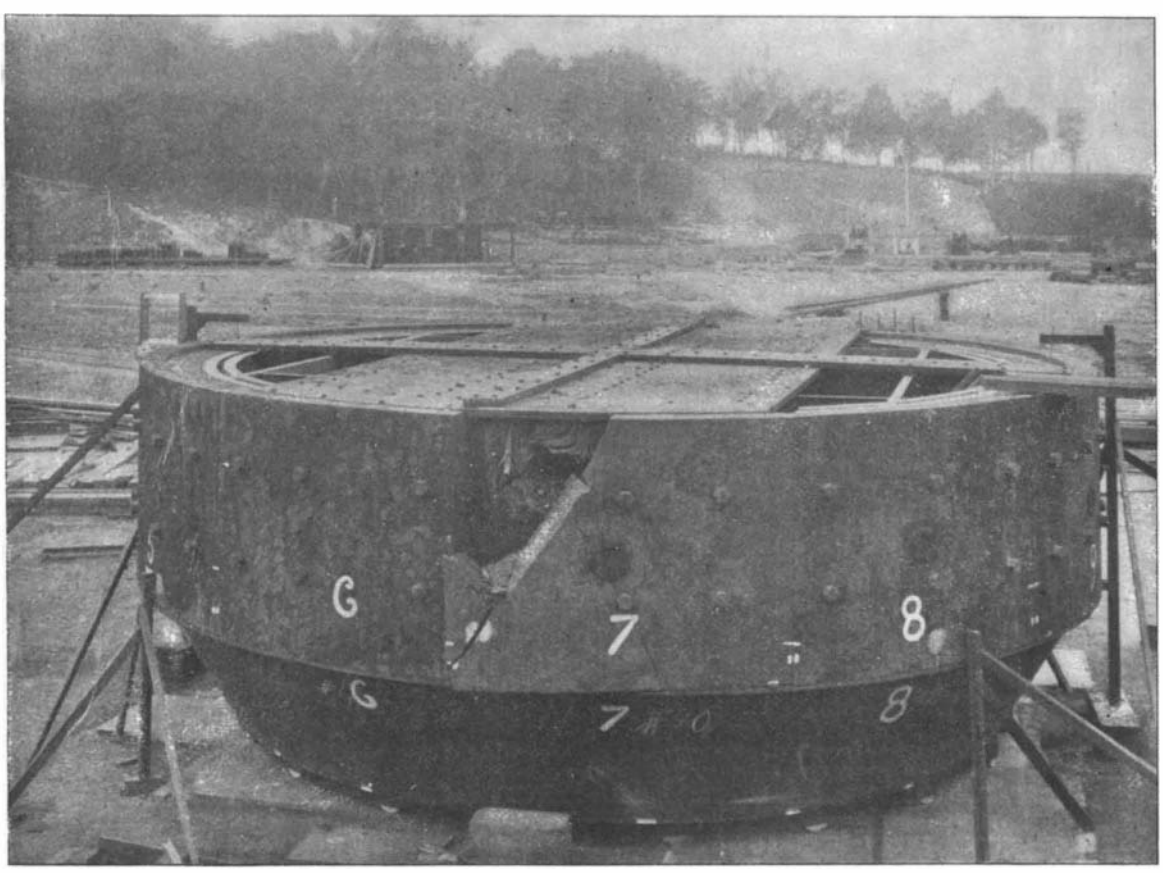
In London, Dr. P. L. Sclater, the executive head of the London Zoological Society, gave all the information and facilities for photographing that were desired in the society's gardens, and Mr. Clarence Bartlett, Assistant Superintendent, explained the entire working machinery of this truly magnificent zoological institution. At Antwerp the visitor is fairly amazed at the perfection of all the larger buildings for animals and the extreme beauty and attractiveness of nearly every feature of that scientific establishment. Director L'hoest and his assistant, M. J. De Winter, were untiring in their willingness to afford all the information desired, and to show everything not open to general view. Only two and one-half hours distant is found the beautiful garden at Rotterdam, known to but few Americans, where Dr. Von Bemmelin pointed out with pardonable pride the newest lion house in Europe, and the first great flying cage ever constructed for the larger wading birds. An equally short distance farther on, at Amsterdam, is found a very rich collection, installed amid charming surroundings, in which the health and "condition" of every bird and quadruped seems absolutely perfect. In the absence of Director Kerbert, Inspector Castens devoted hours of time to answering the question, "How do you keep everything in such fine condition?"

At Hanover, Dr. Ernest Schaff fully explained the plan of foundation and management of his zoological forest, and supplied a plan of the new and admirably constructed antelope house. At Berlin was found another royal establishment, with the larger mammalia housed in ornate and costly buildings. The garden occupies part of the imperial grounds and it is one of which the citizens of Berlin may well be proud. Dr. Ludwig Heck, its director, became much interested in the New York plan, and his co-operation was heartily extended. At Hamburg another very fine garden was inspected, in which all the shade is the result of artificial planting. It thus affords a fine opportunity to observe what can be accomplished if sufficient time is allowed. The shade trees are now very beautiful, and at once impress the expert visitor as being remarkably well distributed to serve their purpose of shading both the outdoor animals and the walks. Two days were spent with Herr Carl Hagenbeck, who has at Hamburg a Thierpark of his own, quite as large as the Central Park Menagerie of New York. Probably no man living has given more study to the problems of zoological garden construction and the care of animals in captivity, and Mr. Hornaday found him not only willing but eager to explain the mistakes to avoid, as well as the latest developments in the care of animals.

The director of the very interesting garden at Cologne, Dr. Wunderlich, was quite as ready with helpful information as his colleagues of other cities, and some of the features of his establishment were found to possess exceptional interest. The Frankfort garden contains much that is new and admirable. Prof. Milne Edwards, director of the Paris Jardin des Plantes, also extended every facility for study and examination of this the oldest garden of Europe. Regarding the status of a garden which, like this, is free to the entire public, the experiences and observations of Prof. Milne Edwards were both interesting and valuable. He expressed the opinion that no zoological garden should be kept open every day in the week, principally because it is not best for the collections.

The store of photographs, sketches, notes and plans collected during this tour are now being utilized in the preliminary plans for the New York park. It is proposed to determine the location and general design of every building and inclosure before the project is finally submitted to the city authorities in January, 1897.

The site selected by the society is the southern portion of Bronx Park, about a quarter of a mile south of the Botanical Garden. According to the charter granted to the society by the New York Legislature in 1895, the approval of this selection rests with the mayor and commissioners of the sinking fund.



EXTERNAL VIEW OF REAR WALL, SHOWING DESTRUCTION OF 15 INCH PLATE BY FRAGMENT OF SHOT WHICH PASSED THROUGH TURRET. 12 INCH GUN SHOWN IN THE DISTANCE.

A New Material for Floors.

According to a French exchange, the name of "papyrolith" has been given to a novelty in the way of a flooring material recently invented by Mr. Otto Kraner, of Chemnitz. The article is a special preparation of paper pulp in the form of a dry powder. This, when mixed with water, may be spread like mortar over stone, cement, or wood, where it dries quickly and may be smoothly planed; besides which, it may be tinted almost any color, so as to adapt it for parqueting with variegated borders, or for panels and mosaics. Among the advantages claimed by the inventor are freedom from crevices, non-conductivity of heat, elasticity, and remarkable durability.

IN Germany asparagus is peeled before being canned, by the aid of a special machine.