

# **History of Rocketry and Astronautics**

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## Chapter 5

# Rocket Weapons in Ancient China<sup>\*</sup>

Lai-Chen Chien,<sup>†</sup> Yu-Ling Lee,<sup>‡</sup> Mei-Chen Lo<sup>‡</sup> and Yi-Lin Zhu<sup>\*\*</sup>

### Introduction

Rockets have enabled humans to achieve their dreams of flying into the sky and traveling to the Moon. The history of rockets begins with the period following the invention of gunpowder. The Chinese are credited with the first use of rockets as early as 1232.<sup>1</sup> It was an arrow with a tube of gunpowder, expelling a jet of hot gases. See Figure 1.

Gunpowder is one of the most important inventions in human history and is applied in art, production, and war. Historians admit that gunpowder was invented by the Chinese before the 10th century. The production was spread westward by Mongols and Arabs. The French crusaders brought it to Europe. There have been several records describing the manufacture of gunpowder and related weapons in ancient Egypt, England, Germany, and France. The English scientist Roger Bacon described the recipe for gunpowder in 1248. In the second half of the 13th century, there was evidence that rockets were used in Europe.<sup>1</sup> Crusad-

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<sup>†</sup> Institute of Physics, Academia Sinica, Taipei 115, Taiwan, China.

<sup>‡</sup> Institute of Natural Science Education, National Taichung Teachers College, Taichung 403, Taiwan, China.

<sup>\*\*</sup> Science and Technology Commission, Chinese Academy of Space Technology, Beijing 100082, China.

ers brought the rockets from the Middle East. French troops, under Joan of Arc, defended Orleans with rockets in 1429.<sup>2</sup> During the 14th century, the German priest Berthold Schwarz made gunpowder.

According to the records of Chinese history, gunpowder appears during the 4th century BCE with metallurgists. Ancient medical art throughout the world claimed that humans could live forever by taking some “fairy medicine.” In ancient China, Taoism was the wondrous art of the immortal. Under the encouragement of the sovereignty, alchemists tried to produce special food, or medicine for eternal life. This is one of the reasons that alchemy made great progress throughout the world in ancient history. Gunpowder was invented accidentally by alchemists during their production of fairy medicine.

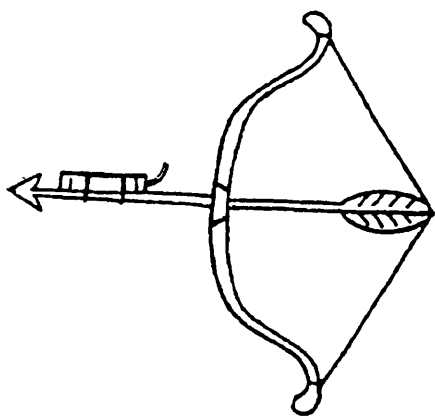


Figure 1: Origin Arrow.

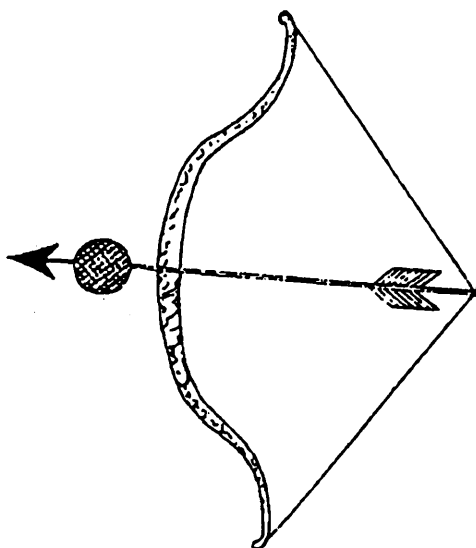


Figure 2: Firing Arrow.

Generally, the gunpowder consisted of 50 percent niter ( $KNO_3$ ), 25 percent sulfur, and 25 percent carbon. The earliest gunpowder was made of arsenic sulfide, sulfur, niter, resin, and grease. Later, the products were improved for easier ignition. During the Hsung Dynasty (960–1279) the recipe for gunpowder was sulfur, niter, pine oil, and Tung oil. In the Ming Dynasty (1386–1644) variations appeared in battle, such as poison, flammable, and soaring gunpowder.<sup>4</sup> The constituents were crushed into powder and put into a tight container. Thus, the newly developed products were manufactured. When it was ignited, the gunpowder burned rapidly, exploded, and the expelling jet shot the projectile forward by reaction force.

In ancient China, the terminology “rocket” meant an arrow attached to flammable articles. It attacked the enemy by fire and was really a “firing arrow.” The earliest record describing the application of gunpowder, a firing arrow, in a war was during 220–265. An outstanding strategist dispatched troops using firing arrows to attack enemy soldiers. They burned the foe’s ladder during the siege of a castle and won the campaign. At that battle, the firing arrows were propelled by reaction forces produced by burning gunpowder. Flammable articles were tied to the arrow body. See Figure 2. Shooting the arrows with bows, the soldiers ignited the gunpowder to kill enemy troops and set fire to destroy the hostile camp.

The ancient Chinese applied gunpowder to firecrackers and fireworks during festivities to symbolize the joy of the festival celebration. Later, it was also utilized in military purposes for beacon fire and weapons. It played an important role in the war for information transportation.

History recorded that the gunpowder products were developed by the government to produce more delicate, powerful weapons, such as guns, cannons, and advanced military equipment.<sup>3</sup> During the post period of the Hsung Dynasty (1227–1279), cannons and nozzle propulsion rockets had been devised. Rockets are propulsion devices that provide forward motion to a vehicle by expelling a jet of gas. The rocket made possible uncrewed weapons to attack hostile foes at a distance beyond the combatant. Later, the equipment was adopted by Mongols. This is the power by which Mongols could conquer Asia and Europe easily. After hundreds of years of improvement, rockets were more powerful weapons during the Ming Dynasty (1368–1644). Besides the traditional rockets, multi-tube and multi-stage ones were the most significant rockets developed in history.

In this investigation, a review will be done of the original models of ancient rockets and the later developed soaring rockets—multi-tube and multi-stage rockets for military purposes during the Hsung Dynasty and the Ming Dynasty. The performance and configuration of these weapons will be presented in detail.

## Original Rockets

Making use of the reaction force of gunpowder, technicians developed various simple rockets. The warhead was not only the type of arrow. The configurations of knife, spear, sword, and swallow tail were designed. The original model rockets were single stage ones, while a multi-tube rocket can send several, even hundreds of rockets, simultaneously.

## Whipstalk Arrow

The Whipstalk Arrow is recognized as the first thermal gas propelled weapon powered by reaction force and appeared during 998–1078. A technician thought of the configuration and wrote the manufacturing process for the rockets. The weapon was made of pieces of bamboo and had a length of six feet, with an iron arrowhead and five ounces of gunpowder in a ball attached under the body. See Figure 3. When the weapon was shot with bows, the gunpowder ignited. The arrows were ejected by the power of the bow and the exhausting gas. This was the first one fired by propellant.

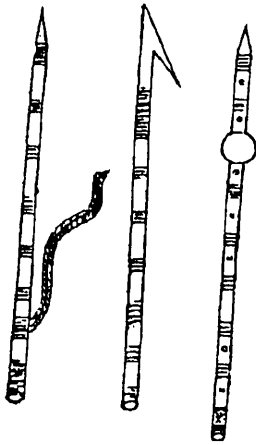


Figure 3: Whipstalk Arrow.

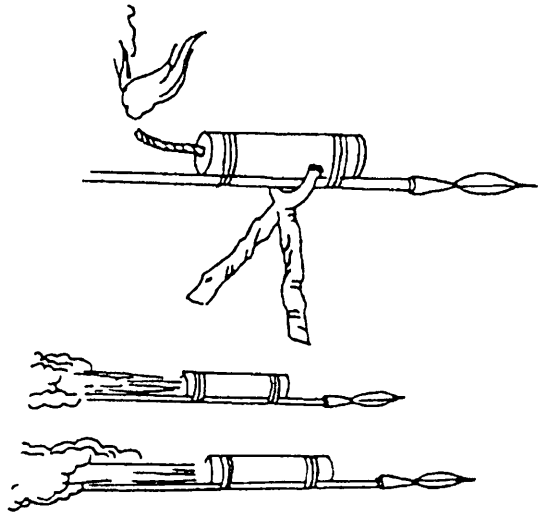


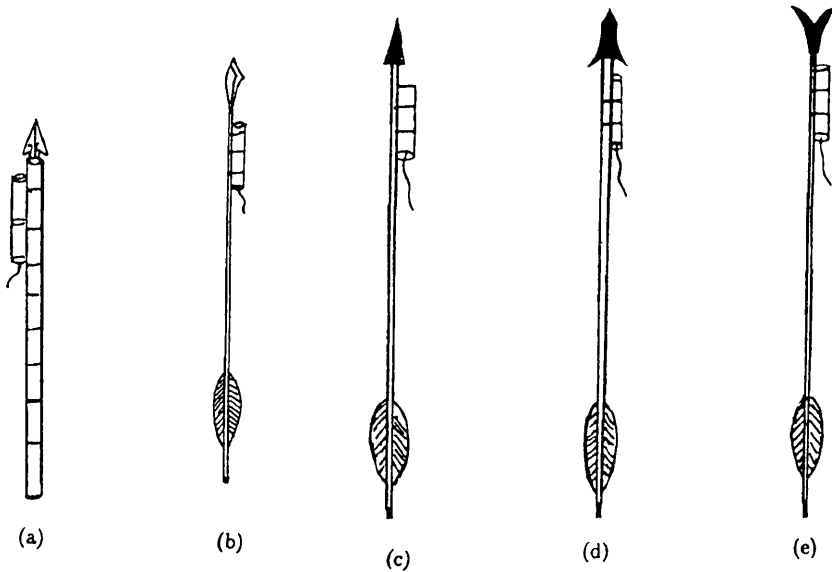
Figure 4: Flying Fire Spear.

## Flying Fire Spear

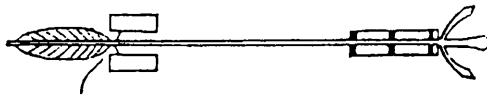
About 1119–1125, the flying fire spear appeared. See Figure 4. It was a single stage spear with one tube rocket, launched from a launching site. The gunpowder of higher quality niter was packed into a paper container. At the bottom of the barrel, there was an igniter. The gunpowder barrel was on the center of the shaft for weight balance. The high temperature and high speed jet rushed backward, and the arrow thrust forward. The firing spear was hurled by the reaction of the jet. It was the prototype of the rocket. See Figure 4. It shows the flying fire spear and its launching shaft.

## Family of Single Rockets

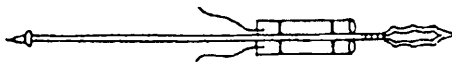
A series of single rockets appeared on ancient Chinese battlefields. In order to injure the foe more seriously, the warhead was improved. Instead of a traditional arrowhead, various shapes of heads were designed. They were a shooting star rocket, knife rocket, spear rocket, sword rocket, and swallow tail rocket. See Figure 5. To increase the range, more than one propulsion source was fixed on the body. Typical ones were the small bee rocket and two tiger rocket. See Figure 6. Two small rockets were equipped on the arrow rod to shoot the armament further.



**Figure 5:** (a) Shooting Star Rocket, (b) Knife Rocket, (c) Spear Rocket, (d) Swallow Rocket and (e) Swallow Tail Rocket.



(a) Small Bee Rocket.



(b) Two Tiger Rocket.

**Figure 6:** (a) Small Bee Rocket and (b) Two Tiger Rocket.

## Multi-Tube Rocket

In order to increase the power to hurt more soldiers, multi-tube rockets were designed. It carried more rockets in a circular or rectangular container. All the igniters of the rockets were combined tightly to fire contemporaneously. When touched off, the big igniter burned, then all the rockets shot synchronously.

## Magic Rocket

Three simple rockets were installed into a launching tube with their fuses combined to fire concurrently. See Figure 7. The body of the rocket was a wooden rod of five feet length and six inches in diameter. The metal arms were five inches in length and one inch in width and had the shape of a sword or knife. The characteristics of the deadly weapon were the poison warhead and gunpowder barrel. The warheads were soaked in poison water. It could kill soldiers and horses. Another feature of the rocket was its flammable gunpowder and the special paper that made the powder container easy to burn. The weapon was powerful for maiming and inflicting burns.



Figure 7: Magic Arrow.

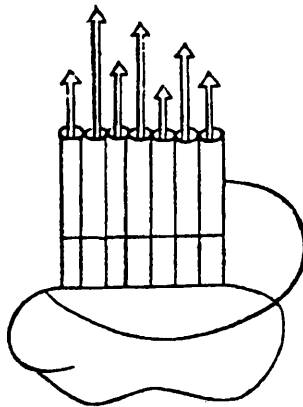


Figure 8: Seven Arrows Pipe and Rocket.



## Seven Arrows Pipe

Seven pieces of bamboo with a length of three feet, removing the knots, were bound together as the body of this instrument. See Figure 8. Every pipe was filled with an arrow. The arrow carried a package of six inches of gunpowder to



propel the arrow and a poison iron head was attached to hurt the enemy. See Figure 8. All the igniters were combined to burn simultaneously. It could be put into a leather bag, so that the soldier could easily take it. Later, it was improved to install nine arrows and was called the Nine Dragon Spear.

### Hundred Arrows Chest

The body of the weapon chest was fabricated of bamboo. Its length was 5 feet and the diameter was 6.7 inches. The paper tube was filled with gunpowder as the propellant. A dagger of five inches long and one inch wide was attached to the head of the arrow. The weight was about two pounds for each arrow. One hundred arrows were installed in the chest and ignited synchronously. Figure 9 indicates the soldiers operating the armaments and the rockets for shooting simultaneously. The range is more than one hundred yards.



Figure 9: Hundred Arrows Chest and Fire Arrow.

### Tiger Shield

This was the armament for defense and attack. The shield was designed to be so light and strong that arrows and knives could not hurt the soldier. Inside the

instrument, 10 arrows fit. Figure 10 shows the configuration. In the attack, rockets fired abruptly in a battle array so that the enemy soldiers had no opportunity to distinguish the fire, so the enemy formation was shattered.

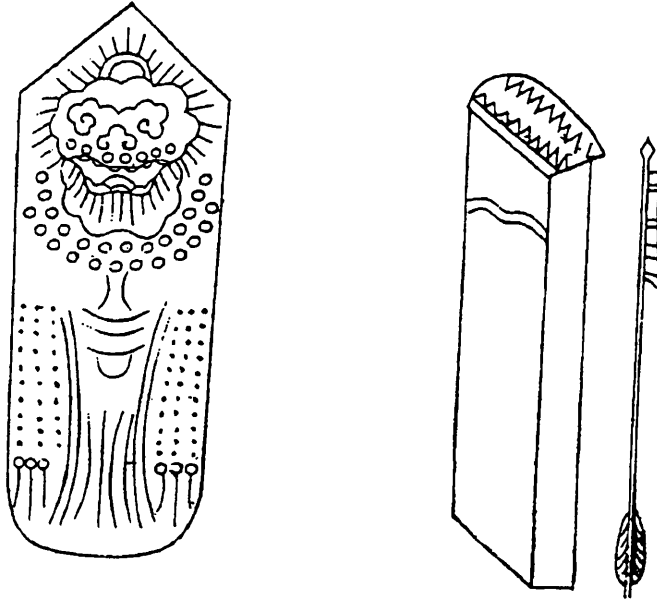


Figure 10: Tiger Shield.

### **Flock Leopard Rocket**

This rocket was a wooden case carved with a fierce leopard on it, and filled with 40 arrows. The arrow body was 2.3 feet with iron head and tails to balance it during flight. The gunpowder casket bound at the forebody was of five inches long. Forty arrows were installed in the launching tube. The range was 400 feet. The outlook of the weapon, the upper board, and the lower one, including an arrow, are shown in Figure 11.

### **Rocket Array Box**

This rocket was a wooden box that concealed 36 Magic Dragon Rockets. The powder tubes were made of paper and filled with explosive powder. The rocket's body consisted of arrow shafts made of thin bamboo with a venomous metal arrow head forward and a feather covered tail wing. See Figure 12. The fuses of the 36 arrows were bound together so that they could shoot simultaneously. Usually there were 100 soldiers equipped with the weapons for battle. On

attacking, the soldiers fired 3,600 rockets at a time, so that the powder could destroy a greater number of enemies. The Rocket Array Box could also be sealed and made waterproof. The soldier could carry it during an expedition, especially in a battle over water, to destroy both enemy troops and ships.<sup>5</sup>

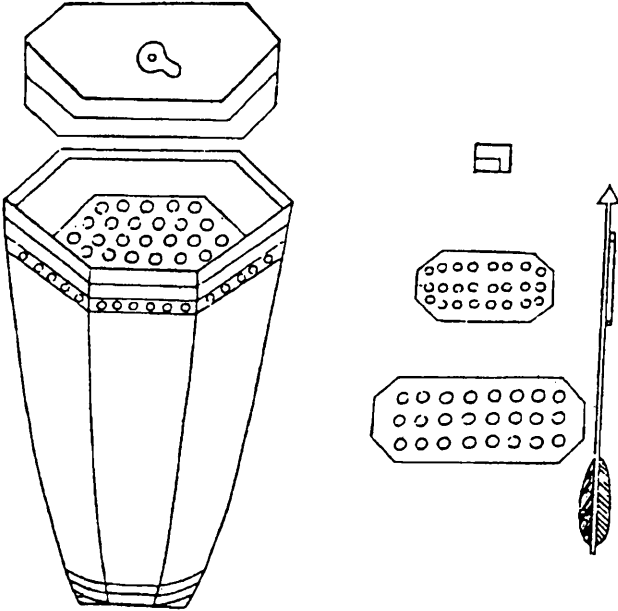


Figure 11: Flock Leopard Rocket.

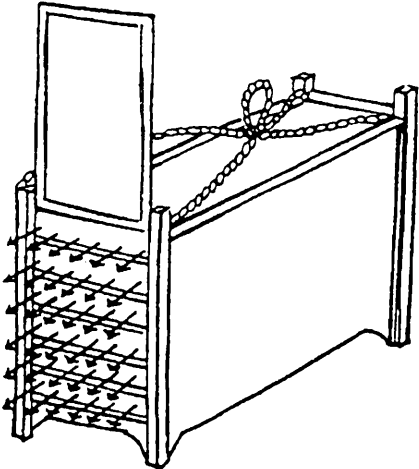


Figure 12: Rocket Array Box.

## Rocket Chariot

In addition to the commander and a driver, there were two soldiers assigned to operate the weapon system known as a rocket chariot. The driver steered the vehicle. The officer governed the chariot and took aim at the target. The vehicle was equipped with six launching tubes (to shoot 180 rockets), two cannons, and two spears. It was a powerful armament to attack the enemy. There was a curtain laid down to protect the weapon from the damage of bad weather and from enemy arrows. See Figure 13. In deploying the combat force, the battle arrays were square formations with six rocket chariots by each side. By this array of 36 chariots, 6,480 rockets were able to be launched simultaneously.

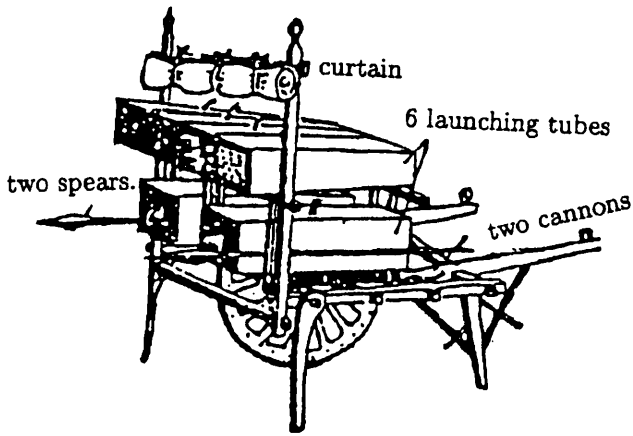


Figure 13: Rocket Chariot.

## Fire Dragon Ship

The ship was designed to launch arrows and rockets. See Figure 14. The exterior of the ship was wrapped with special oxen skin to prevent damage from enemy weapons and to shield it from fire. In the configuration, there were rocket windows and arrow windows. Each ship was assigned four sailors to row the vehicle. The ship rode the wave swiftly and rushed into the enemy fleet. All the weapons fired simultaneously. It was recorded that one fire dragon ship could destroy more than ten warships.

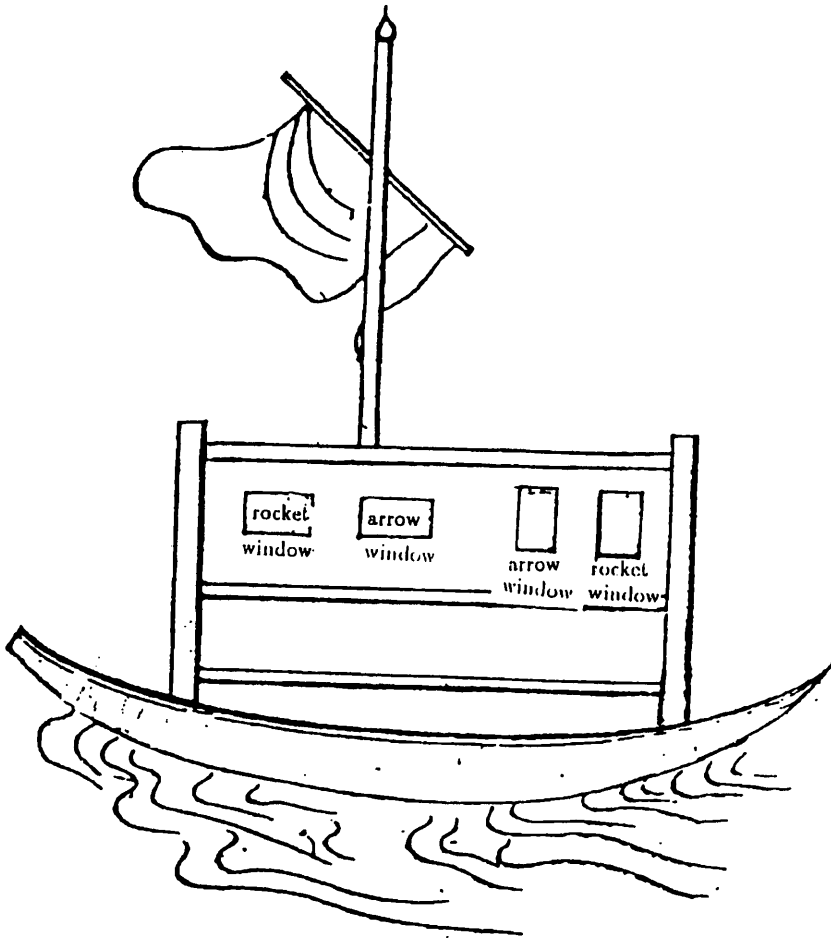
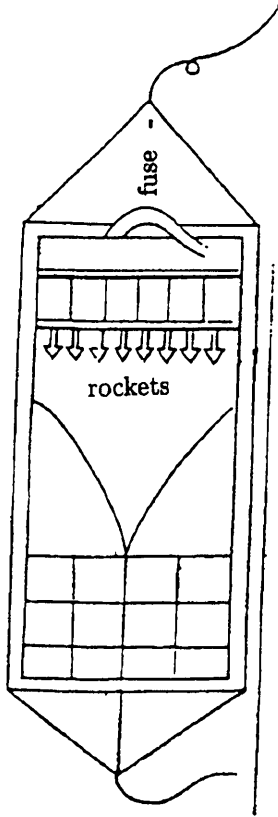


Figure 14: Fire Dragon Ship.

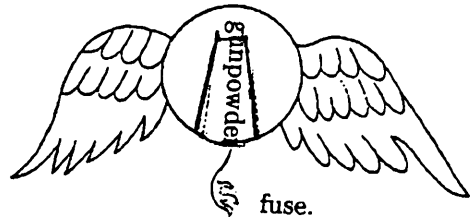
## Flying Rockets

### Invincible Soldier Rocket

This rocket was a wooden frame, seven by three feet, covered by thin leather. It was really a large kite. Under the body, rockets were installed. See Figure 15. During the night, soldiers flew the kites with thick cables to control the flight. A valiant warrior rode the kite, hidden under the wing, and ignited the rocket fuse when the weapon was hovering above the enemy sky. The rockets were thus fired. The enemy soldiers were frightened by the unexpected attack, and, in this way, they were defeated.



**Figure 15:** Invincible Soldier Rocket.



**Figure 16:** Soaring Thunder Cannon.

## Soaring Thunder Cannon

Applying the theory of rockets and kites, technicians invented the prototype of a missile. Figure 16 shows that the main body of the weapon was a ball fabricated by thin bamboo strips of 3.5 inches in radius. Then, more than 10 layers of tissue paper were pasted on the body and painted with Tung oil. A paper tube, of three inches length, was filled with gunpowder and installed in the body to propel the weapon when it was fired. The body was full of explosive gunpowder. There was a wing fixed on each side of the body to fly the weapon. Launching an attack on a fortification, soldiers ignited the fuse. Then, the propelling power delivered the weapon forward taking advantage of the help of the wind. After it burned out, the explosive powder detonated and caused the destruction of the enemy. It was a great advantage when attacking a castle to help kill enemy soldiers. The range of the weapon depended on the wind speed and direction.

## Soaring Flame Bird

The Soaring Flame Bird was made of thin pieces of bamboo fabricated into a model of a bird shape, covered by aluminum paper. The length was 2 feet and the span was 1.2 feet. Besides the power rocket, inside the abdomen was equipped with a can, eight inches long, filled with poison and gunpowder. See Figure 17. The poison air jetted from the bird's mouth. It could fly more than 10 yards. The soldier set fire to the instrument, igniting the power rockets. The bird hovered in the sky. In attacking a fortified city, an army of 64 soldiers with the equipment assaulted the town at night. Hundreds of flame birds flew into the city, where they exploded and killed inhabitants with the poison.

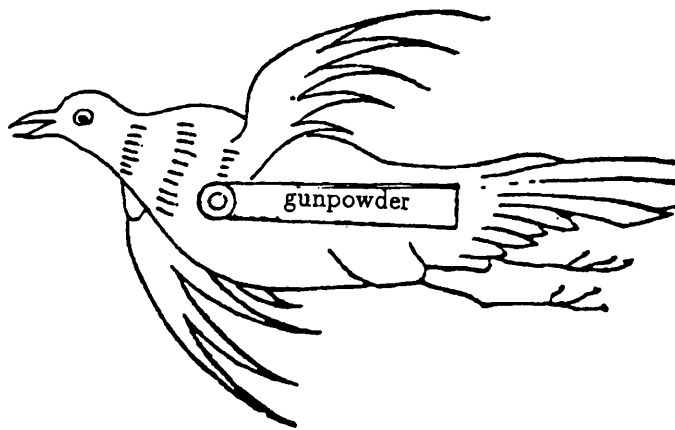


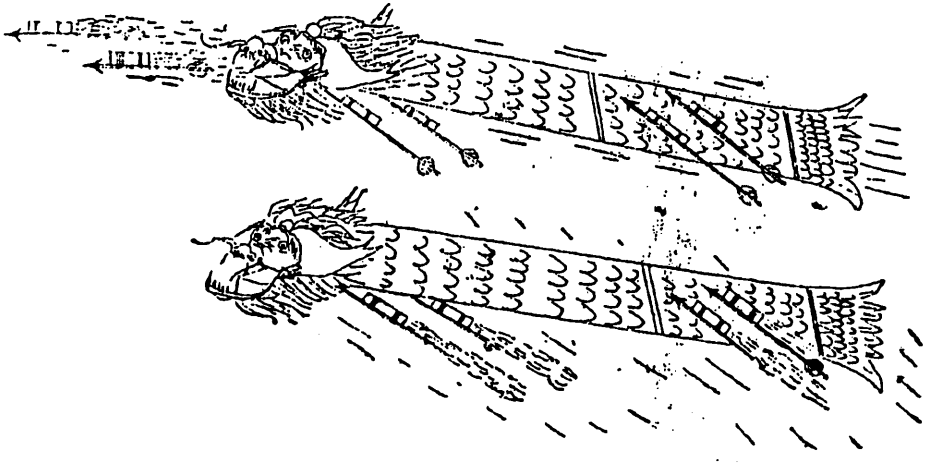
Figure 17: Soaring Flame Bird.

## Multi-Stage Rocket

The two-stage rocket was another invention of the Ming Dynasty. The most famous were the Fire Dragon over Water Rocket, Poison Sand Barrel, and Burning Crow. The primary stage rockets were designed for propulsion, while the second ones were used as weapons to destroy the enemy. The above mentioned multi-stage rockets were presented in a previous paper by a previous investigation.<sup>6</sup> The Fire Dragon is described here in more detail.

The Fire Dragon over Water Rocket and the operation situation are presented in Figure 18. The replica of the Fire Dragon has been displayed in the Space Museum in Beijing. Taking a piece of bamboo, five feet in length, with the knobs of the sections removed as the rocket body, hanging on the wooden dragon

head and tail, one manufactured the weapon as Figure 18 shows. Under the belly of the body, there are two propulsive rockets in the front and rear part respectively. The four under belly rocket igniters were combined to ignite simultaneously to propel the weapon. It could fly three to four feet above the water for a range of more than two miles. It looked like a fire dragon flying over the water surface. When the propulsion rockets burned out, the rockets in the abdomen were ignited and weapons were ejected from the dragon mouth to destroy and burn ships or targets on water. The range could be more than one mile.



**Figure 18:** Fire Dragon Over Water Rocket.

### **Concluding Remarks**

Although the Chinese have made great contributions to the development of the rocket manufacturing technique, they did not later improve and advance the products. The progress was slowed down and idled. There are several factors that hindered the development of the rocket manufacturing technique in China.

When the Manchu Dynasty (1644–1911) governed China it not only discouraged, but also restricted people from producing weapons. Gunpowder and related products were prohibited. The reproduction of old weapons was not encouraged. The research and development of new ones were forbidden by the government. The conceited Manchu Dynasty government ignored the European military weapon development and restricted its people from accepting Western civilization. That is the main reason for the decline of rocket production since the sovereignty of China's Manchu Dynasty.



Mainly, the development of the cannon made it possible to aim more precisely. The early rockets were not as accurate as the cannon and other small arms, which were improving rapidly in the 15th century. Since rockets lacked accuracy and effectiveness, they fell into disuse in warfare for some 300 years.

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