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The Origin of Rockets
in China

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from Gunpowder.
the History of an
International Technology

Rocketry The Beginning

Gunpowder and rockets originated in China. Early Chinese gunpowder was in paste form, unsuitable for use as a rocket propellant. The later development of gunpowder in actual powder form opened the way to the development of the rocket.

Rockets evolved from firecracker configuration in both civil use in a celebratory or religious function and in the military role.

The earliest documentary evidence of Chinese military rockets is from the 12th and 13th centuries. A commentary on naval warfare written around 1170 describes the use of *p'i-li p'ao*, thunderbolt missiles by Admiral Yu Yun-wen in the battle of Ts'ai-shih of 1161. The account describes a paper tube filled with gunpowder exploding with a noise like thunder propelling a bomb upwards and then dropping down.

In a History of the Chin Dynasty the use of *fei-huo ch'iang* flying fire lances by Chin Tartars against Mongol invaders in the battle of K'ai-feng-fu in 1232 is described. Again a paper tube filled with a gunpowder mixture was employed this time to propel a lance fixed to the tube. Unlike the thunderbolt missile, the tube remained intact after the gunpowder was expended.

Knowledge of gunpowder is believed to have spread from China to the Arab world and then Europe via trading links and similarly rockets are described in Arab literature from the early 14th century.

Les Tucker

CHAPTER 2

THE ORIGIN OF ROCKETS IN CHINA*

Jixing Pan

Rockets originated in China where gunpowder was invented and put to military use as early as the beginning of the tenth century. According to later accounts,¹ in 969 an official of the Northern Sung Ministry of War presented the Emperor with models of "fire arrows" (*huo-chien*). These were certainly a type of gunpowder weapon and correspond exactly to those described in the *Wu-ching tsung-yao*. This "Collection of Essential Military Techniques", published in 1044, provides accounts of nine gunpowder weapons and contains the three earliest precise written recipes for gunpowder, which must have been known and used for at least a century previously.²

Rockets require gunpowder which contains at least 70% saltpetre and 20% charcoal, and under 10% sulphur, and such was already in use in China in the early twelfth century for the manufacture of fireworks (*yen-huo*) and firecrackers (*pao-chang*). Accounts of the first half of the twelfth century record that a number of soldiers put on a display for the Emperor in which these were used, and also that a large firework display at court was mounted on a high stand and connected with a general fuse.³ A special cracker called an "earth rat" (*ti lao-shu*), a kind of primitive rocket, greatly frightened the Empress Dowager when it was displayed at court for it rushed about the floor wildly and ran under her chair.⁴ As this happened at the very beginning of the thirteenth century it may be concluded that the Chinese already possessed the necessary technical knowledge for making rockets.

There is no clear proof that gunpowder and rockets were known in any other country earlier than in China. Indian

* For a fuller account of this subject, including English translations of Chinese sources concerning early rockets, see Jixing Pan, "On the Origin of Rockets", *T'oung Pao*, vol LXXIII, pp 2-15 (1987).

claims to the contrary have been made, but it has been suggested that these cannot be substantiated because they are based upon a misinterpretation of Sanskrit words. F W Winter has stated that true rockets and other firearms do not appear to have been established on the sub-continent until after the fifteenth century,⁵ although it was the view of P K Code that the manufacture and application of gunpowder was introduced to India from China during the fourteenth-fifteenth centuries.⁶ Apart from this there was the belief that the so-called "Greek fire" of medieval Byzantium of the seventh to eleventh centuries was launched by rockets, but original accounts show that it was projected from a siphon which cannot be considered a rocket device.⁷ Scholars have shown that "Greek fire" was made of naptha, bitumen, sulphur, resin, lime etc, and that throughout this period there was no saltpetre in it.⁸

The Muslim world played a crucial role in cultural and scientific exchanges between East and West, and a study of the Arab role in the transmission of gunpowder and rockets casts additional light on their place of origin. It is significant that Arab manuscripts of the mid- and later-thirteenth century refer extensively to Chinese materials and uses such as "Chinese snow" (saltpetre), "Chinese flowers" (fireworks), "Chinese arrows" (rockets), and ingredients of gunpowder such as "Chinese iron" and "Chinese red arsenic" (realgar).⁹ And in the Latin manuscript *Liber Ignium ad Comburendos Hostes* (On the Use of Fire to Conflagrate the Enemy), now shown to be a compilation by an Arab or an inhabitant of the Arabian world in the fourteenth century and not by Marcus Graecus (a Greek of Byzantium) in previous years, gunpowder and even rockets are described with a striking similarity to those found in earlier Chinese sources. Thus section 33 speaks of *ignis volantis in aere*, or "flying fire", the term used in Chinese in the earlier Sung dynasty, with a composition as given in the Arab work of: 1 part of sulphur to 3 of charcoal and 9 of saltpetre (7.7% : 23.1% : 69.2%). As the first mention of saltpetre in an Arab text has been found in the *Kitāb al-jāmi fi al-adwiya almufrade* ("Treatise on Simple Drugs" or on Drugs and Simples), written by al-Baytar in 1240, it may be concluded that saltpetre was introduced to Arabia from China between 1225 and 1250, and that European scholars then gained their knowledge of gunpowder and firearms from Arab sources, enabling scholars such as Roger Bacon (1214-1292) and Albertus Magnus (c1206-1280) to investigate them further.¹⁰

Though most scholars agree that rockets originated in China, they differ as to timing. Joseph Needham proposed the twelfth century at a conference in 1981, a view later narrowed to the second half of the twelfth century in the major book on military

technology published in 1986.¹¹ This paper agrees with Needham's opinion and offers additional evidence in support.

The most popular point of view was first put forward by Reinaud and Favé in 1845. They argued that historical evidence in the *Sung-shih* showed that rockets were invented by Feng Chi-sheng in 969.¹² But the technical conditions for the manufacture of powdered gunpowder as used in rockets did not exist before the twelfth century. The gunpowder described in the eleventh century *Wu-ching tsung-yao* has a lower saltpetre and charcoal and a higher sulphur content (c60% : 10% : c30% respectively). And since this mixture contained 10% vegetable oil such gunpowder was made in a paste form, unsuitable as a propellant for rockets. The same work also tells us that "fire arrows" (*huo-chien*) and incendiary arrows thrown with a whip (*huo-yao pien-chien*) were projected by bows, cross-bows, and other mechanical devices. But the same term "*huo-chien*" was used for both the incendiary arrow and the rocket, which means that the meaning in each case must be determined by the precise historical context.

The *Chin-shih* (History of the Chin Dynasty, 1115-1234), describes the *fei-huo ch'iang* (flying fire lances) used against the Mongols by Chin troops in the battle of K'ai-fêng-fu in 1232.¹³ The *Hsin Yuan-shih* (New History of the Yuan Dynasty, 1279-1368), published in 1921, calls this weapon *p'en-huo t'ung chien* (arrows with tubes which spout fire).¹⁴ Exact meanings have been contested by Western scholars who have had to rely upon translations of the Chinese sources, and some have held that the term *fei-huo ch'iang* implied a rocket since it was not shot from a bow or cross-bow, whilst others have challenged this on the grounds that if fire was thrown no more than thirty feet, this was an improbably short range for a rocket.

The following translation of the *Chin-shih* text is offered as throwing some light on the "flying fire lances":

Besides *chen-t'ien lei* ("Heaven-shaking thunder bombs") the Chin Tartars also used a certain *fei-huo ch'iang* ("flying fire lance") in the defence of cities. Some [*huo-yao* ("fire-drug" or gunpowder)] was applied, and the lance was ignited with fire where upon it was launched with a flame which shot forwards from the tube for a distance of more than ten paces. These flying fire lances were made according to the following method. The tube was about 2 feet long, made of sixteen layers of yellow paper and filled with willow charcoal, powdered iron, powdered porcelain, sulphur, arsenic, [saltpetre] and the like. The paper tube was then fastened to the point of a lance. The paper tube remained intact even after the *yao* (gunpowder) was spent.¹⁵

The above paragraph may be annotated as follows:

1 *Chu yao* means to put some *yao* or "drug" into the paper tube. *Yao* must here be understood as the abbreviation of *huo-yao* or "fire-drug" (gunpowder), that is to say besides willow charcoal, powdered iron, powdered porcelain, sulphur and arsenic, there was also saltpetre, although specific mention of it was omitted by the authors of the *Chin-shih*. Chinese writers did not always enumerate each ingredient separately when talking about the composition of gunpowder, unless they were professional writers of military works.

2 *Ch'ien shao shih yu pu* should be translated as: "flame s. forward from the tube for more than ten paces". "Ten paces" cannot be regarded as the effective range of the weapon; the *Chin-shih* in fact describes its scope for spreading fire elsewhere, as W Ley points out.¹⁶

3 *Yi huo fa chih* means that the "flying fire lances" were launched by fire (flame). Since the *Chin-shih* does not mention any other launching force, we may conclude that the lances were launched by flame and gases expelled from the rocket tube.

4 The *Chin-shih* also tells us that *yao chin erh t'ung pu sun*: "the paper tube remained intact even after the gunpowder was spent". This is typical of rocket tubes.

We may conclude from the passage above that the "flying fire lances" used in China in 1232 were rocket devices, which were then launched into the Muslim world in the late thirteenth or early fourteenth century. We are not told the effective range of these weapons but we know that the *fei ch'iang chien* or "flying lance arrow" mentioned in Mao Yüan-i's *Wu-pei chih* (Records of Preparations for War) of 1621 is the same as the weapon described in the *Chin-shih*. Mao explains the *fei ch'iang chien* as "a kind of *huo-cuen*" (rocket). Because its arrow-shaft is longer (6 feet) and has a different metal arrowhead (Figure 1), it was given a different name.¹⁷ According to Mao it had a range of 500 paces.

But there is a reference to a rocket device being used even earlier than 1232. In his *Hai-ch'iu fu hou-hsü* (Postface to the Ode on the Sea-Eel Warships) of about 1170, the famous scholar Yang Wan-li (1127-1205) tells us that in the battle of Ts'ai-shih of 1161 the Sung fleet, led by Admiral Yü Yün-wen (1110-1174), used *p'i-li p'ao* ("thunderbolt missiles") against the enemy.¹⁸ Opinions have long differed as to the exact nature of the *p'i-li p'ao*, and it has been variously described as a type of cannon; an explosive bomb; something similar to the "automatic fire" introduced to China from the West by the Arabs; and as a rocket device.¹⁹

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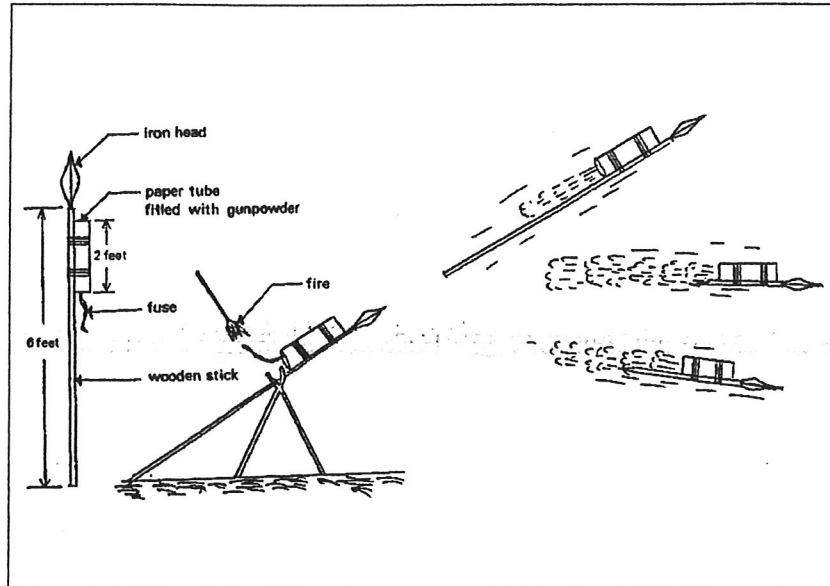


Figure 1 *Fei-huo-ch'iang* or flying fire lance used in the battle of K'ai-feng-fu in 1232 and its flight state

P.28 - a rocket device

Yang's description of the *p'i-li p'ao* warrants careful examination. He says that it consisted of a paper tube filled with lime, sulphur, and other ingredients which he does not list. When the tube was ignited it produced a noise like thunder, and the paper tube was broken: that is, it exploded. Only gunpowder could produce such an effect, which means that the tube must have contained charcoal and saltpetre. Yang also says that the device first rose upwards and then dropped down from the sky; if it fell into a river it exploded and jumped out of the water. As described by Yang, the behaviour of the *p'i-li p'ao* is similar to that of the *ch'i huo* ("flying fire") or *erh t'i chiao* ("double-bang firecracker") with which Sung folk amused themselves in the early twelfth century, except that it is a direct-reaction device, like the one mentioned by Chou Mi in his *Wu-lin chiu shih* of 1270.

The *p'i-li p'ao* was in fact an enlarged double-bang firecracker, in the sense that it was a primitive rocket-propelled bomb. The gunpowder tube also contained lime, so that it could pour out a lime-fog which blinded both men and horses. So we may deduce that the earliest reliable reference to the use of rockets was in fact 1161 (Figure 2).

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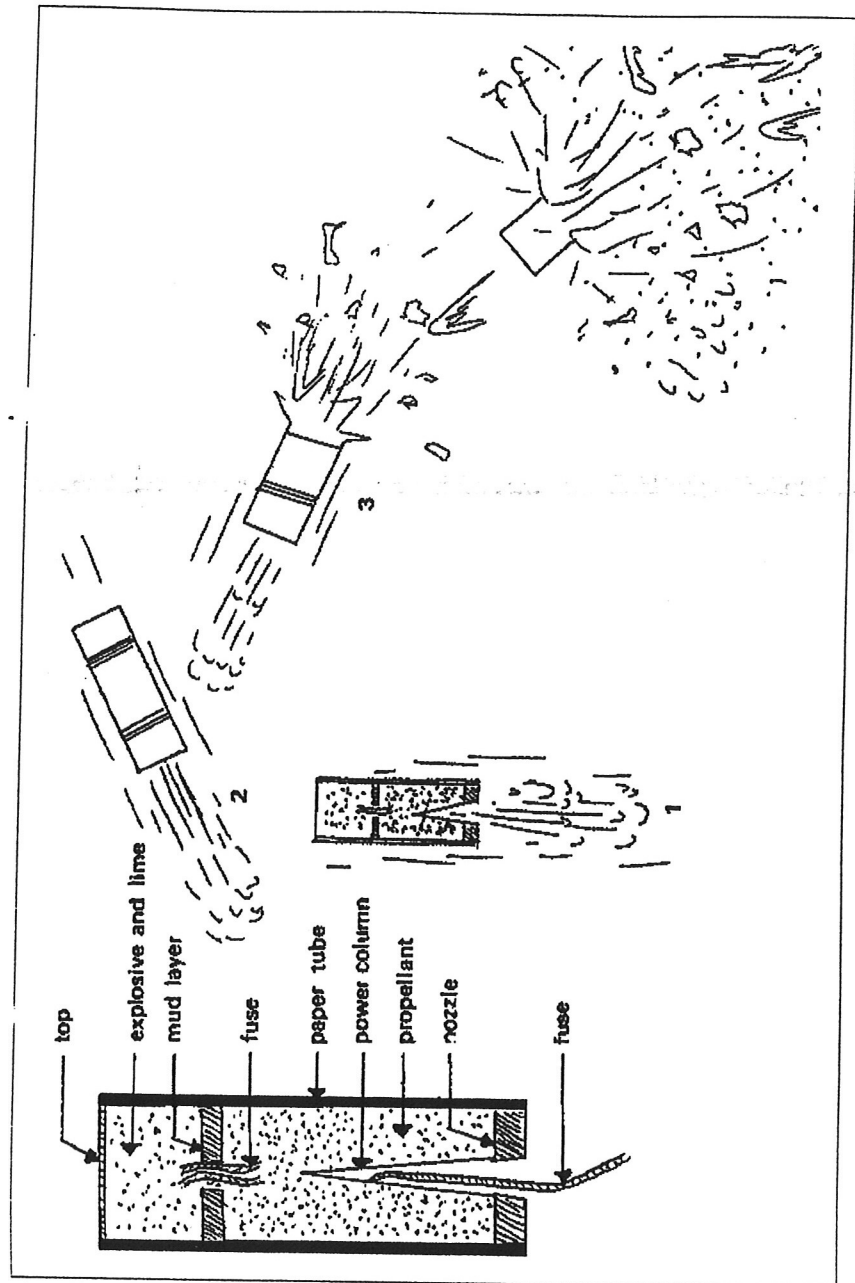


Figure 2 P'i-li-p'ao or thunderbolt missile used in the battle of Ts'ai-shih in 1161 and its flight state (1-4)

(P. 29 - Earliest reliable reference
to use of rockets)

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COMPOSITION OF GUNPOWDER

Gunpowder in successive periods	Contents in %			Explanation
	Saltpetre	Sulphur	Charcoal	
1 Gunpowder in the <i>Wu Ching Tsung Yao</i> (1044)	61.9	30.7	7.4	Paste form, cannot be propellant of rockets
2 ditto, II	60.5	29.6	9.9	ditto
3 Gunpowder for rockets in al-Rammāh's book (1280)	70.1	8.8	21.1	Powdered form, good propellant of rockets
4 Gunpowder for rockets in the <i>Liber Ignium</i> , Section 33 (14th century)	69.2	7.7	23.1	ditto
5 Gunpowder for rockets in the <i>Huo Kung Hsieh Yao</i> (1643)	71.4	3.6	25.0	ditto
6 Gunpowder for rockets in the <i>Chin Tang Chieh Chu Shih-Erh Ch'ou</i> (17th century)	74.2	2.6	23.8	ditto
7 Gunpowder for navy rockets in the Ch'ing dynasty (1886)	71.0	4.0	25.0	ditto
8 Gunpowder for modern meteorological rockets (1978)	70.0	5.6	24.4	ditto

Notes

- 1, 2 Tseng Kung-liang, *Wu-ching tsung-yao*, Bk 4, ch 11, p 23; ch 12, pp 56-57.
- 3, 4 J R Partington, *A History of Greek Fire and Gunpowder*, pp 202, 54.
- 5 Chiao Hsu, *Huo-kung hsieh-yao* or "Essentials of Gunnery" (1643), ch 2, p 31.
- 6 Li P'an, *Chin-t'ang chieh-chu shih-erh ch'ou* (17th century), ch 4.
- 7 Wang Kung-ch'ou, *Chung-kuo ch'uang-she hai-chun yi* or "Proposal for Founding a Navy in China" (1886), in *Ko-chih shu-yuan k'o-yi*, ch 1, pp 16-17 (Shanghai, 1898).
- 8 *Jen-kung fang-pao* or "Artificial Protection against Hail", p 37 (Peking, 1978).

No information has been found in Chinese sources as to the composition of gunpowder for rockets used in China in 1161 and 1232, but we believe it must have been similar to that described in Arabian works including al-Rammāh's, because al-Rammāh had made use of Chinese materials.

Figure 3 Composition of Gunpowder used in China and abroad in different periods

- South China. It at any rate points to the close interaction between Assam and South China in the field of gunpowder technology from a very early stage.
- 19 'Afif, *Tārīkh-i Fīroz Shāhī*, pp 356–357. It is a description of pyrotechnics, involving “bursting” of “flower scattering rockets” (*hawāī-hā-i gulrez 'anberbez mī bākht*) on the occasion of a *shab bārūt* at Delhi during the reign of Sultan Fīroz Tughlaq (1351–1388).
 - 20 *Tārīkh-i Fīrishta*, vol I, pp 290–291, 308.
 - 21 See my article “Early Use of Cannon and Musket in India: AD 1442–1526”, *Jnl Econ and Soc Hist of the Orient*, 1980, pp 156–158, see n 4.
 - 22 Edward Moor, *Narrative*, London, 1794, cited by William Irvine, *The Army of the Indian Moghals*, reprint, New Delhi, 1962, p 149.
 - 23 For Irfan Habib’s view that *bān* “did not come through the Islamic World, but, apparently overseas directly from China through Deccan”, see his article “Changes in Technology in Medieval India”, *Studies in History*, vol II, no 1, New Delhi, 1986, p 32. However, a type of *bān* used during Akbar’s reign was called *kahak bān Māzandārānī*, a designation which tends to indicate that the design was borrowed from Iran. Cf *Fathnāma-i Gujarāt*, dated November 1572, MS, University Collection, Persian, *akhbār*, no 170. The corrected text and English translation may be consulted in my book, *The Political Biography of a Mughal Noble: Mun'im Khan Khan-i Khanan 1497–1575*, Orient Longman, New Delhi, 1973, pp 127, 163.
 - 24 *Waqā'i 'Sarkār Ajmer wa Ranthambor*, MS, Asafia Library, Haiderabad, *fan-i tārikh*, 2242; transcript in the Research Library of the Centre of Advanced Study in History, AMU, no 16, p 355.
 - 25 Shihab Hakim, *Ma'āsiri Mahmūd Shāhī* (compiled 1467–1468), edited by Nuru'l Hasan Ansari, Delhi, 1968, pp 57–86.
 - 26 'Abbas Sarwani, *Tārīkh-i Sher Shāhī*, (compiled 1587), MS, India Office, Ethé 219, ID 218, ff 181b–182a, gives a detailed account of the accident at Kalinjar. In this account the archaic term *huqqa* is used for the rockets.
 - 27 Cf my book *Biography of a Mughal Noble*, p 127.
 - 28 Abul Fazl, *A'in-i Akbarī*, vol I, p 82. Price of a *bān* ranged from Rs 2½ to Rs 4/-.

