The Creation & Development of Gunpowder

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Source: Jack Kelly, *Gunpowder – Alchemy, Bombards, & Pyrotechnics: The History of the Explosive that Changed the World* (Basic Books: New York, 2004)

The history of gunpowder is a history of mistakes, errors, enlightenment, and trial and error. Gunpowder had its beginnings in China as man started experimenting with the science of chemistry. Europeans had the opportunity at the same time to have discovered gunpowder, but their study of chemistry in the sixth century was a quest for riches. Their dabbling in chemistry was directed toward alchemy, or the transformation of base metals into gold. The Chinese became involved in chemistry for another purpose: seeking an elixir of longevity to life – a chemical Fountain of Youth.

The Chinese had come to recognize that swallowing certain herbal concoctions or drinking certain liquid potions had an effect on their health, such as curing an upset stomach or removing a headache. Why couldn't the right combination of natural ingredients prolong their life? The man who could discover such an elixir would be wealthy beyond his dreams and live perhaps forever. This dream drove thousands of men and women to dabble in the art of chemistry. This process of their mixing hundreds of combinations of materials together ultimately led to many discoveries. None of them gave everlasting life, but one of them became the object of shortening thousands of lives: gunpowder.

Probably the earliest documentation of a form of gunpowder comes from a book dated 850 A.D. The book debunked 35 elixirs proposed to increase longevity, noting that one of them which combined saltpeter, sulfur, and dried honey (a source of carbon), when heated resulted in smoke and flames that burnt a house down. The basic formula for gunpowder had been discovered, but the enormity of the find and the mysterious complexity of this substance meant that it was 200 years before this explosive material was developed into the effective use of gunpowder (1044 A.D. during the Sung dynasty).

It was natural that the main ingredient for gunpowder would find its way into hundreds of attempts to find an elixir of youth. The ready availability of saltpeter as a white crust on certain soils in China led to years of experimentation with it. Cooks were after all, using it as a flavoring like other salts. But they found that at high temperatures (335 degrees +) the normally stable saltpeter flared up or exploded. Eventually, gunpowder, or "fire drug" as the Chinese called it, was found to require saltpeter to make up ¾ of its volume to be effective. Lesser amounts burnt, but did not explode.

The fiery potential of sulfur (which makes up about 10% of gunpowder) which exists in a pure state in nature, combined with charcoal (15% of gunpowder) (created from wood burnt in an oxygen deprived environment) provides the fuel needed to mix with saltpeter to create gunpowder. Who knows what kitchen or laboratory accident might have made it clear to its discoverer that these combined items might have a value.

Sulfur reacts first to the introduction of heat from a spark or flame, igniting at a relatively low temperature (261 degrees centigrade). Its burning generates additional heat that ignites the charcoal and shatters the saltpeter. The oxygen stored in the saltpeter is released, igniting more fuel. The charcoal, burning at a higher temperature than the sulfur, accelerates the process further. The resultant gases expand enormously, giving the gunpowder its blast effect. Thus, ignition translates gunpowder's stored chemical energy into the thermal energy of flame and the mechanical energy of compressed gases.

As these concoctions of chemicals came to create smoke, flames, and/or explosions it became clear that containers of some sort were needed to direct that energy and put it to work. Fireworks were the first expression of this concept. Four basic forms of containment outline the uses of gunpowder to our present time:

1. Enclosure in a sealed container with a fuse, blows the container apart like a firecracker or bomb. The tougher the container, the more violent the explosion.
2. Enclosure in a tube with an open end projects the combustible products to fly out in a fiery spray for pyrotechnic displays.
3. If the open-ended tube is not fixed in place, the force of the escaping gases drives the container in the opposite direction to form a rocket (discovered accidentally about 1264 AD).
4. Placing an item in the open-ended tube on top of the powder, almost filling the width of the opening with it, creates a projectile that bursts out at a high speed when the exploding gases escape.

Ultimately, by 1127 A.D. the Chinese were using explosive paper bombs to create noise and confusion among their enemies. It was another hundred years before an increased volume of saltpeter came in use rich enough to explode metal casings (1231 A.D.).
The earliest widespread military use of "fire drug" by 1083 was as an attachment to fire arrows and as fire producing incendiaries delivered by catapults. The success of these weapons led quickly to a ban on the export of saltpeter and sulfur by the Chinese. Gunpowder became a Chinese monopoly.

These [air quotes] "Heaven-Shaking Thunder Crash Bombs" could be heard 33 miles distant and scorch an area 40 yards square. In conjunction with flying-fire spears (a 2-foot tube of gunpowder attached to a long spear), they were in use against the invading armies of the son of Genghis-Kahn in Northern China.

Of course, a variety of bombs quickly followed. While the fire and flames created by gunpowder were of primary interest initially, the use of small metal and ceramic debris in some bombs and fire lances and the development of rockets (mid 1200 A.D.) led to the concept of the gun. Firing a projectile(s) became more important than spitting flames.

Fire lances replaced their bamboo tubes with metal tubes in order to use a more powerful powder. As these became larger, one man couldn't handle them, and they attached them

to frames or wheels, and became known as erupters, firing bundles of arrows or metal balls at a time.

The Chinese discovered that the closer a projectile filled the opening of a barrel, the more forcefully it left the barrel. Thicker barrels allowed use of stronger gunpowder charges.

The history of hand guns is a long story in itself but the earliest guns in China (while under Mongol control) appeared in the late 1200s. By the mid 1300s, cannons and hand held guns were common in warfare within China as the Mongols and Chinese fought for control. A bronze, hand cannon from 1332 is only a foot long and weighs 8 pounds. Stone and metal balls were fired by it.

China could not for long hold a monopoly over the use of gunpowder. By the mid 1200s knowledge of gunpowder was documented in Europe and other parts of Asia. 1331 A.D. was the date of first military use in Europe. King Edward III of England was the first to use it as one of his major weapon sources in a major battle in 1346 against King Phillip in France where he was greatly out numbered. It was so effective, that the race was on in Europe to adapt it somehow into modern warfare, although exactly how to make best use of it with existing weapons and military strategy was not clear.

By 1412 a 3-foot cannon using a half pound of powder could fire a 2-inch ball at high velocity or a bag of half-inch lead pellets.

The problem in making gunpowder in Europe was finding natural sources of saltpeter. By the late 1300s, they discovered ways of creating it artificially. One recipe in 1561 mixed human feces, urine, horse dung, and lime – all of it sheltered from rain and turned regularly for a year. A hundred pounds of scraping yielded only a half pound of saltpeter. A whole new industry of saltpeter plantations was born. Some theorize that the expense of this new military tactic led to the heavier taxes that so often provoked one's population into revolt.

In spite of the cost and effort required to create gunpowder, its effective use in military engagements could not be ignored. Joan of Arc is said to have used it more effectively than others of her time because she was not encumbered by the experience of traditional warfare tactics. New to warfare, but with a natural sense of tactics, she recognized the real value of its use was not as a scare tactic and as a result led the removal of the English from power in France in the early 1400s with great reliance on the use of gunpowder.

This unique victory was followed by the fall of Constantinople in the East when the Turkish sultan Mehmed II recognized the genius of a Hungarian named Urban, one of the most skilled gunpowder technicians and metallurgists of the time, who created the largest cannon of its time – 26 feet long and able to fire a half-ton stone ball (an amazing engineering feat for its time). Fifty oxen were needed to move the cannon and 700 men were assigned to its crew. The stone would travel a mile and imbed itself 6 feet into the ground.

Gunpowder by the ton was required. It took hours to load the cannon, limiting it to seven shots a day. Any error in packing gunpowder too loosely or tightly, in the mixing of the ingredients, in humidity, and other factors could create a fizzle and not a boom, or an explosion too powerful for a cannon to handle without blowing itself up and everyone around it!

In May 1453, the impossible happened. Following a 6-week siege, Constantinople fell, shocking the Christian world, as it was common knowledge that the double walled castle was impregnable, having repulsed dozens of sieges in its history. Gunpowder was changing the world!

Over the next couple hundred years, gunpowder and cannon manufacture took on dozens of changes through trial and error and engineering and scientific study. Even the most minute variation could spell success or disaster. Scottish King James II found this out the hard way when he was killed when a powder chamber exploded accidentally. The precise mixing of gunpowder was no less problematic than the casting of weapons and methods of igniting the gunpowder properly in cannons and guns. The wrong mixture of metals or the wrong temperature used in cooling the metals in a cannon's manufacture could mean success or failure.

The development of the handgun and the advancement of various bombs and shells are in themselves another story covering many years with as many complications as the development of gunpowder, but the basic cannon (developed by 1500 A.D.) was still in use during the American Civil War, almost 300 years later.

In summary, "fire drug" or gunpowder, comprised of a few simple chemicals, confounded the world's military establishment for centuries, continually upending the status quo with each new discovery and improvement, and creating with each new development the next super power, changing world history forever, not with a bang but with a boom!