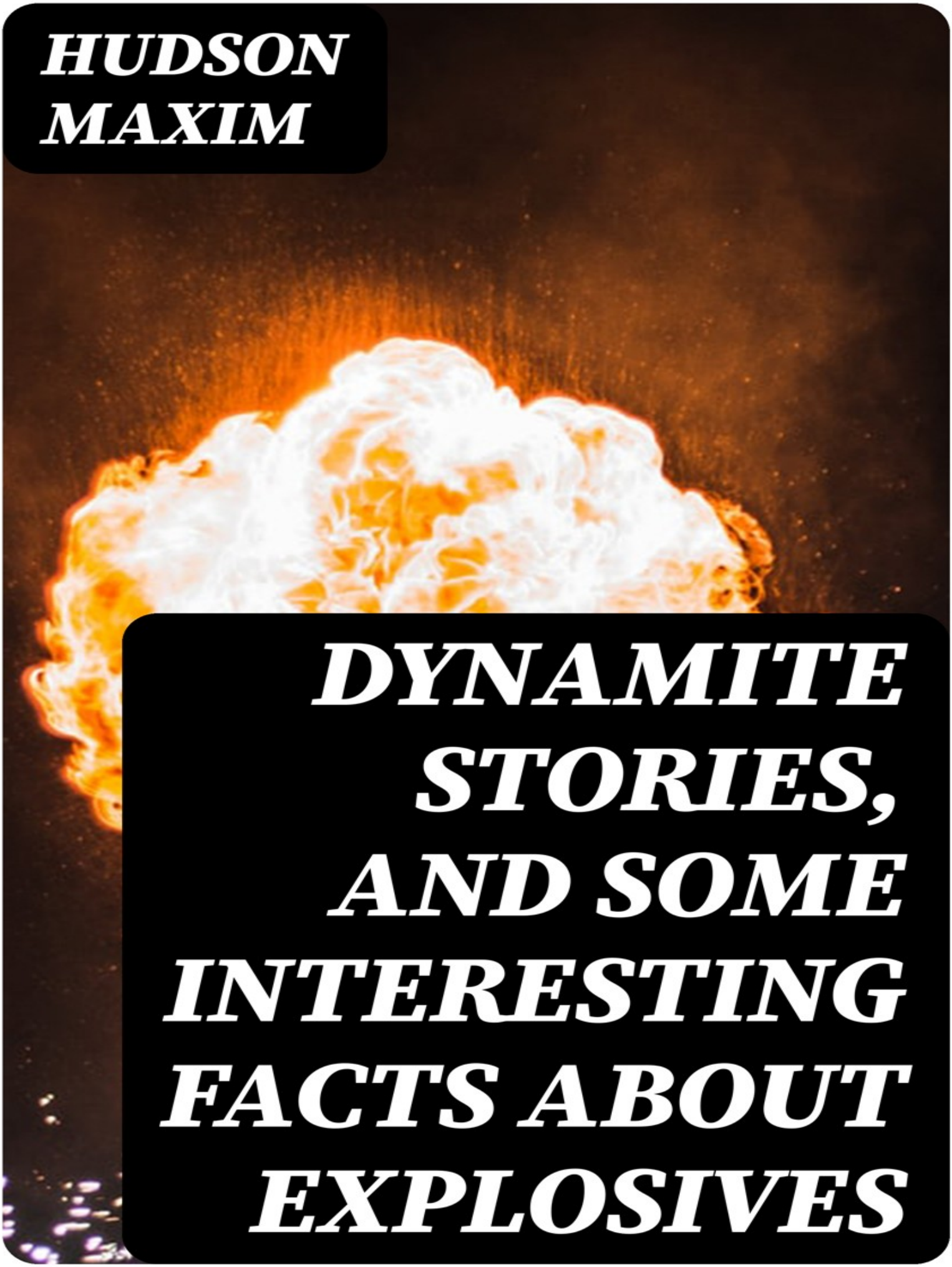
HUDSON MAXIM



DYNAMITE STORIES, AND SOME INTERESTING FACTS ABOUT EXPLOSIVES

Hudson Maxim

Dynamite Stories, and Some Interesting Facts About Explosives

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INTRODUCTION

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SOME INTERESTING FACTS ABOUT EXPLOSIVES

An explosive material consists of a combustible and of an oxidizing agent for burning the combustible. Hence it contains within its own substance the necessary oxygen for its combustion, so that it will burn without atmospheric air and therefore in a confined space.

There are two main kinds of explosive materials—high explosives and gunpowder. There are also two main kinds of high explosives—dynamites and military high explosives. Lastly there are two main kinds of gunpowders—black, smoky gunpowder and smokeless gunpowder.

Dynamite is used mostly for commercial blasting purposes, such as blasting rock in the construction of railways, and so forth. Military high explosives are mostly employed for submarine mines, warheads for torpedoes, and as bursting charges for high explosive projectiles.

A high explosive is consumed almost instantly by what is called a detonative wave; hence it is said to detonate. When gunpowder explodes, it is not consumed by a detonative wave, but burns from the surface, and the more strongly it is confined, that is to say, the higher the pressure under which it is burned, the more rapid is its combustion. Although the action is rapid, it is yet much slower than is the action of detonation of high explosives.

The name gunpowder is a misnomer, for gunpowder is no longer a powder, but is made in the form of hard and dense

grains or sticks, according to the use for which it is intended.

A gunpowder is smoky when its products of combustion are not all gaseous. Only about forty-four per cent. of the products of combustion of black gunpowder is gaseous. The rest is inert solid matter, which makes the smoke.

The products of combustion of smokeless powder, however, are practically all gaseous. Consequently, weight for weight, it is much more powerful than black powder.

Black gunpowder is a mechanical mixture of charcoal, sulphur and saltpeter, the charcoal and sulphur being the combustible elements, and the saltpeter the oxidizing element or the element that supplies the oxygen.

In smokeless powder the oxygen is held in chemical union with nitrogen and hydrogen, but the bond between the nitrogen and the other elements is weak, so that when ignited the other more active elements are enabled easily to unite at the expense of the nitrogen.

In the combustion of all explosive materials, great heat is generated, and the force of the explosion is dependent upon the volume of gases and the high temperature to which they are raised.

The smokeless powder used in the United States is made by dissolving a special kind of guncotton or nitrocellulose in ether and alcohol, just sufficient of the solvent being used to gelatinate the nitrocellulose, which is then stuffed through a forming die into rods. The rods are cut into sections of about three diameters long. The die, the invention of the writer, contains seven mandrels arranged in such wise that when the material is forced through the die the bar is multi-

perforated with seven holes at equal distances apart. The grains or rods of smokeless powder are then dried for use.

When burned in a cannon, all of the surfaces of the material are practically instantly ignited by a small flash charge of black rifle powder used for the purpose of setting fire to the charge of smokeless powder. The combustion in the perforations causes them to become larger and larger until the grain is all consumed. This form of grain tends better to maintain the pressure behind the projectile in its flight through the gun, and enables the use of larger charges of powder with lower pressures than could otherwise be employed. In fact, it would be impossible to use a smokeless powder made of pure nitrocellulose in big guns without the multi-perforations.

In certain European countries where the multi-perforated powder has not been adopted, nitroglycerin is employed, combined with the nitrocellulose, which causes the material to burn through a greater thickness in a given time. Thus a smokeless powder may be made without the multi-perforations, but smokeless powders containing nitroglycerin erode the guns and destroy them very quickly, while guns employing pure nitrocellulose smokeless powders last much longer.

When one of our big army or navy cannon is fired, the time which elapses from the instant of complete ignition of the powder charge to the instant that the projectile leaves the muzzle of the gun is about the fiftieth or the sixtieth of a second, and in that time the hard and horn-like smokeless powder material is burned through only about a sixteenth of an inch; hence the rate of combustion or rate of explosion of

smokeless powder in a cannon is about four inches per second, while it has been ascertained by actual experiments that the rate of combustion or rate of explosion of dynamite and other high explosives is about four miles per second, so that the rate of consumption of smokeless powder, as compared to that of a high explosive, is as are four inches to four miles.

As the time required for the projectile to be thrown from a twelve-inch cannon is only about the sixtieth of a second, sixty of these huge guns could be placed side by side and fired by electricity one after the other, while grandfather's clock is making but one tick.

Our ideas of duration are but relative. We have seen that the combustion in a cannon, though very rapid to our senses, is actually very slow indeed as compared with the much more rapid combustion of a high explosive; and great as is the speed of the detonative wave, yet the speed of the earth in its orbit is four times as great.

If a celestial giant with a huge dynamite bomb the size of the earth itself were to approach the earth in its flight through space, and detonate the bomb immediately behind the earth, it would take half an hour for the bomb to explode, that is to say, it would take half an hour, or thirty minutes, for the explosive wave to pass through the eight thousand miles of its diameter. As the speed of the earth in its orbit is four times as great as that of the explosive wave, the earth would rush away, leaving the bomb about thirty thousand miles behind by the time it had completely exploded. If the interstellar ether were a high explosive mixture and were to be set off by the bomb, the earth would

pass on clear around the sun, and while coming back, about six months later, would meet the explosive wave still going. It would require nearly a year for such a detonative wave to reach our sun from the earth.

We have seen that if the earth were a ball of dynamite, it would require half an hour to explode. If the sun were a mass of dynamite it would require about two and a half days to explode.

We frequently hear the theory advanced that planets and suns sometimes explode from pent-up forces within them, and that our earth might possibly blow up. Now, the force exerted by a high explosive is dependent entirely upon the pressure capable of being exerted by the gases liberated by the explosion. The pressure exerted by the most powerful high explosives has been estimated to be about 500,000 pounds to the square inch. Consequently, were the whole molten interior of the earth to be replaced with dynamite and detonated, the explosion that would follow would not lift the earth's crust. The superincumbent weight of the earth's crust is greater than would be the pressure exerted by the dynamite.

If it were possible to throw a projectile from the earth to the nearest fixed star, Alpha Centauri, it would take about four years for the light of the flash to reach that star. The sound, if it could travel through ether, would reach there about four million years later. The projectile, traveling more than twice as fast as sound, would reach there in about two million years.

When one of our big twelve-inch cannon is fired, the projectile, weighing a thousand pounds, has a muzzle

energy, stated in mechanical terms, of about 50,000 foot tons, that is to say, its energy is equal to 50,000 tons falling from a height of one foot—energy enough to lift two 25,000-ton battleships to the height of a foot.

As the projectile weighs half a ton, the energy is equal to that which would be developed by dropping the projectile from a height of more than twenty miles, making no account of the resistance of the atmosphere.

Dropping upon a piece of armorplate too hard and thick for the projectile to penetrate, the heat developed would be sufficient to melt 750 pounds of cast iron.

When one of these projectiles is fired from the gun directly against twelve-inch armorplate, which the projectile is capable of penetrating, the hard-tempered steel plate in front of the projectile is fuzed or rendered plastic from the heat generated by the energy of the impact, and is forced like wax from the path of the projectile.

There are many popular errors regarding the action of explosive materials. One of the most notable is the opinion that the action of dynamite is downward, and that if a body of high explosive be detonated on the surface of the earth the main effect is downward.

The exact opposite is the truth. When a mass of explosive is detonated, it is converted practically instantly into a ball of incandescent gases and vapors under very high pressure. When confined the gases act to disrupt their container.

When a large steel projectile is charged with a high explosive, like picric acid, and the explosive detonated, the walls of the projectile are not only broken but they are also

torn, twisted and shredded, and so quick is the action that the inner surface of the metal is compressed and densified against the outer metal.

For this reason it is easy to tell from the character of the fragments of a projectile whether or not a high explosive or an explosive of inferior power was employed, that is to say, whether or not the explosion was of high order or of low order.

There is one false belief about the action of high explosives that has been about the hardest of any to kill, and the cost of killing it has been very expensive. Furthermore, it possesses more lives than the proverbial nine-lived cat. This belief is that five hundred pounds or so of dynamite exploded upon a warship or upon coast fortifications would destroy ship or fortifications, and that a few of such large bombs of dynamite dropped in a city would lay the city in ruins.

Upon the advent of the aeroplane and the dirigible balloon, it was confidently believed that the aerial bomb would quickly become the most destructive implement of warfare. It was prophesied that should war come between England and Germany, London would soon be reduced to a heap of ruins by bombs dropped from the German Zeppelins.

Several years before the European War broke out, I predicted that Zeppelin bombs would not and could not by any possibility work very wide destruction, and events have since vindicated my prediction. I pointed out the fact that should a hundred Zeppelins visit the city of London, once a day, for a year, returning to their base without mishap, and

each Zeppelin succeed in destroying two buildings, the destruction would just about keep up with the growth of that city, for they build in London sixty thousand houses a year.

We all remember the destructive powers that were predicted for the fifteen-inch Zalinski pneumatic dynamite guns that were mounted at Sandy Hook and at San Francisco at enormous Government expense. These guns were capable of throwing with compressed air about six hundred pounds of nitrogelatin to a distance of from a mile-and-a-half to two miles. It was popularly believed that one of these bombs striking upon a huge armorclad warship would utterly destroy it.

Also two of these guns were mounted in a sort of cruiser called the *Vesuvius*. During the Spanish War the *Vesuvius* was taken down to Cuba, and in one action several of the huge bombs were thrown upon the earthworks and fortifications of the Spanish. They succeeded merely in mussing up the green, grassy effect. They did no material damage, for the reason that the action of the explosive was nearly all upward into the air.

When the pneumatic dynamite gun was promulgated, it was popularly believed that all high explosives were exceedingly sensitive, and that it was necessary to get them out of the gun very gently if they were to be thrown from ordnance.

The writer was the first to dispel this folly, through the invention of Maximite, a high explosive which will stand not only the shock of being fired from heavy guns at high velocities, but which will also, without exploding, stand the far greater shock of penetrating the heaviest armorplate—

armorplate as heavy as the projectile will stand to pass through without breaking up.

While I was working upon Maximite and trying to get the Government to adopt it, Congress appropriated the money for building an eighteen-inch gun for testing a shell invented by Louis Gathmann, which was intended to destroy battleships by exploding the shell on the outside of their heavy armorplate, it being believed that if five hundred pounds of guncotton were to be fired against the side of an armored ship and exploded, the whole side of the ship would be blown in and the vessel destroyed.

The gun employed by Gathmann was essentially the same type of gun as that previously designed by me, and explained in a lecture by me before the Royal United Service Institution of Great Britain in 1897, and illustrated in a book of mine published the same year by Eyre & Spottiswoode, British Government printers, except that the bore of my gun, which was of the same weight as that of the Gathmann gun, was greater. With my gun, however, I proposed to throw armor-piercing projectiles, or projectiles capable of penetrating an object struck and exploding inside of it. I did not believe that a quantity of high explosive that could be thrown in a shell and exploded on the outside of a heavily armored ship would destroy it, but believed it necessary that the explosive should penetrate and explode inside the ship, and within earthworks and fortifications in order to destroy them.

Maximite was adopted by the United States Army in 1901. It was during that same year that the experiments