PROGRESS MADE IN USE OF EXPLOSIVES

What Science Has Done in the Development of War.

AGENTS OF DESTRUCTION UNDERGO A MATERIAL CHANGE AND BECOME FAR MORE DEADLY—GUN COTTON AND ITS MANIFOLD USES.

From the Times-Herald.

The brief period from 1886 to 1898 will, perhaps, in coming ages, be best framed for the extremely rapid advancement made in modern explosives. This epoch-making span of time may perhaps be further expanded, for the new science is yet in an experimental stage. There may be discoveries in the near future as remarkable and momentous as those of the past decade and a half. If so, this period will be doubly remembered. Explosives are necessarily destructive, and their development implies the acquisition of new and terrible power. The application of this science marks the border line between ancient and modern times.

Explosion has been defined as the extremely rapid conversion of solid or liquid substances into gas or vapor, occupying many times the volume of the original body. This gas is further expanded by the heat generated during the transformation. Any substance that is capable of underging the above metamorphosis is termed an explosive.

GERM OF THE DISCOVERY.

The germ of the science of explosives lay in the accidental discovery of the peculiar properties of saltpeter, which is found plentifully scattered in nature upon the surface of the plains of India and of China. Knowledge of its deflagrating qualities could not well be avoided after the use of fire upon those vast Asiatic stretches of land, for by means of the charred embers of wood fires used for cooking, the two most important ingredients of gunpowder could easily have been brought into contact with each other. The accidental dropping of crude saltpeter upon coals of fire would have been followed by prolonged and accelerated combustion. Without any known facts to rely upon, historians generally agree that in some such way the beginnings of the history of explosives were inaugurated. Sulphur was doubtless an after addition, not necessary to cause explosion.

Black powder, from the time of its introduction into Europe, has always consisted of saltpeter, charcoal and sulphur in various proportions. An excess of charcoal quickens combustion, an excess of saltpeter slackens it. The propulsion force depends chiefly on the rate of combustion and the volume of gas produced, varying with the proportions of the mixture. Gunpowder gas fills about 300 times the space occupied by the solid powder.

A CENTURY AGO.

If the ingredients of black gunpowder have remained the same for many centuries it is not because numerous experiments were not made to improve its composition by adding other substances. In 1784 Barcelo made various attempts to change the composition, and he had many followers. Inventors are still working at the problem.

The construction of modern guns has made imperative some modifications in the form and effects of the explosive used. A slow-burning powder was needed, which would burn in increasing ratio and develop its maximum strength just when the shot reached the muzzle of the gun. Germany took the initiative in this direction in 1882, when a slow-burning powder was produced in that country called cocoa powder, because in color it resembled a cake of chocolate. The method of manufacture was kept secret, but other countries procured samples of the powder, analyzed it and soon learned to make a better substitute. This German cocoa powder differed from black gunpowder mainly by changing the proportions of the ingredients to 79 per cent. saltpeter, 18 per cent. charcoal and 3 per cent sulphur, and by using an underburnt charcoal, which gave it the peculiar color. For this brown powder charcoal made from rye straw was also used.

Various shapes have been adopted for the brown powder, now used by all countries for heavy ordnance, and excellent results have followed the use of hexagonal prismatic grains pierced by small holes through which the flames pass, burning from the center outward and constantly evolving more gas till combustion is completed.

FOR LARGE GUNS.

It is well known that for many years the improvement of powders for large guns has not kept pace with the manufacture of the gun itself. The secretary of the United States navy two years ago called attention to the difficulty of obtaining in sufficient quantities for actual service a high grade brown powder for large guns, nor was it assured that these powders would endure the test of long storage. It has been found that the efficiency of brown powder varies regularly with the weather, requiring 3 per cent. more in midwinter and 3 per cent. less in midsummer than in spring or autumn.

It is now quite generally believed by naval and military experts that gunpowder is rapidly passing away as an effective and standard explosive. Other modern explosives have, during the past twelve years, been substituted to such an extent that to return to gunpowder seems impossible. The substitutes have not passed the periods of probation, but changes in firearms have compelled the revolution in explosives. The invention of rapid-firing guns made necessary the use of a smokeless powder. The rifle of smaller caliber demanded an explosive of greater force.

While these experiments were progressing in England, France and Germany, Alfred Nobel formed the idea of reducing the rate of combustion in his blasting gelatin by increasing the percentage of gun cotton, in order that it might be used as a substitute for gunpowder. This led to the patenting of a smokeless powder in 1888 called ballistite, which he introduced in the Italian army and which was also adopted by Germany. As now manufactured ballistite consists of fifty parts soluble nitro cellulose and fifty parts nitroglycerin. Its use has been discontinued by Germany, but it is still in favor in Italy. It has been coated with graphite to prevent the exudations of the nitroglycerin.

Two modern explosives are at the base of all these substances for gunpowder—gun cotton and nitroglycerine. The so-called nitro compounds were first discovered in 1832, when Bracount of Nancy found that starch, wood fibers and similar substances would easily yield a combustible substance, which he called xylodine, when heated with concentrated nitric acid. But no practical results followed these and other discoveries, because neither uniform effect nor stability were secured.

DISCOVERY OF GUN COTTON.

In 1845 Schobein of Bale discovered that cotton could be converted into a highly explosive body without altering its structure, by treating it with nitric acid. The same discovery was made independently the year following by Bottger of Frankfort-on-the-Main. Both inventors tried to sell the secret to the German union, but the union would make the purchase only on condition that the new explosive possessed an advantage over gunpowder. Other nations heard of it, and throughout Europe many experiments were made with a view of substituting gun cotton for gunpowder.

Nitroglycerine was discovered in 1846 by Sobrero, professor of chemistry at Turin, but the discovery remained undeveloped for many years. In 1863 Alfred Nobel, the noted Swedish chemist, invented dynamite by mixing liquid nitroglycerine with a highly porous infusional earth. He also, in 1878, invented gelatin and other explosives for blasting purposes. Dynamite is used for civil and gun cotton for military operations. Numerous other explosives have appeared in recent years, but most of them have disappeared after a brief and unsuccessful trial. Picric acid has been known for many years. In 1867 potassium picrate was used in America and in England as a charge for bombs. In 1887 the French government introduced picric acid as melinite.

Austria was the first country to engage elaborately in the attempted substitution of gun cotton for gunpowder. A factory was erected at Hirtenberg in 1853 and the explosive was introduced in some special artillery. But it was found that the guns were attacked by the gases and that the high pressures injured the barrels. It was then decided to use the new explosive only in filling shells and in torpedoes. There were two terrific explosions in the Hirtenberg magazines in 1862 and 1865, and after the second disaster the manufacture of gun cotton ceased in Austria until 1875.

REVOLUTIONIZED WARFARE.

Between the years 1864 and 1886 the initial stages were completed which were destined to revolutionize modern warfare. In the former year E. Schultze of Potsdam began the manufacture of gunpowder from nitrated wood. In 1865 Sir Frederick Abel, chemist of the British war department, patented a process for purifying gun cotton, reducing it to a fine powder by beating machines and then pressing it. That process is now generally used. In 1886 Vielle, the celebrated chemist of the French gunpowder works, discovered a means of making smokeless gunpowder from gun cotton dissolved in sulphuric ether mixed with picric acid.

SMOKELESS POWDER.

Sir Frederick Abel and Professor James Dewar, members of the English committee on explosives, invented a smokeless powder consisting of a combination of the highest nitrated cellulose with nitroglycerin by dissolving both in acetone. It was introduced into the English service as cordite, for use with small arms and guns of all calibres. It is now composed of nitroglycerin, fifty-eight parts; gun cotton, thirty-seven parts and mineral jelly, five parts. Cordite proves stable under extreme conditions varying from the arctic cold of Canada to the tropical heat of India, and resists exposure to moisture of all kinds. Its effects on the bore of guns is a serious difficulty. It erodes the gun to such an extent as to suggest its abandonment.

The United States naval smokeless powder is a nitro cellulose powder consisting of a mixture of insoluble and soluble nitro cellulose, to which is added the nitrates of barium and potassium and a small percentage of calcium carbonate. The proportions for 6-inch rapid-fire guns are mixed nitro cellulose, eight parts; barium nitrate fifteen parts; potassium nitrate, four parts, and calcium carbonate, one part. The United States war department has been experimenting with various types of smokeless gunpowder, varying from an entire composition of gun cotton and no nitroglycerin to about 40 per cent nitroglycerin. The "WA" powder, proposed for service in the United States for the use of guns both in the army and navy, consists of insoluble gun cotton and nitroglycerin, with an organic substance as a deterrent or regulator. Like all smokeless gunpowder it exerts a deleterious effect upon the bore of guns.

TWO GENERAL CLASSES.

In general, present smokeless powders are of two general classes: First, insoluble gun cotton or soluble nitro cotton, alone or mixed with each other or with regulative substances, and, second, the above with nitro-glycerin added. Smokeless powders derived from picric acid and other substances have been discarded.

Among the essentials of smokeless powders are smokelessness, stability under varying conditions, safety in handling and freedom from gases injurious to guns or inhalation. There are none that comply with all these conditions. The combustion of smokeless powder is usually complete, the resulting gases being chiefly carbonic acid and steam.

The above uses of the new explosives are to weapons—greatly improved, it is true—which in some form have been in use for many centuries. But the revolution wrought by gun cotton and nitroglycerin in warfare has also brought into a high degree of efficiency new and terrible devices of destruction. Mines and torpedoes were only germs during the regime of black gunpowder. They are now most valuable adjuncts, especially in naval warfare, and, in the opinion of some experts, have superseded, or will soon supersede, gunnery in relative importance.

Both torpedoes and mines were first used in naval operations in the war of the rebellion, during which struggle twenty-eight vessels were blown up by mines and six by torpedoes. These devices, deadly as they were at times, were usually of the crudest description. The mines were often merely wooden barrels filled with gunpowder and fired by slow-burning fuses. No braver or more daring naval deed in relation to mines was performed than the passage of Admiral Farragut's fleet through a channel in the Mississippi river known to be alive with mines. One ship, the Tecumseh, was struck, but though desperate odds were against him, the admiral ran the gauntlet fortunately without further loss. The cases of the torpedoes scraped against the copper bottoms of the ships, and in several instances the primers snapped audibly, but no more torpedoes exploded.

During the Franco-Prussian war the French fleets did not enter Prussian harbors through fear of submarine dangers. The Japanese fleet at Yalu did not hesitate to attack their enemy on the open sea, but refrained from following the vessels up the river. The hidden dangers were held to be far greater than guns. The only way to overcome the danger of mines is to destroy them, a slow and laborious task for an enemy.

For offensive operations in attacking fleets on the open sea the torpedo is recognized as the most effective weapon. It is a marvel of mechanical ingenuity and perfection.

TYPES OF TORPEDOES.

The Whitehead torpedo, the standard with most nations at present, was evolved in 1864 from the brain of Captain Lupuis, an Austrian naval officer. It has since been greatly improved. It is in appearance cigar-shaped, from fourteen to nineteen feet in length and from fourteen to nineteen inches in diameter at its thickest point. The shell is made of steel or phosphor-bronze. Within are three compartments. In the first is a heavy charge of gun cotton. The second is the air receiver, filled with compressed air, while in the third are the propelling engines and guilding mechanism. The Howell torpedo, invented by a United States naval officer, is not unlike the Whitehead in shape, but is driven by means of a fly wheel contained in the shell.

Besides this type there are locomotive or dirigible torpedoes, which, when fired, are controlled from shore by means of a fine cable, wound up in the torpedo like a reel.

The navy departments of most nations have adopted compressed gun cotton both for submarine mines and for torpedo charges. It has been selected as the United States' service explosive. Experiments with gun cotton were begun by Professor Hill at the United States torpedo station in 1872. Eleven years ago the first gun cotton torpedo outfit was issued to the United States ship Trenton, the gun cotton being supplied in cylindrical disks three inches in diameter and two inches high.

The manufacture of gun cotton, and of nearly all nitro-compounds, consists of immersing the cotton, glycerine or other material in a mixture of nitric and sulphuric acid for a long time. The explosive body is then removed from the spent acid, washed and treated with alkalies till all trace of acidity is lost. If a trace of acid remains spontaneous decomposition and often explosion occurs. Care must be taken that the cotton is perfectly pure. In the chemical reaction water in the cellulose is replaced by nitric acid, or hydrogen by the nitro groups. Gun cotton has a much more powerful effect than black powder and burns without leaving any residue. In outward appearance it differs only slightly from the ordinary cotton, but is somewhat darker, is harsher to the touch and grates slightly in squeezing. It is also heavier than cotton. It is safer to handle than dynamite, and one pound gives in combustion about 22,165 inches of gas and produces the effect of from four to six pounds of gunpowder. Its preparation for service is a complicated process, and it is made in various shapes for various uses. In torpedoes gun cotton is detonated by fulminate of mercury, which when ignited by a blow expands to about 2,500 times its own size. This sudden expansion gives a severe blow to the gun cotton and detonates it. Fulminate of mercury is the chemical combination of mercury with alcohol and nitric acid.