UNITED STATES NAVAL PROVING GROUND, INDIAN HEAD.

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The United States Naval Proving Ground was established at Indian Head, Md., in 1891. Previous to that time experiments in ordnance and gunnery had been performed at what was known as the Experimental Battery, situated on the left bank of the Severn, opposite Annapolis. In the early '80's the name was changed to Proving Ground; and as the proof of high-powered guns began about this time, the necessity for a longer range and better water communication with the gun factory at Washington determined the Navy Department to remove the proving ground to its present location.

A few acres would be sufficient to accommodate the emplacements for the guns and armor butts, together with the necessary dwellings of those occupied in carrying on the work. It is, however, desirable, and indeed necessary, that the country for a considerable radius should be free from persons or property that might be injured by the erratic missiles which so frequently fly off during the shell and armor tests. To this end about nine hundred acres of land were purchased, and the concrete foundations that hold the heavy gun carriages were laid in a narrow valley leading down to the Potomac.

The guns are arranged in two batteries on each side of this valley. The one on the northern side is arranged so that the guns may be pointed down the river, where there is a clear range of about twelve miles. The velocity battery is on the southern side of the valley; and as the high land that bounds this narrow plain on the north side is quite bluff, its sloping surface formed a ready-made butt, in which the projectiles were safely buried. As time went on, however, the hillside became the depository of a large number of shells; new shells fired into the earth would frequently strike a glancing blow on one of these bits of metal, and instead of plowing deeply into the clay until they came to rest, would be deflected upward with terrific energy, and go hurtling over the woods for a half mile or more. So long as they fell within the limits of the government reservation there was no great objection; but ultimately an errant shell would find its way outside the reservation limits, and this necessitated mining the hillside, from time to time, and removing all the buried metal.

It is an almost invariable rule for every man in the vicinity to take shelter in one of the bomb-proofs whenever a gun is fired. There are four of these, two conveniently located near each battery. They are chambers dug out of the hillside, lined and arched with brick, and heavily walled in front. Generally the guns are fired by electricity, and the leading-wire is simply trailed along the ground to the firing-key within the bomb-proof. In case the gun to be tested has no electrical firing attachment, the lock-lanyard is rove through leading-blocks to the same shelter.

INDIAN HEAD PROVING GROUND—THE BUTTS, SHOWING METHOD OF SUPPORTING PLATE AND BACKING

The principal work of the Proving Ground consists in proving guns and testing armor, shell, powder, cartridge-cases, fuses and gun-carriages. The proof of guns consists in firing a certain number of charges at pressures varying from the lowest the gun is likely to be subjected to, to those considerably above its working requirements when mounted on board ship. At each fire the velocity is carefully measured by means of three Boulengé chronographs. The use of three chronographs enables the recorder to throw out any widely varying result, or to discard all three in case all three differ to a great extent. The chronograph room is situated several hundred yards up the hill in the rear of the velocity-battery and is sheltered from shock by a protecting knoll. In firing for velocity, the shot breaks two electric circuits by cutting wires arranged on the screens in front of the gun. These screens are about 100 feet apart, and at 3,000 foot-seconds velocity it takes the shell just one-thirtieth of a second to traverse the distance. The measurements recorded by means of this simple and ingenious instrument are probably exact to 0·002 of a second.

The pressure is measured by three crusher-gages. The gage consists of a small cylinder, closed at one end by means of a screw plug, and at the other by a piston, which is pressed against a disk of copper about one-half inch diameter. The shortening of this disk furnishes a measure of the pressure to which it has been subjected during the explosion.

Armor plates for test arrive at the proving ground secured to oak backing in the same way as they are fastened to the ship's side. The backed plate is then secured against four upright oak balks, whose lower ends are well buried in the ground. These are bound together with cross-timbers and the thrust of the whole structure is taken by four diagonal braces, the lower ends of which are driven into the sand butts.

With heavy, strong plates, the injury to the target structure is always slight. When the plate is light and breaks up, the upright timbers are generally splintered into matchwood; the entire beam seems to be disintegrated. The blow dealt is terrific, and if the plate stands up well, a large part of its energy is expended in crushing and heating the projectile; if, on the contrary, the plate is weak, the energy is dissipated in destroying the target.

The striking force of a projectile from one of the "Kearsarge's" heaviest guns is about 45,000 foot-tons with the high velocities now obtained. It requires something besides mere figures to make this intelligible to the human mind. Perhaps the statement that it is equal to the blow delivered by dropping 300 tons from the roadway of the Brooklyn Bridge to the level of the river below would present it in a more graphic way.

The test of the carriage that holds the gun consists in subjecting it to a series of rounds with the gun elevated finally to its maximum, usually about 15°. The recoil is measured each time, and the working parts of the mount are examined for stress.

The stress to which the carriage is subjected during this ordeal is also serious. Taking the "Iowa's" 12-inch mounts as an example, each time the gun is fired a pull of 200 tons is put on the piston-rod that checks the recoil.

The Proving Ground is the crucible in which are assayed all inventions that relate to guns and armor. It has been the policy of the Navy Department to give a fair hearing to all schemes that possessed on their face the slightest merit. Many of those presented are ridiculous, and are at once declined. Some of them hold but slight promise of success; but even these are permitted to demonstrate their usefulness or the reverse. Those that show evident indications of value are given all possible aid to bring them into use. It is extremely difficult to convince an inventor of the fallacy of his invention. Arguments to this end are usually met by a threat on his part to sell the patent to some European government. If the device is tested at all, the inventor is usually allowed to witness the success or failure of his idea. As a rule, in case of failure, the results must be overwhelmingly against him to convince him of his defeat.

Unfortunately, the great amount of testing work that has been going on, incident to the building up of our navy, has prevented much purely experimental research being done. There is a wide field for investigation in the new smokeless powder; in the effect of lengthening or shortening the gun; in the question of the variation in pressures along the bore, etc. In some of these investigations the Proving Ground staff has received valuable assistance from the electrically-controlled camera.

Many of the questions lie purely within the domain of engineering, such for instance as the effect on the roller-path when a turret weighing 500 tons is struck by an 1,100-pound projectile having a velocity of 2,000 foot-seconds? This costly but conclusive experiment, which is illustrated in the Special Army and Coast Defence Edition of the SCIENTIFIC AMERICAN, of July 9, 1898, was actually made at the Proving Ground under the direction of Admiral Sampson when he was Chief of the Bureau of Ordnance.

A modern gun, simple as it looks, is a work of engineering more complex than some of the latest triumphs in bridge-building. The modern armor-plate has slowly developed to its present structure through more than twenty years of costly effort. The evolution of the armor-piercing projectile from the "solid shot" of the Civil War has been marked by a similar progress of scientific investigation, of which the work of the Proving Ground staff has formed an indispensable element.

An $800,000 Award for Patent Infringement.

The judgment recently obtained by Messrs. Benner & Benner against the city of New York in the case of Christopher C. Campbell vs. the City of New York marks the last step in a patent infringement suit which has occupied the courts for nearly thirty years.

On May 24, 1864, James Knibbs received letters patent for a device which has since become known as the "Knibbs relief-valve." It was the purpose of Knibbs' invention to enable a fire-engine pump to operate at full speed, regardless of the number of hose-pipes employed to lead off the water, a purpose which had been previously attained either by shutting off some of the hose-pipes or by opening a waste-valve to permit the escape of the surplus water. Knibbs overcame the difficulties presented by the old system simply by connecting the suction and discharge with a short length of pipe in which a throttle-valve was fitted. By means of this short connecting piece, the surplus water was thrown back into the suction-pipe; and by means of the throttle-valve the pressure in the hose-pipe could be completely controlled. If the valve were entirely closed, all the hose-pipes would discharge water. If a hose were suddenly shut off, the valve was partially opened to permit the passage of the surplus water to the suction-pipe.

The patent which Knibbs obtained covered not merely the use of this "relief-valve," but also the principle of "returning any excessive water in the force part or section of a steam, fire, or other engine pump to the suction part or section thereof." Broad as it is, the claim was sustained by the courts in the suit for infringement. The mechanical features of the patent are fully described in the SCIENTIFIC AMERICAN of June 5, 1897.

Knibbs assigned his right in the invention to Christopher C. Campbell; and by Campbell the suits against the city were instituted.

The value of the invention was unquestionable. One year after the granting of the patent, the New York Fire Department fitted its engines with the relief-valve. Payment for the privilege of using the valve was exacted by Campbell; but the city held that the sum demanded was excessive. A suit begun in the State Court was carried to the United States Circuit Court after a few years of litigation; but it was not until many more years had passed that the validity of the patent and the justice of Campbell's claims were at last recognized.

When the case came up for a final hearing in the Circuit Court, Justice Wheeler was called upon to decide exactly what sum in his opinion the plaintiff was justly entitled to receive. After passing in review various cases in which the competency of witness to pass upon the efficiency of a device and upon the saving in cost and labor resulting from greater efficiency, Judge Wheeler discussed the several exceptions which had been taken to the Master's report. He decided that men who, although not necessarily experts, were nevertheless by long experience thoroughly familiar with the patented device and with the economy which resulted from its use, were fully competent to give evidence which would enable a judge or a jury to decide to what extent the injured person had suffered. The court, accepting the testimony given by such witnesses, found the saving in hose to be $183,394.32 and the saving in men employed to be $606,344. Adding these sums to the $28,336 which the Master reported were profits from savings in making repairs, the court decided that the plaintiff was entitled to receive $818,074.72.

This is the second important judgment obtained within a short time against the city of New York for infringement of patented fire-engine inventions. For, on May 19, 1899, the special Master, in a suit brought against the city by the heirs of William A. Brickill, decided that damages to the amount of $894,633 should be paid to them. Brickill was the inventor of the feed-water heater used on New York's fire-engines. The legal controversy which the case aroused lasted for twenty-nine years. The Brickill case was described in the SCIENTIFIC AMERICAN for June 10, 1899.