Artillery Projectiles, Fuzes and Propellants

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The weapon of the Artillery is often thought to be the cannon or howitzer. The weapon of the artillery is the projectile. I will give an overview of middle aged to modern era projectiles, fuzes and propellants. The origins of the artillery based weapons can be dated back 61,000 years to the age of the bow and arrow, the first propelled weapon system used as hunting and killing tool (Britanica, Bow and Arrow). I will be focusing on the more recent aspects of Artillery weapons systems from 1132 in the province of Jujian in China to modern era weapon systems deployed in Canada.

The projectile of artillery weapons has evolved from the hollowed out balls to the common shell we see today. The first hollowed out balls were filled with gun powder and shrapnel. The gun powder would be ignited and the carrier ball would disperse shrapnel fragments (Hamilton, 13). These shells were ignited by a timed fuze (wick) and impact mechanisms. As we move into the 16th century we see the evolution of the projectile into a cast iron hollowed ball. Earliest dated cast iron hollow ball is 1580 as reported by Spiegel International. These iron balls were still filled with gun powder and ignited by an external fuze with no precise timing. With the a little innovation in the 18th century it was realized that windage was used to ignite the fuze inside the barrel. Windage refers to the propelling charge, when ignited would travel through the barrel causing the fuze in the projectile catch. This eliminated the need to ignite the fuze before loading it (Hogg). In the mid 19th century the common shaped artillery shell was adopted and is in use today. This was normally made of cast iron but other metals and including glass was tested (Hogg, 164). During this time there were several attempts to increase the projectiles velocity and accuracy in firing. The key thing that had to happen was to reduce windage created inside the bore. The first attempt was by the use of a sabot. This device was smaller than the bore that provided the centering of the projectile in the bore and increase initial start pressure forcing the round out. The next advance in providing accurate firing and greater start pressure was introduced with the invention of rifling the bore. This rifling was applied to artillery weapons by Armstrong, Whitworth and Lancaster. They used the rifling principles which were invented by Jaspard Zoller at the end of the 15th century (Hogg). This provided greater accuracy in the delivery of the projectile that put a spin on an elongated projectile. After trial and error, from lead coated projectiles and studded projectiles a copper band around the projectile was adopted. This copper band when put under stress would form to the rifling of the bore. This provided rotation, initial start pressure and it seated the round centered in the bore (Hogg, 165). The shape of the projectile is elongated and is describes by 7 parts: Body, shoulders, ogive, base, base plug, rotating band (driving band) and bourlette. Reference Annex A.

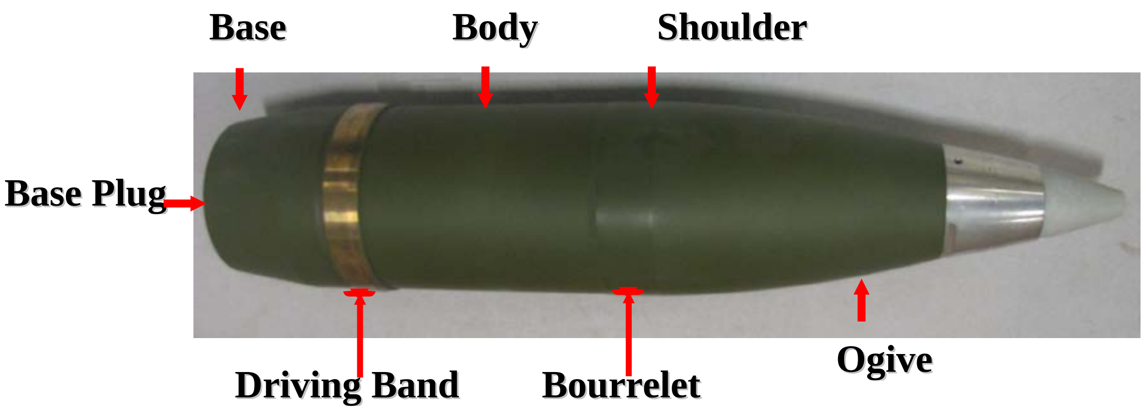
Fuzes as discussed earlier started off as igniting a combustible material that had a specific burn time. This was not the most precise method as it required time measurement and recording to have precise delivery (Hogg). As stated earlier, windage enabled the ignition of the fuze by using the propelling charge flash. The earliest account for percussion fuzes were in 1650, this used a flint to create spark which would ignite the gun powder contained inside the carrier shell (Hogg). There were some attempts to create a better fuze with examples such as mercury fulimate in 1800 which was highly explosive and dangerous to handle; to copper percussion caps used in1818. It wasn’t until 1846 when a wooden fuze was created. 6 inches long and used shear wire to hold blocks between the fuze magazine and a burning match. The match was ignited by propellant flash and the shear wire broke on impact (Hogg, 203).With the introduction to rifled breech loading guns it introduced percussion nose fitted fuzes. The fuzes were detonated upon impact of a surface. This caused a chain reaction to occur causing the fuze to detonate the contents inside of the carrier shell. Fuzes used in the modern era have many functions all of which apply the same principle of carrying a chain reaction to occur which detonates a projectile or causes one to function. Some of these functions are: Point Detonating (PD), Delay, time and proximity. These fuzes can be one of two types disruptive or igniferous. An igniferous fuze produces a flash or spit of flame that is used to expel the contents of the projectile. This fuze can be used for smoke and illumination. Disruptive fuzes produce a detonation which detonates the projectile filling (RCAS). The following picture is a disruptive fuze. This is the M577 which has two settings, delay and super quick also know as PD. As seen in annex b the fuze has the M125A1 booster. This booster provides a 60m delay arming in front of the howitzer along with providing an amplified shock wave to cause the projectile to detonate. The booster cap functions from the obturation (turning of the projectile). The centripetal force of the projectile causes booster cap to allow the primer to detonate. Another example of a disruptive fuze is the M739A1 fuze reference Annex C. A few examples of igniferous fuzes are the M582A1 and the C32A1 (annex d). The M582A1 fuze is used in a time function. This function allows the delivery of the projectiles contents at the time required. The fuze is set manually and it displays the fuze setting in an analog view. For example this fuze can expel an illumination, smoke or cause a high explosive round to detonate at a specific time. The C32A1 fuze can be used as a time, delay or proximity functions. The proximity setting will arm after a set value indicated by the command post and it will activate its sensors. Once the sensor detects an object it will cause the projectile to explode. This fuze also has the time function just as the M582A1 and the delay function of the M739A1. The advancement in fuzes has enabled artillery men to deliver the projectile and have it function where they want it more effectively. The proximity, time, PD and delay fuzes are commonly used in NATO Forces. The modern era fuzes I have mentioned above have been and are currently used by the Royal Canadian Artillery.

Propellant is the primary source of initiating the chain reaction to accelerate the projectile through the bore. The first to be created was black powder or also know as gun powder which is a low explosive consisting of intimate mixture of potassium or sodium nitrate, charcoal and sulphur (RCAS). It is useful due to its ease of ignition and the high rate of burning at low pressures. It is a shock insensitive explosive but very sensitive to flame or sparks as well as friction (RCAS). The origins of black powder are uncertain but are believed to be created from China (About.com). After the Mogols conquered China they technology soon spread throughout the Middle East and into Europe. Over centuries of improvements to gun powder large amounts were required to fire projectiles. In 1846 Nitrocellulose also known as guncotton was discovered (Brtianica, Nitrocellulose). At the same time Nitroglycerin was discovered. Individually nitrocellulose is defined as a single-based propellant. Combined with nitroglycerin this compound is classified as a double-based propellant. This double-based propellant provides more power and stability than guncotton and black powder. Triple-based propellants incorporate nitrocellulose, nitroglycerin and nitroguanodine (RDECOM, 6). The need for a more concentrated propellant is to have a slow burning, low heat, with high velocity output on a projectile. Low explosive propellants are burn at a lower rate than High Explosives (HE) which causes gases to build up which propel the projectile at a higher velocity. High explosives are used for more disruptive actions (RCAS). These can be used as boosters, bursting charges and as an initiator. Low explosive propellant burns at a rate for desired projectile velocity, ballistic regularity and safe maximum chamber pressure. In the Royal Canadian Artillery the ideal propellant: has a regular and controllable burning, be smokeless and flashless, leave no residue, free of poisonous fumes, cause minimal gun erosion, easy to ignite, be stable in storage, insensitive to shock and friction, no effected by moisture or temperature, capable of rapid and easy manufacture, safe to manufacture and provide maximum power for minimum bulk. The Royal Canadian Artillery uses a single-based propellant. I will discuss the propellant for the 105mm M67 propellant. It consists of seven charges. Charges one to two are single perforated which are quick burning. Charge three to seven is multi-perforated which is for progressive burning. Charge five incorporates a decopperizing agent to keep the bore clean. As seen in Annex E is an example of single and multi-perforated grain propellant. These grains like propellant are contained in cloth bags and labels accordingly to charge, which is determined by weight (Annex F). The propellants are connected together with twine and can be separated to meet the requirements for the range and projectile type to be fired. There are many other types of propelling charges for different calibre of weapon systems. Sometimes the initial pressure caused by the propellant will not achieve the range required. In this instance there are other means such as rocket assisted rounds which ignite during flight to cause the round to go further.

The use and combination of the evolution of artillery weaponry; projectile shape and construction, fuze functionality and propelling charge effectiveness gives the artillery gunner the ability to accurately place a projectile on time and on target. The combination of the advances allows for precise accurate delivery of various types of ammunition in the artillery arsenal. The artillery projectile can travel further with more accuracy with the ability to detonate above ground, underground or precisely when it hits a desired target. The fuze has allowed artillery projectiles capabilities such as delivering illumination rounds to mark targets for engagement, illuminate potential enemy locations. It also allows for the delivery for smoke rounds which can screen friendly movement or blind the enemy. Over the course of 900 years the evolution of artillery weapons and the delivery system has greatly improved. With the introduction to more complex weapon systems such as the M777`s Excalibur round the future holds the potential for more advanced and more efficient weapon system and delivery methods.

Annex

Annex A.

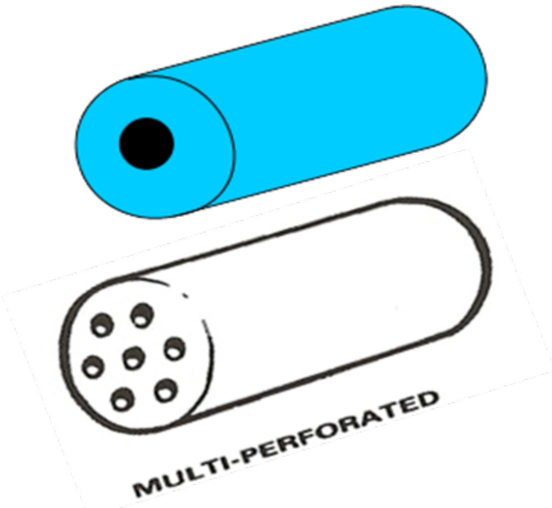


Annex B.

Annex C.

Annex D.

Annex E.



Single Perforated
Monotubulaire

Multi-Perforated
Multitubulaire

Annex F.

Sources

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