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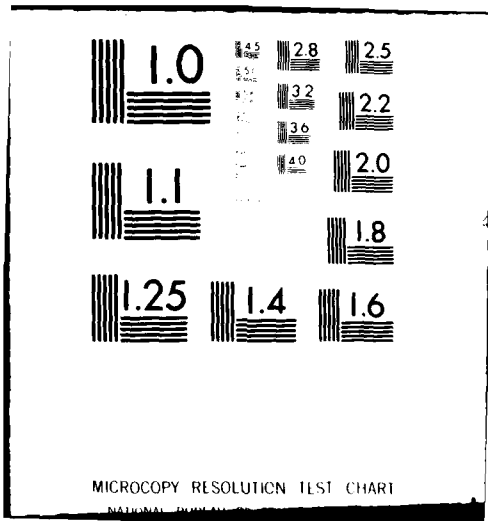
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THE HISTORY OF THE DEVELOPMENT AND USE OF ROCKETS

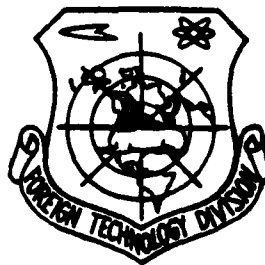
by

Ling Fugen

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EDITED TRANSLATION

FTD-ID(RS)T-1555-80

8 December 1980

MICROFICHE NR: FTD-80-C-001155

THE HISTORY OF THE DEVELOPMENT AND USE OF
ROCKETS

By: Ling/Fugen

(China)

English pages: 16

Source: *Edited Trans.* Hang K'ung Chih Shih, *1977* Nov 1978,
pp. 16-18

Country of origin: China

Translated by: LINGUISTIC SYSTEMS, INC.
F33657-78-D-0618
William Brown.

Requester: FTD/TQTA

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THE HISTORY OF THE DEVELOPMENT AND
USE OF ROCKETS
by Ling Fugen

[Preface]

Rockets are an important ancient Chinese invention and after one thousand years of development they have reached the present level of rocket technology and can send satellites, airships, probes and other space aircraft into outer space. What form were the most primitive rockets? How did they develop to this present level? After reading this history, the reader will have some understanding of it.

[Text]

In ancient Greece, there was the myth of Daedalus' and his son's flight toward the sun and in ancient China there was the legend of Chang E fleeing to the moon. By 1700 B.C., there was already mention in China of a "flying machine which sailed with

the wind and could travel 10,000 li in one day" and there were drawn imaginary paintings of "a vehicle that mounted the clouds and rode the mist." Later, there were even more stories concerning flying people and flying wooden birds. It can be seen from this that man has been hoping for space flight for several thousand years. Now, man has finally grasped the advanced scientific technology to use strong rockets to launch satellites and airships and the old age ideal of traveling in space has finally been realized.

Rockets used to launch satellites and airships are a major symbol of modern advanced scientific technology. Yet, historically, rockets are very old. The history from China's invention of primitive rockets up to the present spans nearly 1,000 years.

Arrows That Carried "Fire"

China was the earliest nation to use the word rocket. According to historical records, at the end of the Han dynasty (227 A.D.) when Zhu Geliang attacked Hào Zhao he used "rockets." The use of this so called rocket more than 1,700 years ago was only a common arrow tied with firewood, cotton and hemp which burned oil, was ignited with fire and relied on a man's strength to use a bow to shoot it. The purpose was to use the fire on the arrow to ignite

and burn an enemy camp and other targets. Because of this, the original meaning of the word rocket was "fire" carried on an "arrow." To differentiate it from modern rockets with reaction thrust, we can call them arrows carrying "fire." The distinction between them and real rockets lies in the different methods of providing thrust. The arrow carrying "fire" relies on a person's strength to use a crossbow to shoot and the forward thrust is provided by the crossbow. The thrust of a rocket, however, is provided by its own spurting of substances toward the rear. This type of principle of using the reaction power of spurting to go forward is called the principle of reaction thrust.

The Development of the Principle of Reaction Thrust

The natural world early used the principle of reaction thrust to provide animals with the mobility to move themselves forward. For example, the abalone and cuttlefish use the methods of spraying water or liquid towards the rear so as to cause it to go forward quickly.

The discovery and use of the reaction thrust principle probably dates from 300 B.C.. At that time, Italy produced a wooden dove which used steam reaction thrust. Three centuries later, in 53 B.C., in Greece there was a mathematician called Heron

who invented an apparatus called the "steam rotated ball." This is the oldest engine which used the principle of reaction thrust. The steam rotated ball was composed of two major parts (see chart1).

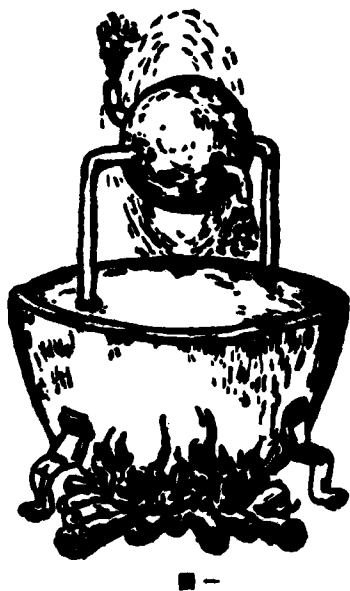


Chart 1

One part was a closed vessel (also called a boiler). Inside there was water and underneath there was a fire for heat. The other part was an empty ball which used two bent right angle tubes propped up in the closed boiler and on the ball there were also two outflow tubes on opposite sides. After the water was heated and turned into steam, it was sprayed out of the ball's two tubes causing the

ball to have reverse rotation and thus become a reaction heating power engine.

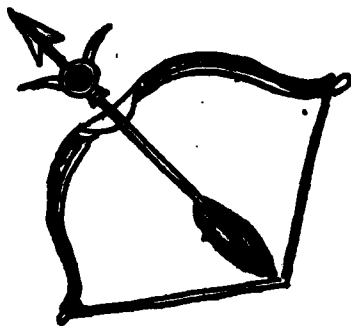
The Invention of Gunpowder and the Production of Rockets

Although the steam rotated ball was a type of reaction thrust engine invented before the Christian era yet its mass was very large, its efficiency was very low and there was no hope for it to be fitted on a rocket.

In ancient China there were many chemists who refined cinnabar and in their refining of cinnabar they discovered that when sulphur and nitre were put together this often produced a great flame and even an explosion. In 682 A.D., the ancient Chinese doctor and alchemist Sun Simo summarized the method of refining gunpowder in his "Cinnabar Classic." This shows that at the latest, during the Tang dynasty China had already invented gunpowder.

Gunpowder is combustible and naturally this was able to lead people to think of tying it on an arrow and shooting it to burn and kill an enemy. The "bow shot a fire garnet arrow" (see chart 2) recorded in the old books is this type of gunpowder arrow. Because when the gunpowder burns it can discharge a large amount of gas, in the process of using the gunpowder arrow, there can always be an

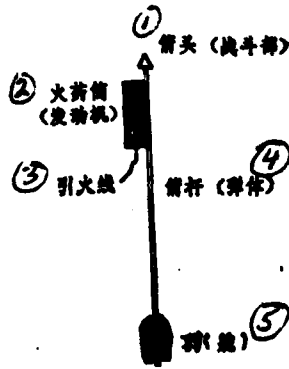
increase in the shooting range of the arrow. This then inspired people to change the use of gunpowder to provide forward power for the arrow and thus produced the original rocket.



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Chart 2

Chart 3 is a schematic drawing of the original rocket. First paper is used to paste a tube, then the gunpowder is solidly placed in the tube (which is actually a solid rocket engine) and afterwards this gunpowder tube is fastened on the arrow stem. The front of the gunpowder tube is closed and the back is open (spray tube). When the gunpowder burns, a large amount of gas sprays out of the back hole and uses the reaction power to thrust the rocket forward.



图三

Chart 3

1. Arrow head (combat part)
2. Gunpowder tube (engine)
3. Fuse
4. Arrow stem (trajectory body)
5. Feathers (rudder)

This type of primitive rocket has a gunpowder tube which acts as a thrust apparatus, an arrow head that acts as a combat part, an arrow stem that acts as a trajectory body and feathers that act as tail wings to guarantee flight stabilization. The entire apparatus can be seen as an embryonic form of the modern rocket. This type of primitive rocket is internationally recognized as the earliest type and which was invented by China, yet as to exactly when it first

appeared, opinions vary. We think that playthings such as "firecrackers", "ground mice" and "meteors" which utilized the principle of reaction thrust already existed prior to 1000 B.C.. In principle, they are the first rockets. Yet, the earliest rockets used in warfare are recorded to have been in 1232 A.D. in the battle at Kaifeng Prefecture between the Song and Jin. However, rockets went through a process from being invented and being improved to being used in military affairs. From this we can infer that the appearance of the most primitive rocket was about 1000 B.C.. Chart 4 depicts the circumstances of using a rocket to attack a target at that early date.



圖四

Chart 4

Chart 5 depicts the circumstances of a rocket placed on a "launching frame" and a bound bamboo rod.



图五

Chart 5

During the early period, rockets were mostly used at the same time as the rockets carrying "fire." In the old books it is recorded that during the Song, Yuan and Ming dynasties crossbows were used for fighting. Yet, after the beginning of the Ming dynasty, rockets were used more often and underwent great development.

1. The use of many rockets tied together increased thrust and heavier combat was thrown on the opposition. In principle, it is the same as the joined transport rockets (the use of several small rockets joined together to form a larger thrust transport rocket to launch a heavier satellite) commonly used in modern space facilities. The "divine fire flying duck" (see chart 6) recorded in

1377 A.D. in China is the earliest joined rocket.

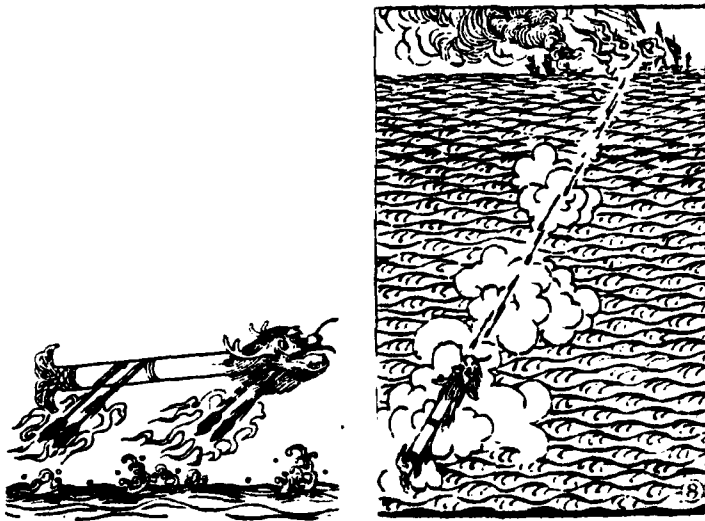


图六

Chart 6

Its structure is as follows: it first uses thin bamboo strips to weave a basket, gunpowder is put in and cotton paper is pasted on. Afterwards, duck type head, tail and wings are placed on the basket to give it the form of a hovering duck. Under each wing are installed two large firecrackers. On its back is drilled an eye, there is placed an over one foot long fuse which joins the four firecrackers. This type of rocket can travel over 300 meters. After it falls on the opposition, it uses its duck body to catch fire and burn the enemy camp and vessels and thereby it possesses a fixed power. It is recorded that it obtained certain victory at the time.

2. The use of a two stage rocket to increase launching range. The first mention of the idea of a multistage rocket was made by Chaurkefusky (?) at the beginning of the twentieth century. However, early in China, in 1621, there was first mentioned a multistage rocket called the "fire dragon emitting water" (see chart 7).



图七

Chart 7

This earliest multistage rocket was made of 5 foot long mao bamboo. The front had a wooden dragon head and the back had a wooden dragon tail. The front and back sides of the bottom of the dragon body had two large rockets and in its belly were also placed several rockets. The fuses for the several rockets in the belly were all

joined to the bottom of the two large rockets under the dragon body. When it was launched, it was 3 or 4 feet from the surface of the water. It was sent 2 or 3 li by the thrust provided by the two large rockets on the bottom of the dragon belly. When the large rockets burned out, the rockets in the dragon belly are ignited and sent to attack the target. This is obviously a type of simple multistage rocket.

At that time there was also a type of rocket that could return called the "flying in space powder tube" (see chart 8).

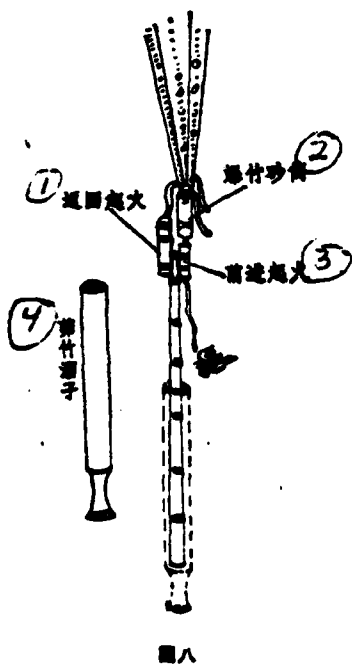


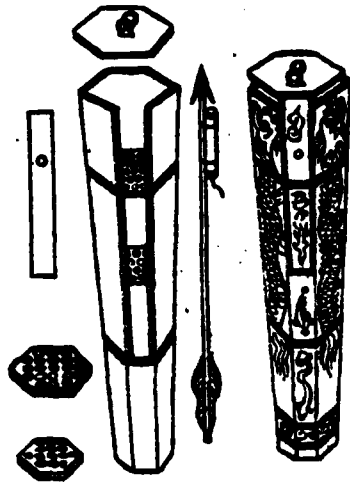
Chart 8

1. Return firecracker
2. Firecracker powder tube
3. Forward firecracker
4. Mao bamboo slide

This type of rocket used a thin bamboo strip for its body, on the outside were tied two firecrackers and there was a spray opening facing forward (return firecracker) and a spray opening facing the rear (forward firecracker). On the head part of the forward firecracker was arranged a firecracker powder tube which had granulated gunpowder. When launched, it was placed in the slide tube made of bamboo (the mao bamboo slide) and first the forward firecracker was ignited and after reaching the enemy the explosion of the granulated gunpowder killed the enemy soldiers. Afterwards, the firecracker was ignited facing the rear and returned to its own camp thus causing the enemy not to know what weapon it was.

3. The simultaneous firing of many rockets increases density and raises killing power. Generally, when many rockets are placed on one tube the fuses are joined together. When being used, they are simultaneously ignited and simultaneously launched. At one time there were fired 10 "fire crossbow meteor arrows", at one time there were fired 20 "fire dragon arrows", at one time there were fired 30 "destroying the single line battle array arrows", at one time there were fired 32 "bee nests" (see chart 9), at one time there were fired 40 "group of leopards running across arrows" and at one time

there were fired 100 "hundred tigers running together arrows."



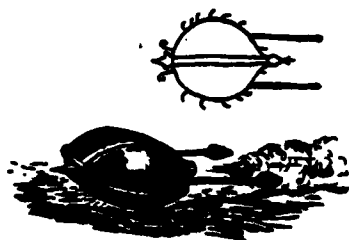
圖九

Chart 9

Chinese rockets used in ancient warfare were gradually transmitted to the west and many other types of rocket weapons were produced. For example, the "combustible egg" (see chart 10) was designed by the Arabs in the thirteenth century. It used firecracker spray combustion, a sliding surface and a war horse to frighten the enemy. The "rocket vehicle" (see chart 11) made in Italy during the fifteenth century was a weapon specialized in attacking enemies. The famous artist and scientist DaVinci also designed a "fire wheel" (see chart 12) that used a group of longitudinally arranged rockets

which on the one hand sprayed and burned and on the other hand rolled forward. It smashed the enemy and burned their camp.

(to be continued)



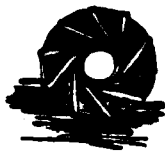
图十

Chart 10



图十一

Chart 11



■十二

Chart 12