

= Wujing Zongyao =

The Wujing Zongyao , known in English as the Complete Essentials for the Military Classics , is a Chinese military compendium written from around 1040 to 1044 . It contains the earliest known written formulas for gunpowder , made from saltpeter , sulphur , and charcoal , along with many added ingredients .

The book was compiled during the Northern Song dynasty by scholars such as Zeng Gongliang , Ding Du (??) and Yang Weide (???) , whose writing influenced many later Chinese military writers . The compendium was published under the auspices of Emperor Renzong , who also authored the book 's preface . The book covers a wide range of subjects , everything from naval warships to different types of catapults . In addition to formulas for gunpowder , the compendium contains details on various gunpowder weapons such as incendiary bombs , fire arrows , incendiary projectiles , grenades , and smoke bombs . It also describes an early form of the compass (using thermoremanence) , and has the oldest illustration of a Chinese Greek fire flamethrower with a double @-@ acting two @-@ piston cylinder @-@ pump capable of shooting a continuous blast of flame .

= = History = =

The Wujing Zongyao was compiled under the imperial sponsorship of Emperor Renzong of Song (r . 1022 ? 1063 AD) , partially as a response to the Song dynasty 's war with the Tanguts of Western Xia . A team of Chinese scholars compiled the treatise of the Wujing Zongyao from 1040 to 1044 , in order to improve the knowledge of all the known martial techniques used in warfare . Its chief editor was Zeng Gongliang , while he was assisted by the prominent astronomer Yang Weide and the scholar Ding Du . After five years , the book was published with a preface authored by Emperor Renzong . Historian Peter Lorge theorizes that the purpose of the compendium was to disseminate military knowledge to a wider government audience . Emperor Renzong was concerned that many officials were unfamiliar with the military classics . Lorge remarks that Zeng Gongliang , the chief editor , was a government official rather than a military general . The book was likely written to be read by other government officials .

Parts of the Wujing Zongyao were copied from older sources ; historian Ralph D. Sawyer calls it " essentially a cut @-@ and @-@ paste job . " The book contains many passages from earlier classical military writings whose original authors are left unidentified , a common practice at the time . During the Song dynasty , the Wujing Zongyao was appended to two other books : the Xingjun xuzhi and the Baizhan qifa , which were written by anonymous authors .

The Wujing Zongyao was one of 347 military treatises listed in the biographical chapters of the Song Shi (1345 AD) , the historical work that embodied part of the Twenty @-@ Four Histories . Of these 347 different military treatises from the Song dynasty period , only the Wujing Zongyao , the Huqianjing (Tiger Seal Manual) of Xu Dong in 1004 AD , and fragments of similar works found in the later Yonglo Datian have survived . The original text of the Wujing Zongyao was kept in the Imperial Library , while a number of hand @-@ written copies were distributed elsewhere , including a copy given to Wang Shao by Emperor Shenzong of Song in 1069 AD .

However , with the sacking of the capital Kaifeng in the Jin ? Song wars by the invading Jurchens in 1126 AD , the enormous amount of prized literature found in the Imperial Library was lost , including the original copy of the Wujing Zongyao . After the original was lost , there was only a scarce number of surviving copies rewritten by hand . There was a scarcity because the book was meant to be kept a secret amongst a few trustees of the government , as publishing and printing many copies using woodblock printing would have allowed the possibility of it falling into enemy hands . Nevertheless , from a remaining copy of the Wujing Zongyao , it was remade into a newly published edition in 1231 AD during the Southern Song dynasty era . Then , during the Ming Dynasty (1368 ? 1644 AD) , a book published in 1439 AD featured fragments of the original Wujing Zongyao edition of 1231 while omitting some material and combining it with two other books , the preface of this book written by Li Jin . Then there was a reprinted edition of the entire Wujing Zongyao in 1510 AD , this

complete version being the oldest extant copy available . Furthermore , the historian Joseph Needham asserts that this edition of 1510 AD is the most reliable in its faithfulness to the original version , since it was printed from blocks that were re @-@ carved directly from tracings of the edition made in 1231 AD .

After the edition of 1510 was printed , other Ming Dynasty copies were made . This included the Jiajing edition (1522 ? 1566 AD) , the Wanli edition (1573 ? 1619 AD) of Quanzhou , and the Wanli edition (1573 ? 1619) of Jinling by Tang Xinyün (preserved by Cunjingge) . During the Qing Dynasty (1644 ? 1911 AD) it was also reprinted in two different editions during the 18th century , and again in 1934 with the Shanghai edition .

The Xu Wujing Zongyao (????? ; literally " Continuation of Wujing Zongyao ") is a sequel or " continuation " of the Wujing Zongyao written in the late Ming dynasty . The book primarily discusses army formations and military deployments . It was written by Fan Jingwen (1587 ? 1644) , who was then the Vice President of the Board of War (???? ; bingbu shangshu) . Fan wrote the book because he felt that reprints of the Wujing Zongyao circulating at that time were out of date and did not take into account the technological and strategic changes that had occurred since the Song dynasty . The only surviving copy of the Xu Wujing Zongyao is held by Fudan University Library .

= = Compass and navigation = =

In the 3rd century , the Chinese engineer Ma Jun invented the south @-@ pointing chariot . This was a wheeled vehicle that employed differential gearing in order to lock a figurine of an immortal in place on the end of a long wooden staff , the figure having its arm stretched out and always pointing to the southern cardinal direction . Although the authors of the Wujing Zongyao were mistaken in believing that the design of the south @-@ pointing chariot was not handed down (as it was reinvented during the Song period and combined with an odometer) , they described a new device which allowed one to navigate . This was the ' south pointing fish ' (a thermoremanence compass) , essentially a heated iron (or preferably steel) object cut in the shape of a fish and suspended in a bowl of water . The Wujing Zongyao part 1 volume 15 text stated :

When troops encountered gloomy weather or dark nights , and the directions of space could not be distinguished , they let an old horse go on before to lead them , or else they made use of the south @-@ pointing carriage , or the south @-@ pointing fish to identify the directions . Now the carriage method has not been handed down , but in the fish method a thin leaf of iron is cut into the shape of a fish two inches long and half an inch broad , having a pointed head and tail . This is then heated in a charcoal fire , and when it has become thoroughly red @-@ hot , it is taken out by the head with iron tongs and placed so that its tail points due north . In this position it is quenched with water in a basin , so that its tail is submerged for several tenths of an inch . It is then kept in a tightly closed box . To use it , a small bowl filled with water is set up in a windless place , and the fish is laid as flat as possible upon the water @-@ surface so that it floats , whereupon its head will point south .

It was during the Song dynasty that the compass became associated with maritime navigation . Several decades after the Wujing Zongyao was written , the scientist and statesman Shen Kuo (1031 ? 1095 AD) wrote of the first truly magnetized compass needle in his book Dream Pool Essays (1088 AD) . With a more efficient compass magnetized by lodestone , the thermoremanence compass fell out of use . The later maritime author Zhu Yu soon wrote of the magnetic needle compass as a means to navigate at sea , in his book Pingzhou Table Talks of 1119 AD .

= = Gunpowder = =

= = = Gunpowder weapons = = =

The Wujing Zongyao records detailed descriptions of different gunpowder weapons such as incendiary projectiles , smoke bombs , fire arrows , and grenades . It documents incendiary

projectiles containing low @-@ nitrate gunpowder , which were launched from catapults or lowered down from city walls at besiegers . Examples of these incendiaries include the " swallow @-@ tail " incendiary (??? ; yanweiju) and the flying incendiary (?? ; feiju) . The swallow @-@ tail incendiary was made of straw that had been tied together and dipped in fat or oil . Chinese soldiers defending a city under siege would light the incendiary and lower it onto any wooden structure of the invading army to engulf it in fire . The flying incendiary visually resembled the swallow @-@ tail incendiary , but was lowered using an iron chain from a swape lever installed within the walls of the city . The book also describes an ' igniter ball ' used in warfare and for finding the firing range . The Wujing Zongyao stated the following :

The ' igniter ball ' (yin huo qiu) is made of paper round like a ball , inside which is put between three and five pounds of powdered bricks . Melt yellow wax and let it stand until clear , then add powdered charcoal and make it into a paste permeating the ball ; bind it up with hempen string . When you want to find the range of anything , shoot off this fire @-@ ball first , then other incendiary balls can follow .

Gunpowder was attached to fire arrows (??) , an incendiary arrow that functioned like a rocket . The Wujing Zongyao records that fire arrows were launched from bows or crossbows . The gunpowder used for fire arrows was likely a low @-@ nitrate powder , and the quantity of gunpowder varied according to the type of bow . In the book , the force of gunpowder is said to be enough to launch an arrow , but only when the elasticity of the crossbow is sufficient .

The Wujing Zongyao discusses various types of incendiary bombs and grenades . They used a low @-@ nitrate gunpowder that , while not powerful enough to cause an explosion , was effective for incendiary weapons . The huoqiu (?? ; literally " fire ball ") was filled with gunpowder and launched using a trebuchet . Upon impact , the huoqiu would start a fire among an invading army . Chinese bombs such as the thunder clap bomb or pili pao used a greater percentage of gunpowder than that of the huoqiu . The gunpowder mixture for a bomb was placed within a rigid container that held in the expanding gas , allowing for more powerful explosions . The thunder clap bomb was constructed with a container made from bamboo .

In the Wujing Zongyao and other military texts , the distinction between a bomb and a grenade is ambiguous . At the time , the Chinese usually did not categorize gunpowder weapons according to their delivery method . One of the few exceptions is the shoupao , or hand bomb , which is analogous to the hand grenade .

= = = Formulas = = =

Gunpowder was invented in the 9th century by Chinese alchemists . The earliest reference to gunpowder comes from the Daoist book Zhenyuan miaodao yaolue , written circa 850 . The use of gunpowder in warfare began in China during the early 10th century , with the advent of the black @-@ powder @-@ impregnated fuse that was used to light the burst of the Chinese two @-@ piston flamethrower . It was not until the Wujing Zongyao that the exact formulas for early Chinese black powder was revealed . In the Wujing Zongyao there are three formulas for black powder provided , including one for an explosive bomb launched from a trebuchet catapult , another for a similar bomb with hooks attached so that it could latch on to any wooden structure and set it on fire , and another formula specified for a poison @-@ smoke bomb used for chemical warfare .

The Wujing Zongyao 's first recorded black @-@ powder formula used in these bombs held a potassium nitrate level of 55 @. @ 4 % to 55 @. @ 5 % , sulfur content of 19 @. @ 4 % to 26 @. @ 5 % , and carbonaceous content of 23 % to 25 @. @ 2 % . The first step for making gunpowder is to powder and mix together sulphur , saltpetre , charcoal , pitch , and dried lacquer . Tung oil , dried plants , and wax are mixed next to create a paste . The paste and powder are combined and carefully stirred . Then the mixture is placed inside a paper container , wrapped up , and tied using hemp twine . Several precautions are taken to prevent the gunpowder from becoming damp .

For the second labeled formula , the inner ball alone had a nitrate percentage of 61 @. @ 5 % to 50 @. @ 2 % , a sulfur content of 30 @. @ 8 % to 25 @. @ 1 % , and if all carbonaceous matter was taken , 24 @. @ 7 % , if just taking the charcoal content alone , the carbon level was 7 @. @ 7 % . If

the outer coating and inner ball are both included with the second black @-@ powder formula , that would yield a nitrate level of 34 @.@ 7 % to 54 @.@ 8 % , a sulfur content of 17 @.@ 4 % to 27 @.@ 4 % , and if all carbonaceous material is used , 47 @.@ 9 % carbon , if only charcoal is used , 17 @.@ 8 % . If the inner ball of the third black @-@ powder formula is only considered , it held nitrate levels of 39 @.@ 6 % if all carbonaceous matter was taken , 49 @.@ 4 % nitrate if excluding the poisons , and 60 % if charcoal is specified alone . The sulfur content was 19 @.@ 8 % if all carbonaceous matter was considered , 24 @.@ 7 % if this excluded poisons , and 30 % if charcoal is specified alone . The carbon content was 40 @.@ 5 % if all carbonaceous matter was considered , 25 @.@ 9 % if this excluded poisons , and 10 % if charcoal alone was specified . If both the inner ball and outer coating are considered for the third formula , that would yield a nitrate level of 27 % if all carbonaceous matter was taken , 31 @.@ 2 % if this excluded poisons , and 51 @.@ 7 % if charcoal alone was used . The sulfur content would be 13 @.@ 5 % if all carbonaceous matter was taken , 15 @.@ 6 % if this excluded the poisons , and 25 @.@ 9 % if only charcoal alone was specified . The carbon content was 59 @.@ 5 % if all carbonaceous matter was taken into account , 53 @.@ 2 % if this excluded poisons , and 22 @.@ 4 % if charcoal alone was specified .

The first black @-@ powder concoction was simply labeled as the " method for making the fire @-@ chemical " , with its ingredients and measured weight (in ounces) of each ingredient listed in the section below with the others listed in similar fashion .

1st formula