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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE BLINDNESS OF THE SUBMARINE.

The loss of the British submarine, that was recently struck by a merchant steamer, and sent to the bottom with its hapless crew of eleven officers and men, proves once more, in a very dramatic way, that the most serious fault of the submarine in its present stage of development is that it is blind. In saying this we refer to submarines as a whole, and do not wish to be understood as saying that in the great activity which is now being shown in the development of this most interesting craft, there may not be some one type that is able to maneuver under water with its eyes open most of the time; indeed, there is reason to believe that in this country the "Lake" submarine, which was recently indorsed so strongly by a United States army board, is provided with an improved form of "periscope" that is greatly superior to anything of the kind that has been used up to the present at least in these waters.

The British submarine disaster happened to one of the new and larger vessels of the Holland type, which have recently been constructed by the Admiralty. It was lying submerged off the Nab lightship, awaiting the approach of a battleship, when it was run down by a South African liner. Inasmuch as the accident happened at a time when a special lookout was being kept, it is natural to conclude that the failure of the submarine to detect the approach of the liner was due to the limited range of her periscope. We are not aware what means of vision is being used by the British submarines; but if it is the same as that with which we are familiar in this country, the field included by the glass is limited to a narrow angle of vision ahead. It can readily be understood that if the instrument was of this type, and was being directed steadily toward the approaching battleship, the merchant steamer might have run down the submarine from astern, the crew of the submerged boat having no warning of the impending disaster until they were struck and rolled over by the big ship.

An improved type of periscope, recently described in the Scientific American Supplement, contains five separate lenses, four of which look to the four quarters of the compass, and convey a reduced image, sufficient for observation all around the horizon, to the navigator in the submarine, while the fifth lens looks ahead and presents the image in its true size, without distortion. So far, so good—provided the weather be clear and the water calm; but the troubles of blindness begin to overtake all submarines when the winds freshen and the sea rises. Then, with the pitching of the boat, which, even when submerged, must be more or less affected by the waves, the periscope tube begins to rock with a reversed pendulum motion, and the field of vision caught by the lenses varies from sky to water and from water to sky, while the salt spray blown against the glass begins further to destroy the sight of the little submerged fighting ship. It will be a brave step in the right direction when someone discovers a means of automatically maintaining the line of sight of the periscope lens in the level position.

The recent disaster will necessarily, for a time at least, shake the public faith in the submarine; but that it will seriously hinder its development, we do not believe. It was only a few days before this accident, during another series of submarine maneuvers in which a fleet of British battleships was attacked, that a decision was given in favor of the submarine; some of the battleships being ruled as torpedoed and put out of action. Moreover, the crowded condition of the field of operations when the boat was lost, the maneuvers being carried out in one of the most busy maritime thoroughfares, would never occur in war time, except on the rare occasion of a general *melée* at the close of a hard-fought naval engagement.

HIGH-EXPLOSIVE PROJECTILES.

The frequent reports from the Far East to the effect that many of the shells thrown into Port Arthur fail to burst, naturally renders the question of our own projectiles one of great interest.

At the time when maximite was undergoing tests by the Ordnance Board of the United States Army, just prior to the purchase of the secret of its manufacture and its adoption by the government as a bursting charge for projectiles, as full particulars as were permitted to be published concerning this explosive appeared in the Scientific American. Since that time its extensive employment has afforded ample opportunities for further studying and verifying its valuable qualities.

The explosive is melted in steam-jacketed kettles, and shells are filled with it by the simple process of pouring. On cooling, it forms a very hard and dense mass, firmly adhering to the walls of the projectile, which renders it incapable of shifting when the projectile is discharged from the gun, or by the impact when the projectile strikes armor-plate.

It is about fifty per cent stronger than is ordinary dynamite, and its density is about 1.66, being a little more than once and a half as heavy as water. It is practically incapable of being exploded by any form of shock, and upon ignition it will simply burn like pitch. Experiments have demonstrated that projectiles filled with it can be fired through armor-plate as thick as the projectile itself will stand to pass through, without danger of exploding the maximite from shock, thus allowing the fuze to detonate the high explosive within the vessel itself.

A fuze for high explosives requires a detonator or exploder, usually consisting of fulminate of mercury, or some other fulminating compound. Ordinary dynamite requires only several grains to effect its complete detonation, but the new explosive is so insensitive that from 300 to 350 grains of the most powerful fulminate are required. When thus detonated, the projectile is broken into a very large number of fragments. A twelve-inch projectile weighing half a ton was broken into probably ten thousand fragments in one of the experiments at Sandy Hook. Seven thousand of these fragments were actually recovered and counted.

It has been a difficult task to provide a fuze which will carry a sufficiently large detonator and still be safely discharged from the gun, without danger of going off prematurely and setting off the high explosive, wrecking the gun and killing the gunners.

Lyddite, the high explosive used by the British government during the Boer war, was simply picric acid melted and cast into the projectiles. While cast picric acid is sufficiently insensitive to enable shells filled with it to be fired from guns with safety, it can only be fired through moderately thin plate without exploding from the shock. Nevertheless, in the Boer war a very large percentage of the Lyddite shells did not explode at all, while many more only partially exploded, as evidenced by the green character of the smoke, and the fact that the captured Boers were frequently found to be stained a brilliant canary color. This was owing to the fact that the British government had no fuze by which picric acid could be exploded with any degree of certainty. Many of the shells thrown by the Japanese in the recent bombardment of Port Arthur failed to explode from the same cause.

The difficulty in exploding fused picric acid has led many of the Continental powers to use picric acid in granular form compressed into the projectile, although its density is much less. Still, much less fulminate is required to explode picric acid in powder or granular form than when it is cast solid, and an efficient fuze is not so difficult to provide. But while it is impossible to penetrate armor-plate of any considerable thickness, even with cast picric acid, picric acid in granular form will stand even less shock, and cannot be considered an efficient explosive for armor-piercing projectiles.

Furthermore, it is obvious that when a high-explosive projectile penetrates a warship and explodes inside, if the projectile contains a larger quantity of the same explosive, a higher shattering and wrecking effect will be produced upon the surrounding structure of the vessel, owing to the larger volume of gases produced. Consequently, it is even for this reason alone desirable to penetrate a war vessel with the maximum weight of explosive in the projectile, other things being equal.

The Austrian government has recently adopted a mixture of powdered aluminium and nitrate of ammonia as a bursting charge for projectiles. This explosive is termed ammonal. It is said to be exceedingly powerful, and to have produced most satisfactory results, as far as explosive energy is concerned. It is also claimed that it is quite insensitive to shock, and can be safely fired from guns. But it is not clear that it can be fired through armor-plate with much success.

To explode ammonal, it seems to be only necessary to ignite it, as in the case of black powder. The very fact that ammonal can be exploded by mere ignition renders it dangerous as a bursting charge for projectiles, for the reason that the least flaw in the projectile or fuze would allow the chamber gases of the gun to enter the chamber of the projectile and cause an explosion, blowing up the gun and killing the gunners. The same is true with powdered picric acid, only to a slightly less extent than with ammonal. It is furthermore obvious that the detonator or igniting means of a high explosive should not be located within the high explosive while in the gun. In other words, the fuze should be so constructed that the detonator should not be within a detonative distance or firing distance of the high explosive until after the projectile has left the gun and has struck the target.

For the detonation of our own and other insensitive high explosives used in projectiles, Mr. Maxim has recently developed a fuze which experiments have shown to be capable of carrying any desired quantity of fulminate compound, in such a way that it is impossible for the high explosive to be either ignited or set off, even should the detonator be exploded prematurely.

The explosive used by our own army is indeed so insensitive, that should a shell from the guns of an enemy enter and explode in a ship's magazine filled with projectiles fully charged with it, all armed with the fuze and ready to fire, no explosion of the shells would be produced. Furthermore, should a projectile contain a flaw, and the fire from the gunpowder charge enter the shell space, no explosion would be produced in the gun, nor would there be any if the projectile should break up in the gun. A small portion of it would be burned by the powder gases, but with no disastrous results.

The fuze above mentioned is also so constructed that when an armor-piercing projectile strikes the plate, there is just delay action enough to allow the shell to pass clear through the plate, when the fuze acts to explode it immediately behind the plate. If, however, a projectile be fired through very thin plate, or even the hull of a torpedo boat, or should the projectile strike a glancing blow, it will always explode within ten feet.

The position which the United States occupies to-day with respect to foreign powers in the art of throwing high-explosive projectiles from guns and in the penetration of heavy armor-plate with the same, is about as follows: This government can penetrate with its high-explosive projectiles any plate as thick as the projectile itself will stand to go through, and it is provided with a fuze to explode the shell exactly where desired. In the bombardment of towns and fortifications, our shells would never fail to explode with the very highest results.

As near as can be learned, the best that has been attained abroad is to fire high explosives through plates about half as thick as are successfully penetrated by us, while no foreign government is provided with a fuze that can be depended upon to detonate a high explosive which can be successfully used in armor-piercing projectiles.

DISPERSION AND WAVE LENGTH OF N-RAYS.

In a paper recently read before the French Academy of Sciences, Prof. Blondlot records his experiments on the dispersion of N-rays, in connection with which the wave lengths of these rays were measured. The method used is quite similar to the one employed in connection with light rays, aluminium prisms being used, as these do not exhibit the property of storing up the rays. The radiations produced by a Nernst lamp, after traversing a window closed with an aluminium foil, would strike on their way a board of pine wood 2 centimeters in thickness, another aluminium foil, and two sheets of black paper, so that any other radiation could be expected to be eliminated. By means of a slit made in moist pasteboard, a well defined bundle of N-rays was eventually separated, striking an aluminium prism, the one face of which was perpendicular to the direction of the rays. Now the author states that from the opposite face of the prism different bundles of N-rays will issue, having undergone a horizontal dispersion; and the presence and deviation of these rays are ascertained by shifting a slit filled with phosphorescent calcium sulphide, according to the well-known Descartes method. The indices of refraction of the rays thus separated are 1.04, 1.19, 1.29, 1.36, 1.40, 1.48, 1.68, 1.85 respectively. These results were checked by measurements made with an aluminium lens.

In order next to determine the wave lengths concerned, the author caused the bundle of rays to strike another screen of moist pasteboard, containing a narrow slit so as to isolate a very narrow portion of the bundle. To the movable alidade of a goniometer, an aluminium sheet was attached so that its plane was perpendicular to the alidade. This metal sheet contained a slit only 1.15 millimeters in width, provided with phosphorescent calcium sulphide. By turning the alidade, the direction of the bundle of rays may be accurately marked. Now, when placing a grating in front of the slit of the second moist pasteboard, and exploring the issuing bundle by turning the alidade