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RECENT ARMOR PLATE TRIALS.

Much has appeared of late, in the daily press, about an armor plate trial which took place at Indian Head proving grounds, on July 23, 1892, and about one which took place at Redington proving grounds, on July 30, 1892. As most of what has been said about these trials is inaccurate, and some of it absolutely incorrect, we have taken the trouble to investigate, and now place before our readers the facts as far as it is possible to obtain them.

It must be remembered that the development of armor in this country has advanced with tremendous strides, and we are now in an assured position far in advance of foreign governments. This is due to the energy, intelligence, and labor of our manufacturers and ordnance officers. In consequence of our advanced position, it is wise and desirable that certain details of manufacture should be kept secret, and hence it is difficult to obtain correct, and impossible to obtain full, information concerning our armor plates from either the government officers or the manufacturers.

The average person knows nothing of it, and the scientific engineer scarcely realizes what an exact science modern ordnance and gunnery is. As an illustration let us cite the following: The Bethlehem Iron Co. have recently equipped a proving ground, or experimental battery or testing range, at Redington, Pa., about six miles below Bethlehem, on the Lehigh River. Two navy guns were mounted there, one of eight inches caliber, the other of six inches caliber. The rough forgings for these guns were made by the Bethlehem Iron Co., and were then sent on to the Washington navy yard, where they were smooth-machined and assembled at the gun factory. They are in all respects—dimensions, strength, and fittings—exactly like the standard navy eight inch and six inch guns. To determine the velocity of a projectile, two screens or frames are placed in the line of fire, the first at a distance from the muzzle of the gun of about 70 feet, the second 100 feet further on. These frames are crossed with fine wire, and the wire of each frame forms a separate and complete electric circuit with a chronograph located in a house a quarter of a mile away. The projectile, as it passes through the first frame, breaks the fine wire, thus breaking the circuit, and the instant of this breaking is recorded on the chronograph. In like manner the projectile, as it passes on through the second frame, 100 feet distant, breaks the second set of fine wires, and thus that circuit is also broken, and the instant of this breaking is likewise recorded by the chronograph. As the interval of time between these two instants is usually less than one-seventeenth of a second, the chronograph must be a very delicate instrument and must give very accurate results to be of any value whatever.

The velocity of a projectile from any given gun depends on a number of factors, the principal ones being, however, the weight of the charge and the kind of powder used. In firing the first shot from the eight inch gun at Redington, it was desired to get a velocity 1,715 feet per second.

The gentleman in charge of the Redington experiments, who, by the way, is an ex-officer of the navy and has an excellent reputation as an ordnance expert, calculated the amount of powder of a certain grade or quality necessary to give the above velocity. The powder used was brown prismatic, and the chronographs were of the Boulenger pattern. The gun was loaded and fired, and the chronograph gave an observed velocity of 1,702 feet per second. Here was a result within less than eight-tenths of one per cent of the calculated result. An error of less than a hundredth of a second in the record of the chronograph, a few ounces more or less in the weight of the projectile or the powder charge, a few thousandths of an inch variation in the diameter of the projectile, any one of these would account for the difference between the observed and calculated velocity of the projectile. This one example would warrant us in calling the science of gunnery an exact science. This was the first shot fired, and greater exactness was obtained in succeeding shots, because the different parts could be more neatly adjusted by the information obtained from preceding shots, but the first shot had no such advantage.

In the armor plate trials which took place at the Annapolis proving ground in September, 1890, and at Indian Head proving ground in November, 1891, all the plates were severely damaged, some much more than others. For a description of these trials the reader is referred to SCIENTIFIC AMERICAN SUPPLEMENT, No. 837. It will be noticed that in these trials four projectiles from the six inch gun and one from the eight inch gun were fired at each plate. The six inch projectiles weighed 100 pounds and had a striking velocity of 2,075 feet per second. The eight inch projectiles weighed 250 pounds and had a striking velocity of 1,700 feet per second. Total amount of energy thrown at each plate, 16,940 foot tons per second.

The results of the trial of 1890 caused the navy department to abandon for the present the idea of making compound plates, and devote its energies to the development of the steel and nickel-steel plates. The trials of 1891 showed the superiority of the alloy plates of nickel-steel over the simple steel plates, and gave a strong hint of the value of surface carbonization by the Harvey or some similar process.

The manufacture and experiments with nickel-steel harveyized plates went on, every detail of the process being watched with the utmost care, and minor improvements and suggestions in the detail of manufacture were experimented with. Nothing was left undone or untried that experience and ingenuity could suggest. In all the trials the plates were of the uniform dimensions of 8 feet by 6 feet by 10½ inches. In the 1890 and 1891 trials, a total energy of about 16,940 foot tons per second was thrown at each plate. In the 1892 trials, a total energy of about 25,042 foot tons per second was thrown at each plate.

The two 1892 plates were constructed as nearly alike as possible in all particulars except one. The July 23 plate was double forged, that is, it received its final finished forging under the 125 ton hammer after being harveyized. The July 30 plate was single forged, having been forged to its final dimensions before being harveyized. These last two tests were made principally to determine which was the better of the above two methods of forging.

The test of July 23, 1892, took place at Indian Head proving ground. Five eight inch Holtzer projectiles were fired. Three of them broke into a number of pieces, and the penetration was between three and four inches. Two projectiles pierced the plate, the points reaching the rear surface. There were cracks in the upper right hand corner only. The projectiles weighed 250 pounds and had a striking velocity of 1,700 feet per second. The total energy thrown at the plate was 25,040 foot tons per second.

This plate then withstood an onslaught of 50 per cent more destructive energy than the plates of 1891, and was in a better condition by at least 20 per cent. It was by all odds the finest plate that had ever been tested in this country or in any other.

The test of July 30, 1892, took place at Redington proving grounds. Five eight inch Holtzer projectiles were fired. Each shot was broken into many fragments. The penetration of each shot was between three and four inches. The points of the projectiles remained welded in the plate. A tempering crack was opened from the upper right hand shot hole to the top of the plate. The projectiles weighed 250 pounds and had a striking velocity of 1,700 feet per second. The total energy thrown at the plate was 25,042 foot tons per second.

This trial was fully as severe as that of July 23, and the plate stood the attack better. These two trials are the most remarkable ever held, and the July 30 plate stands, to-day, as the record breaker of the armor world.

OPPORTUNITIES FOR INVENTION.

No argument is needed to show that to invention must be accorded a very high place among instrumentalities for promoting progress, but with some the question has arisen whether the climax has not been reached, with retrogression in prospect. Those who raise this question hold that, although in the past great inventions have been made, opportunities grow less as time goes on. They believe that no new principles remain to be discovered, and that there is little if any unknown material; that the greatest adaptations of materials and principles have already been made, and that from now on, inventions must be in the nature of new combinations of old materials and principles according to known laws; therefore, they say, great inventions in the future must necessarily be few. Such is the argument of the pessimist, which at first may seem rational, but seen in the light of modern progress must give way to the opposite view, which holds that every new discovery or invention is almost sure to lead to other discoveries and inventions of equal or greater importance; that we are only on the borders of the realm of invention, and that the possibilities of the future are far greater than those of the past. This is the optimist's view, which is backed by history, reason and common sense. As an example bearing out this view, the enormous development of the applications of electricity may be mentioned. Who, in 1882, thought that, in 1892, electric manufacturing would be one of the principal industries?

Now, according to the pessimistic view, dynamos and motors have neared perfection; new electric appliances and methods are not to be expected; dynamos have an efficiency of 96 per cent, and motors are correspondingly efficient; an improvement of 4 per cent in efficiency only is possible, and that is not worth trying for. The optimist says, although this may be true in regard to dynamos and motors, yet discoveries are always in order, and it is not impossible that some inventor may hit upon a new principle which will revolutionize dynamo and motor construction; what has heretofore been regarded as ultimate may prove only the beginning; but, however this may be, dynamos and motors are not prime movers. The great thing to be expected in the electrical line is an invention which will make electricity a prime mover. This is not a