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PERSIAN MANUSCRIPTS ON CANNON MAKING, DIFFERENT TYPES OF ORDNANCES (CANNONS, HOWITZERS AND MORTARS), ROCKETS AND FIREWORKS

Abstract

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The goal of this article is to give a short overview of some Persian manuscripts on casting bronze cannons, the usage of rockets and different types of ordnance such as cannons, mortars and howitzers. Additionally, some manuscripts on shooting rockets that did not require a bombarding frame will also be discussed in the present article. A manuscript on making and shooting fireworks will also be introduced in the manuscript.

Keywords: Persian manuscripts on firearms, casting bronze cannons, cannon (*tup*), mortar (*xompāre*), howitzer (*qapus*), rocket (*fešang*), fireworks (*ātašbāzi*), grapeshot (*kise-ye sāčme*), cannister shot (*sāčme-ye tup*).

**ПЕРСЬКІ ЛІТОПИСИ ПРО ВИГОТОВЛЕННЯ
ГАРМАТ, РІЗНИХ ТИПІВ БОЄПРИПАСІВ
(ДЛЯ ГАРМАТ, ГАУБИЦЬ ТА МОРТИР),
РАКЕТ ТА ФЕЄРВЕРКІВ**

Анотація УДК 94(55)(091); 623.411

Завдання статті – дати короткий огляд перських манускриптів де розглянуто лиття бронзових гармат, використання ракет та різних типів боеприпасів, як-то для гармат, гаубиць та мортир. Додатково розглянуті літописи де згадується про використання ракет, що не потребують станків та феєрверків.

Ключові слова: перські літописи про вогнепальну зброю, литі бронзові гармати, гармата, мортира, гаубиця, ракета, феєрверк, картеч.

**ПЕРСИДСКІЕ ЛЕТОПИСИ ПРО ИЗГОТОВЛЕНИЕ
ПУШЕК, РАЗЛИЧНЫХ ТИПОВ БОЄПРИПАСОВ
(ДЛЯ ПУШЕК, ГАУБИЦ, МОРТИР),
РАКЕТ И ФЕЙЕРВЕРКОВ**

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Задача статьи – дать короткий обзор персидских летописей, где рассмотрены литье бронзовых пушек, использование ракет и различных типов боеприпасов для пушек, гаубиц и мортир. Дополнительно рассмотрены манускрипты, где упоминается об использовании ракет без станков и фейерверков.

Ключевые слова: персидские летописи об огнестрельном оружии, бронзовые пушки, пушка, мортира, гаубица, ракета, фейерверк, картеч.

INTRODUCTION

There are a number of Persian manuscripts on casting cannons, shooting rockets, mortars, howitzers, cannons and fireworks. Some of these manuscripts are original Persian manuscripts such as an untitled Safavid-period manuscript on cannon casting written by Soleymān. Others are partly translated, annotated and then added with extra infor-

mation by Persian authors such as the manuscript *Resālei dar Fešang* [*Treatise on Rockets*] written by Mohammad Rezā Tabrizi during the Qajar period. Others are merely translations such as the manuscript *Tupxāne va Gohule-ye Ān* (*Artillery and its Projectiles*) translated from Russian into English by Najafqoli Xā and Petros Xān. Before going into explaining different types of Persian manu-

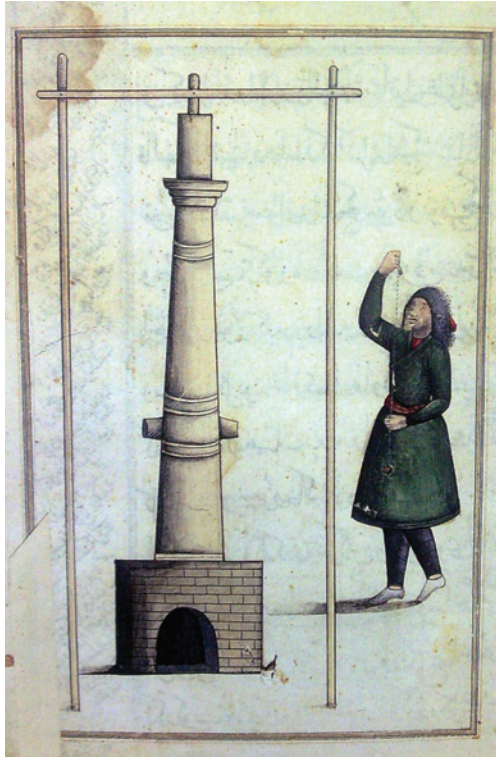


Fig. 1. The cannon mold on top of the foundry fastened with bricks and cement to a crossbeam supported by two [upright] posts fixed at the sides of the mold

scripts on ordnance, a short excursion will be given regarding the related terminology of different types of ordnance or guns. In contrast to rockets these types of weapons need a frame to shoot with and are classified in cannons, mortars and howitzers. Generally, cannons were long guns which shot or fired solid and non-exploding projectiles. These projectiles were meant to smash and shatter their target by the velocity of the firing and mass of the projectile which would travel in a flat parabola. There were also other types of cannon balls such as grapeshot and a later improvement cannister shot (a tin cylinder filled with musket balls) which were used against living targets. Other types of

guns were mortars and howitzers which were shorter and stubbier than cannons. Mortars fired shells (exploding projectiles) and were used in stationary situations such as sieges. On the other hand, howitzers were mounted on carriages and could be used on battlefields and static situations. Howitzers and mortars were used to fire exploding shells and also grapeshot. They could also fire incendiary shells (light balls), smoke balls, stink balls, message balls and carcasses (bundles of flammable, explosive and anti personnel materials). Swivel guns were smaller caliber cannons used in static defense, naval actions and on the backs of camels.

INTRODUCTION OF SOME PERSIAN MANUSCRIPTS ON FIREARMS

In this part of the article, some of Persian manuscripts on firearms are introduced briefly:

a) Manuscript on casting bronze cannons: The earliest known manuscript on firearms is a Safavid-period manuscript on casting bronze cannons written by Soleyman. This manuscript is kept in the Central Library of the University of Tehran with the number 2085. The end of the manuscript is signed with the inscriptions *Kamtarin bande-ye dargāh Soleyman qurči-ye meZRāq* (the Lowest servant of the court, Soleyman who holds and takes care of a short spear [for the king]). The manuscript consists of 51 pages and seventeen drawings.

b) *Tofang-e Verendal va Martin va Sāyer-e Tofanghāye Tahpor* [Werndl* and

* Cronin writes «The Austrian Werndl rifle was the regulation arm of the infantry. About 70,000 of these weapons had been purchased at various times by the Qajar representative in Vienna, but during Naşer-al-Din Shah's reign most of the troops in Tehran were actually armed with old percussion guns».

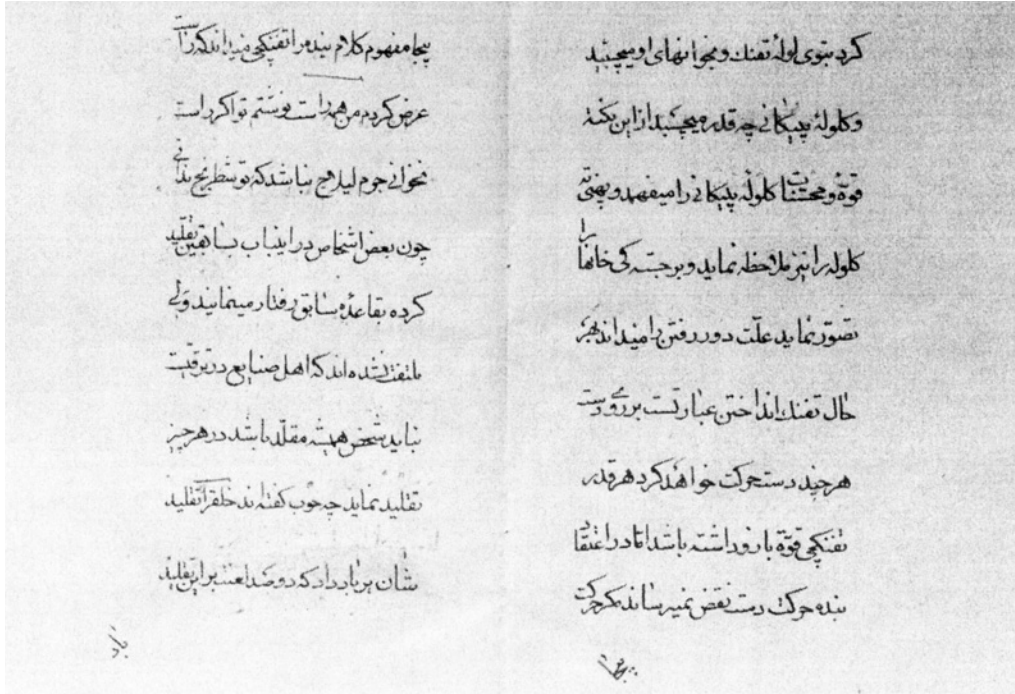


Fig. 2. Two pages of the manuscript *Tofang-e Verendal va Martin va Sāyer-e Tofanghāye Tahpor*.

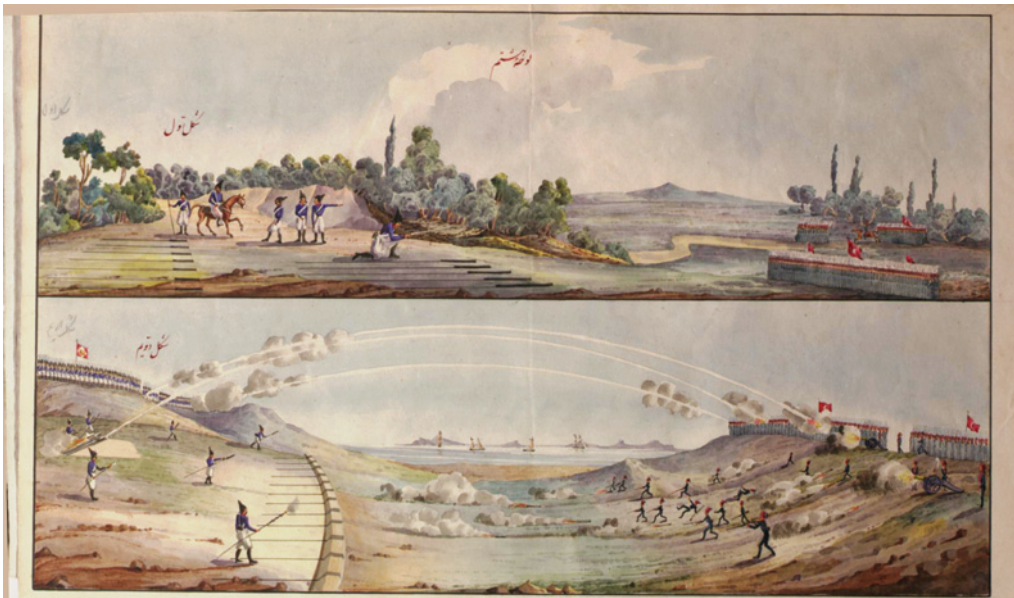


Fig. 3. A drawing from the manuscript *Resālei dar Fešang* showing the usage of the rockets in the field.

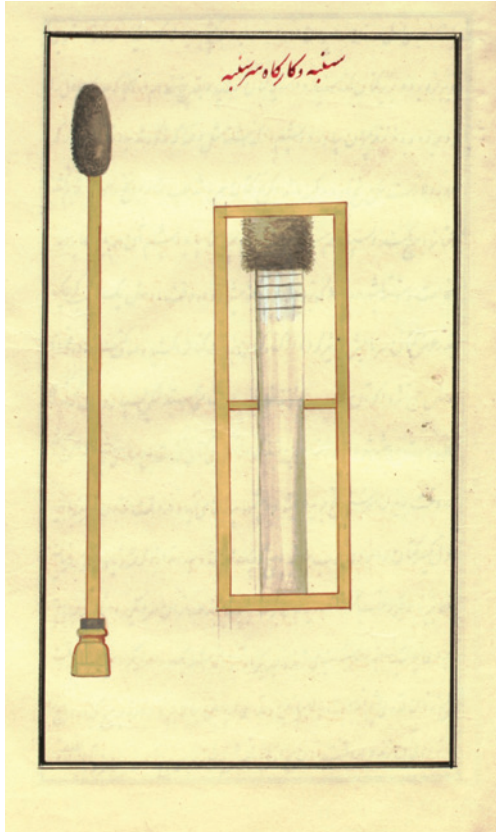


Fig. 4. A drawing from the manuscript *Resāle-ye Qurxāne [Treatise on Arsenal]* showing a rammer and the wooden frame of rammer.



Fig. 5. A drawing from the manuscript *Majmueye Qavā'ed-e Nezām (Collection of Military Regulations)* showing a Persian soldier in training with a flag.

Martin and Other Breechloading Rifles (Fig. 2): It was written by Esmāil Tofangdār Qarabāqi va Šāmlēse. This manuscript was written by the order of Amir Nezām. It was written in 1134 Hegira (1721-1722): The manuscript consists of 43 pages and has no drawings and pictures.

c) **Resālei dar Fešang [Treatise on Rockets]** (Fig. 3): It was written by Mohammad Rezā Tabrizi written in 1256 Hegira, which is 1840 C.E.. The manuscript is kept in the National Library of Iran in Tehran with the number 1055. This manuscript is a combination of a translation of

two different Congreve manuscripts and the writer translates some parts directly and some parts are written and added by Mohammad Rezā Tabrizi himself as he says that he was under the impression that Congreve did not explain clearly and wanted to hide important aspects. It has ten plates. Although the paintings resemble the paintings of Congreve books on rockets, all soldiers in Tabrizi's book are depicted with Qajar-period uniforms of the Persian army holding the Iranian flag of the lion and the sun. The enemy is shown holding the Ottoman flag and

wearing Ottoman uniforms. The manuscript consists of 99 pages.

d) *Resāle-ye Qurxāne [Treatise on Arsenal]* (Fig. 4): It was written by Mohammad Bāqer Tabrizi in 1257 Hegira (1841 C.E.). This manuscript is kept in the National Library of Iran with the Number 1766. The first part consists of different chapters about the gunnery tools of cannons. This part offers a detailed account about how cannons were loaded and shot. Additionally, it provides information about how gunnery tools were made and how they functioned. It also provides information on mortars and howitzers. The

second part is about the rockets and their accessories. This part offers valuable information about war rockets and how they were shot. Finally, the third part is about the fireworks that are used during celebrations. The manuscript has 196 pages and 50 plates.

e) *Majmueye Qavāe'd-e Nezām [Collection of Military Regulations]* (Fig. 5): This manuscript has the number 2772 and was written by an unknown author by the order of Nāssereldin Šāh Qājār in Ramezān 1268 (June 1852 C.E.). This manuscript has many pictures and describes in detail different marching and formation

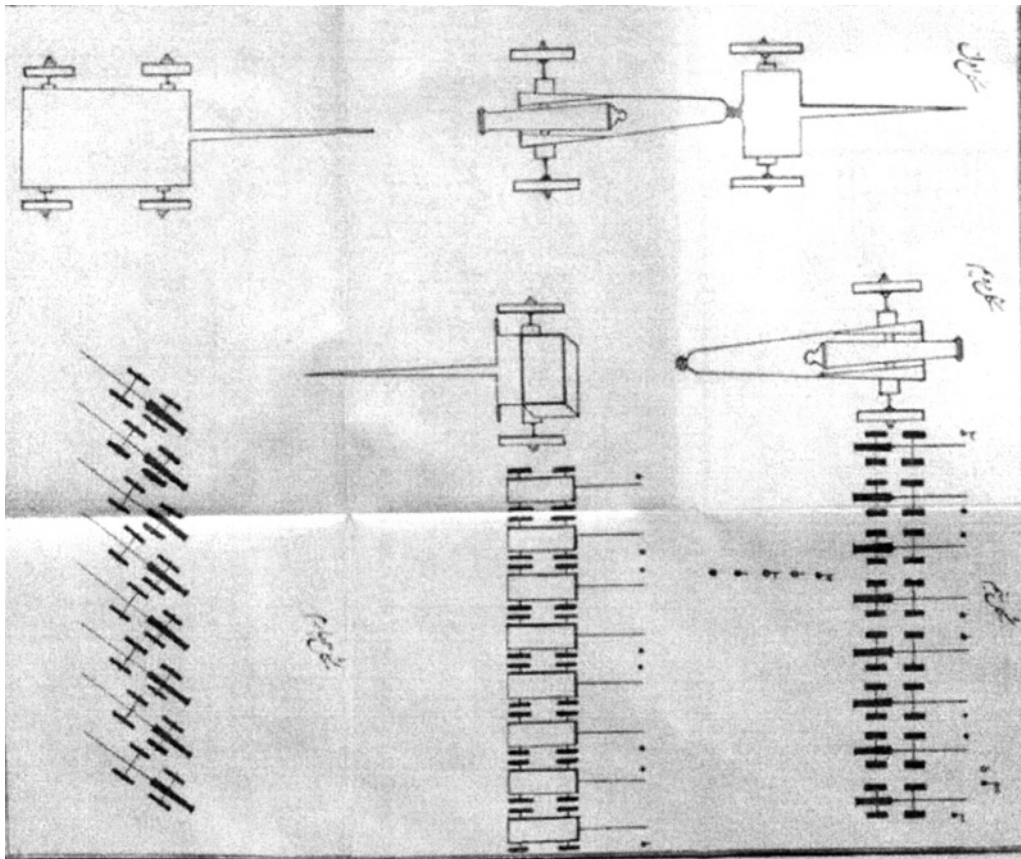


Fig. 6. A drawing from the manuscript *Resāle-ye Elm-e Mašqe Tupxāne (Manuscript on Artillery Training)* showing the formation of cannons.

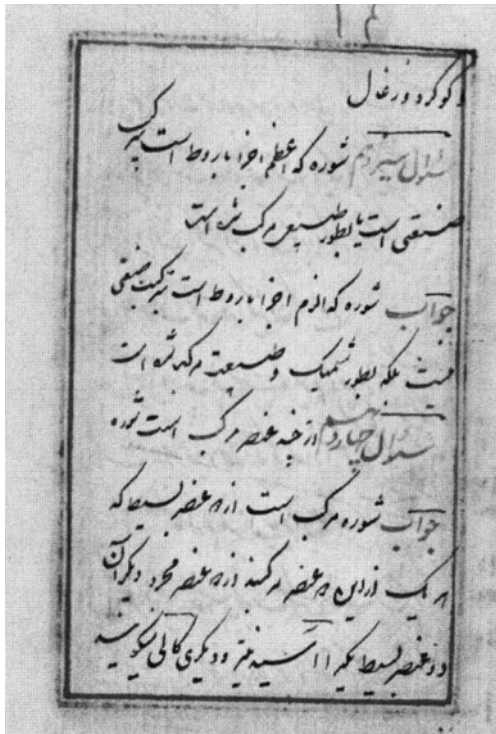


Fig. 7. A picture from the manuscript *Soāl va Javāb dar Elm-e Tupxāne* (*Questions and Answers about the Science of Artillery*).

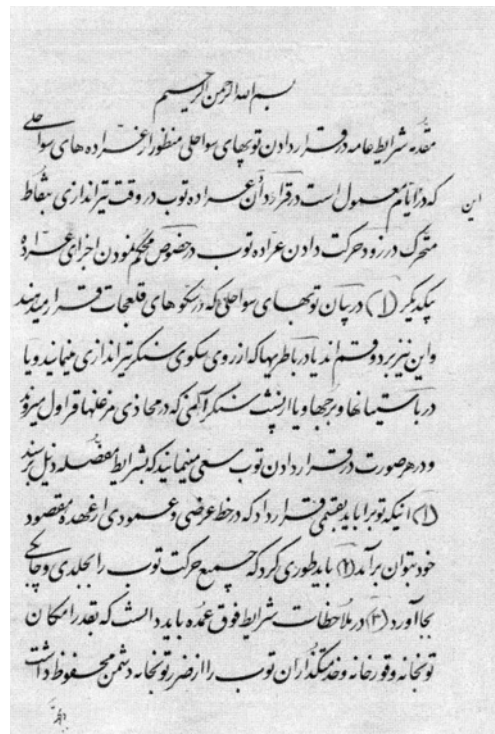


Fig. 8. A picture from the manuscript *Tupxāne va Golule-ye Ān* (*Artillery and its Projectiles*) discussing the positioning of the field of artillery.

regulations for the troops. It consists of 52 pages (including the jacket) and has 35 drawings.

f) *Resāle-ye Elm-e Mašqe Tupxāne* [*Manuscript on Artillery Training*] (Fig. 6): It was written by Mirzā Zaky Māzandarāni Karšiš with the handwriting of Mohammad Ali ben Abdollāh al Tehrāni. The manuscript is dated 1270 Hegira (1853-1854 C.E.). It is kept in the National Library with the number 782156. The manuscript has 58 text pages and 14 pages at the end of the manuscript dedicated to drawings about the formation of cannons.

g) *Soāl va Javāb dar Elm-e Tupxāne* [*Questions and Answers about the Science of Artillery*] (Fig. 7): It was written

by Najafqoli. It was handwritten by Abdolhosseyn Mohammad Rafi' in Tabriz in 22 Moharram 1296 Hegira (15 January 1879 C.E.). The code of the manuscript is 725 F and is kept in the National Library of Iran. The manuscript was written for the crown prince Mozaffareldin Šāh Qājār and was used as an instructional manual to teach him the science of artillery. The book consists of 120 questions and 98 pages and has no drawings.

h) *Tupxāne va Golule-ye Ān* [*Artillery and its Projectiles*] (Fig. 8): It was written by Najafqoli Xān (Nāyeb Ajudān) and Petros Xān (Sarhang) and handwritten by Enayatollāh. The book was written in Tabriz 1296 Hegira (1879 C.E.) and dedicated

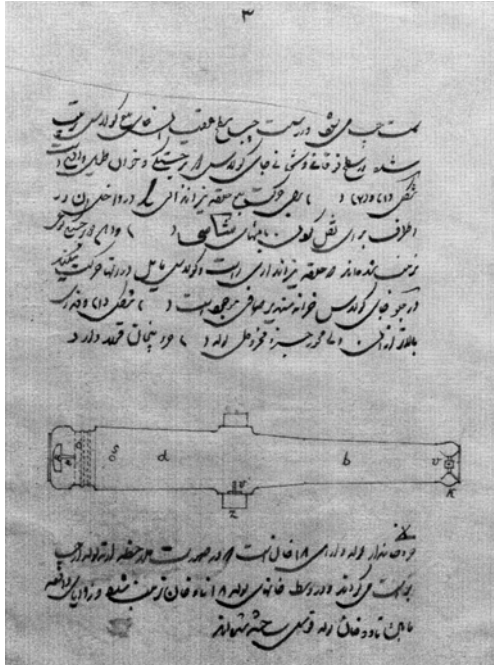


Fig. 9. A picture of the manuscript describing different parts of a cannon.

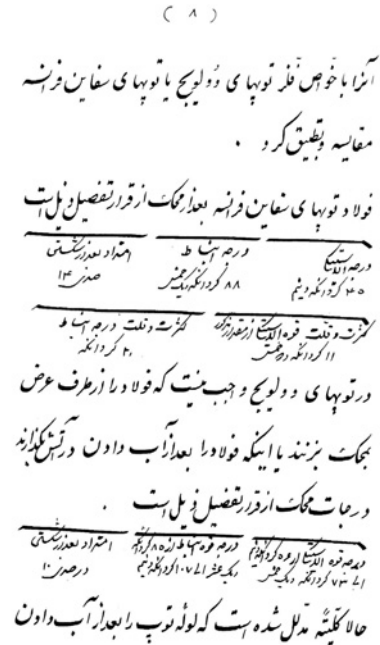


Fig. 10. A page from the manuscript TarzeTuphāye Mitrāyuze Hāçlis (Usage of Hotchkiss Machine Gun).

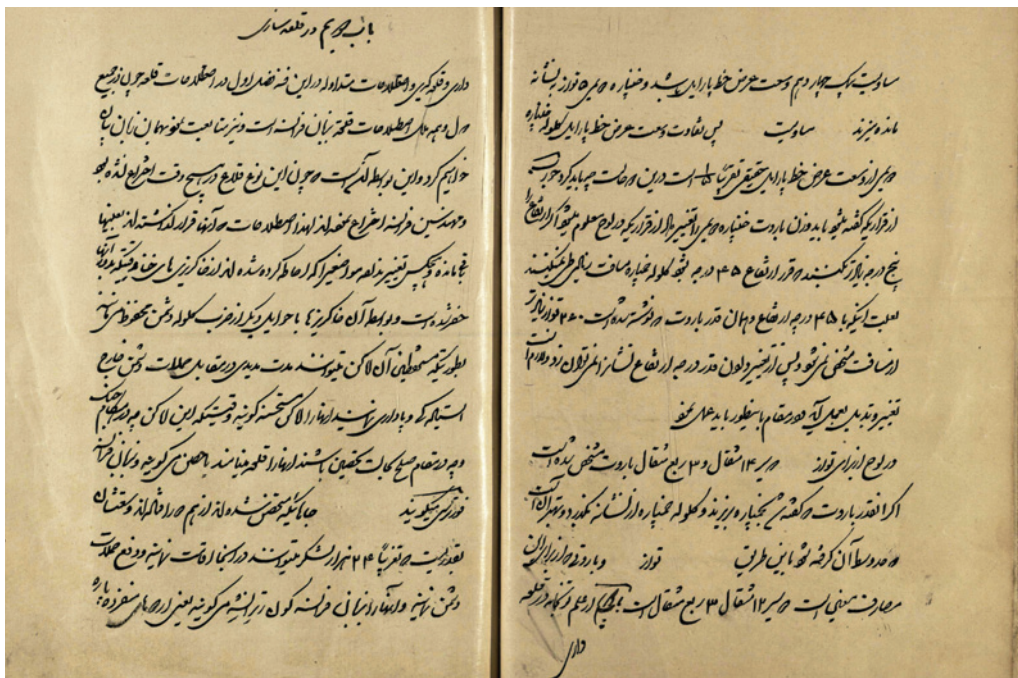


Fig. 12. Two pages of the manuscript Elm-e Tupxāne (Science of Artillery).

to Mozaffareldin Mirzā. The book is kept with the number 1823 in the National Library of Iran. The book was originally in Russian and translated into Persian by the order of the crown prince Mozaffareldin Mirzā. The authors were both artillery officers. The book is not merely a translation but the authors annotated it and added their own parts. They state in the beginning pages of the manuscript that the original manuscript had one introduction and twenty two chapters. The manuscript has 165 pages and no drawings.

i) *Tup-e Kuhi* [*Field Artillery*] (Fig. 9): It was written by an unknown author in 13th century Hegira (19 century C.E.). This seems to be a translation of a European manuscript. This book is kept in the National Library of Iran with the number 5-11015. The manuscript describes in detail a breech-loading cannon. It has thirty eight pages and twenty drawings.

j) *Tarze Tūphāye Mitrāyuze` Hāčlis* [*Usage of Hotchkiss Machine Gun*] (Fig. 10): This manuscript with the number of 3189 was written in the late 19 century. This manuscript consists of 85 pages and has no drawings.

k) *Šarhe Lavāzem-e Jangi* [*Description of War Equipment*] (Fig. 11): This is a Qajar-period manuscript on the usage of the hotchkiss machine gun. The manuscript code is 887. The manuscript has seventy two pages and no drawings.

l) *Elm-e Tupxāne* [*Science of Artillery*] (Fig. 12): It is a Qajar period manuscript about cannons, mortars and howitzers. The manuscript code is 417. The manuscript has 91 pages and no drawings. It was written in Rabi II 1271 Hegira (January 1855 C.E.).

m) *Qānun-e Nezāmiye* [*Military Regulations*] (Fig. 13): It is a Qajar period man-

uscript. The manuscript has the number 2979. The manuscript has fifty pages.

In the following, three of the above-mentioned manuscripts will be described in detail namely the Safavid-period manuscript on casting bronze cannons written by Soleymān, *Resālei dar Fešang* [*Treatise on Rockets*] by Mohammad Rezā Tabrizi.

DETAILED INTRODUCTION TO THE MANUSCRIPT ON CASTING BRONZE CANNONS

The manuscript is kept the Central Library of the University of Tehran with the number 2085 [16, p. 140]. The whole text without a technical annotation and

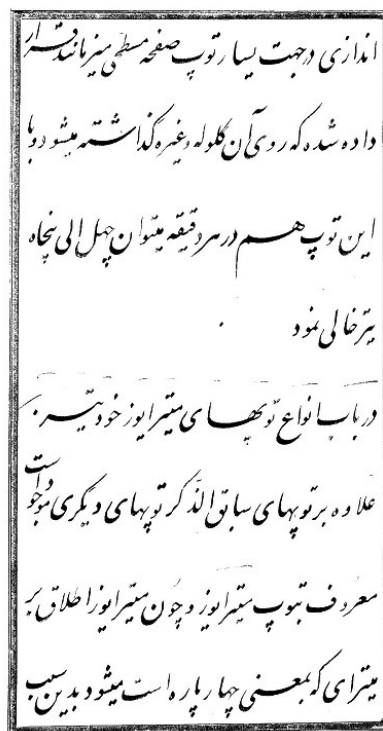


Fig. 11. A page from the manuscript *Šarhe Lavāzem-e Jangi* (*Description of War Equipment*).

* *Mitrāyuz* means «slug shots».

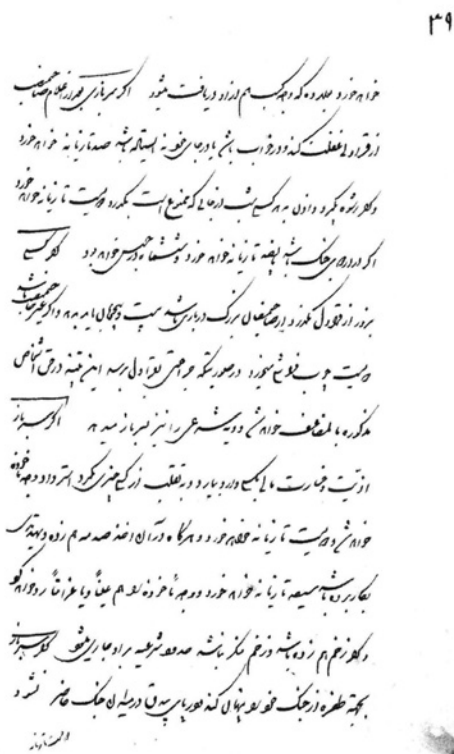


Fig. 13. A page from the manuscript *Qānun-e Nezāmiye (Military Regulations)*.

interpretation is already introduced by Mohebbi [21] who provides very short technical details about it. The cover of the manuscript is missing so its title is not clear. Casting bronze cannons was a complicated process that required a lot of skills. Therefore, the existence of such manuscripts is so rare that makes this one an invaluable manuscript from the Safavid period. The end of the manuscript is signed with the inscriptions *Kamtarin bande-ye dargāh Soleymān qurči-ye mezzrāq* (the Lowest servant of the court, Soleymān who holds and takes care of a short spear [for the king]). The word *kamtarin* (the most humble) in front of

the names was used during Safavid and later periods to indicate the humility of the maker. Thus the name of the writer is *Soleymān* [21]. *Qurči* was a special position of soldiers in the Safavid period and each assigned to holding and carrying a certain type of weapon for the king such as *qurči-ye šamšir* (*qurči* of sword), *qurči-ye tir va kamān* (*qurči* of bow and arrow), *qurči-ye xanjar* (*qurči* of dagger), *qurči-ye zereh* (*qurči* of mail armor), *qurči-ye tofang* (*qurči* of gun) and *qurči-ye mezzrāq* (*qurči* of short spear). Although Bayāni [16, p. 140] erroneously assumes that the first chapter of this manuscript is missing and thus its title is not clear, one should note that this statement is not completely true.

It is correct that the title of the manuscript is not available, but the first page is not missing completely. There are two factors which lead one to assume that parts of the manuscript are missing. The first is the wrong arrangement by the collector of the manuscript. The manuscript is divided into four chapters: Chapter one consists of ten sections, chapter two consists of three sections, chapter three consists of six sections and chapter four consists of two sections. In the arrangement of the book, one page is placed at the end of the manuscript which originally belongs to the first section of chapter one. This page starts with the sentence: «to pass through it and they should observe around the wooden pattern» and ending with the sentence «They mark the distance [line] between the molds with great care so that when they place the molds, each mark is in its own [accurate] place since if the marks were wrong». As mentioned above although this page is included at the end of the manuscript it actually should appear after the first page of the manuscript which ends with the sen-

tence: «A big compass like the picture to». This makes perfect sense as both describe the making of the wooden pattern of the cannon and this way the incomplete first page is complete. Although this part lacks a title due to the fact that the first page including a possible title and the table of contents is missing, judging by the content of the text, one can assume that this part is the first chapter. Both texts fit perfectly together.

Another problem is that in the arrangement of the manuscript the sections three and four of chapter one are missing. But a closer look at the manuscript shows that these sections are included in chapter four. This does not make sense as the chapter four deals with another subject, namely how to break the core mold and remove that. Additionally and more importantly, chapter four starts with the sentence «It consists of two sections». But in the arranged manuscript, four sections are included but this also does not make any sense. The following table shows the table of contents of the manuscript in correct order. Note that the titles of chapter one and section one of chapter one are not in the original manuscript and are added for clarification reasons:

[Chapter one: About making the wooden pattern]

[Section one: The wooden pattern]

Section two: About making the mold meaning making the «wooden pattern» and covering it with clay.

Section three: About making the three-pronged stave.

Section four: About making the mentioned core mold.

Section five: About making the «iron three-pronged stave» for the bottom of molds.

Section six: About casting the breech (casca-bel) meaning the piece that is made of molten

metal so that the top of the spindle attaches to it during the casting of the cannon.

Section seven: About placing the trunnion meaning the round wide piece that is in the middle of the cannon on both sides so that the cannon stands firmly on its carriage (stock).

Section eight: About pinning the lifting rings to the cannon.

Section nine: About making deadhead meaning the clay circle that is placed on the top of the mold.

Section ten: In making the «clay conduit» for pouring the molten metal of the cannon in the mold.

Chapter two: About digging the «casting pit», placing the molds and positioning the core in their middle.

Section one: About digging the casting pit for the molds and for casting the cannon.

Section two: About the three-pronged stave, and taking the molds and the breech (casca-bel) in the casting pit and placing them on top of each other in the pit.

Section three: About placing the «core mold» in the middle of the molds.

Chapter three: About making the furnace and melting the metal for the cannon and pouring it into the mold

Section one: About making the furnace.

Section two: About the weight of the molten metal and their component parts.

Section three: About firewood of the furnace.

Section four: In placing the clay conduit.

Section five: In melting and pouring the molten metal into the mold.

Section six: About making another furnace as a precautionary measure.

Chapter four: About taking out the cannon and the core mold from the casting pit

Section one: About taking out the cannon out of the casting pit.

Section two: About bringing out the middle core from the inside of the cannon.

DETAILED INTRODUCTION TO THE MANUSCRIPT OF ROCKETS

Reports attribute the invention and the first use and application of rockets in the region to the Sultan of India Sultan Fateh Ali Xān Tipu known as Tippu Sultan (or Tippoo/Tipu Sahib, “Tiger of Mysore”) (1750-1799 C.E.). Although the Chinese already used them for military and recreational uses in the 13 century C.E. Tippu Sultan was the first son of Haider Ali by his second wife, Fatima. Both Tipu Sultan and his father were responsible for the development of fuel rocket technology or missiles for military use in India, a technology that helped them defeat the British forces in the first Anglo-Mysore wars. Tippu Sultan composed a military treatise titled *Fathul Mujahidin*. In this he details that 200 rocket-men were assigned to each Mysorean brigade and Mysore had 16 to 24 brigades of infantry. They trained the rocket-men to launch their rockets at an angle calculated from the diameter of the cylinder and the distance of the target. By using wheeled rocket launchers the rocket-men were capable of launching five to ten rockets almost simultaneously in combat. Rockets could be of various sizes, but they usually used a tube of soft hammered iron, closed at one end and attached to a shaft of bamboo. The iron tube functioned as a combustion chamber and was filled with well-packed gunpowder propellant. A rocket with one pound of gunpowder could fly almost 1,000 yards [28]. Only after Tipu Sultan’s death did that technology reach Europe. However, rockets in Europe were not cased in iron and were not capable of taking large chamber pressures - consequently, they were not able to reach the great distances of their Indian counterparts. William Congreve, son of the Comptroller of the Royal Arsenal, started to develop his own rocket designs by sending several Mysore rockets from 1801 C.E. to England for thorough examination.

Congreve discovered a new propellant mixture, and developed a rocket motor with a strong iron tube with conical nose, weighing about 32lb (14.5 kg). The Royal Arsenal’s first test of solid fuel rockets was conducted in 1805 C.E. Later, the rockets were used effectively during the Napoleonic Wars and the War of 1812 C.E. in America. William Congreve published three books on rocketry in 1807, 1814 and 1827).

Little is known about the usage of rockets in Iran during the Qājār period. There is a treatise that is kept in the National Library of Iran in Tehran with the number 1055. The manuscript is titled *Resālei dar Fešang* [*Treatise on Rockets*] and is written by Mohammad Rezā Tabrizi who was a *mohandesbāši* (head of engineering units) [9]. The manuscript was written in 1256 Hegira, which is 1840 C.E.. There is a royal cartouche on the top of the first page that reads “The ruler, the son of the ruler, the son of the ruler, Mohammad Šāh Qājār”. Note that Mohammad Šāh Qājār ruled from 1834 to 1848 C.E. This manuscript is a combination of two different Congreve manuscripts and the writer translates some parts directly and some parts are written and added by Mohammad Rezā Tabrizi as he says that he was under the impression that Congreve did not explain clearly and wanted to hide important aspects from outsiders. Therefore, he adds some important information to the text explaining the use and function of rockets. Even the parts which he translates from Congreve are not direct translations. He leaves out many parts especially those with information describing the use of rockets on European battlefields. The manuscript is addressed to Hāji Mirzā Aqāsi who was Sadr-e Azam (equivalent to Prime Minister) of Mohammad Šāh Qājār (1835-1848).

On the fourth and fifth pages of the manuscript, Tabrizi writes:

“Dear Hāji Mirzā Aqāsi

Because of the Excellency's open-minded attitude, the production of war equipment and weapons ranging from artillery to weapon storage became widespread in this country [referring to Persia/Iran] and with the help of the experienced experts the procurement of the above tools have become popular. The kingdom [of Persia/Iran] has become interested in using the techniques and principles of rockets which are the special invention of the Europeans as is evident in the chapters of the book and used there. In warfare, the rocket is one of the most efficient weapons. Thus, one should take the [necessary] steps to integrate this technique in the arsenal and further an advanced type of it should be used. In the past one of the [military] experts from Europe^{*} had written a manuscript but because of a lack of clarity in the script and words, the inhabitants of this country [Iran] could not benefit from that manuscript and could not understand its unfamiliar points and abstract details. It has become a necessity that the manuscript should be translated and written into Persian and its benefits are revealed with the annotations. But after the first translation, it has become evident that the mentioned author^{**} did not reveal some secrets and details and hid some important themes and explained some topics in an unclear, distorted and incomplete way so that a student would not learn much from it. In reality the mentioned benefits and big advantages [of the rockets] seem to be meaningless and void without mentioning other main topics. Thus, it has become a necessity that the defects of the mentioned manuscript are completed by adding major topics, main explanations and with clear and beautiful phrases so that

they will be completed. By paying attention to the stated opinions, exploring and deducing the mentioned rules, one understands the details stated in the whole [manuscript] and comprehend the major hidden topics. Those topics could not be understood by anyone and even those who were experienced in this technique could do it with great difficulties only after spending days and nights on it. The Excellency appointed me, the humble servant of the court of the heaven, the engineer of artillery Mohammad Rezā Tabrizi, with this important task and the fulfilment of those main goals to write a complete book that is a beneficial collection. With the hope that the supreme and blessed God makes the victorious soldiers of the Excellency, the destiny of power, the Emperor, the Power of Jam [referring to the legendary king Jamšid], the court of heaven, the ruler, the star of servants, the lord, the sun of the banner, the King of stars, the Emperor of Emperors, the bird of prey, the defender of victory, the King of Kings, the defender of the religion, the supporter of Islam, the destroyer of heresy, the warrior in the path of God and someone who knows about the benefits of rockets and agrees with it and who has a victorious destiny. Now, I start with this plan and divide the manuscript into introduction, some chapters and a conclusion.”

The table of contents of Tabrizi's manuscript is as follows:

About the benefits of the military rockets

First chapter: About writing this noble manuscript.

Second chapter: About the invention of war rocket, its development, the use of rockets in naval warfare [fire ships] and siege of ports, etc.

Third chapter: The use of rockets in naval warfare [fire ships].

Fourth chapter: The use of rockets in field service [rocket infantry; the way of shooting

* Here Tabrizi is referring to Congreve manuscripts.

** Tabrizi is referring to Congreve.

the rocket in siege warfare; classification of rocket troops.

Fifth chapter: *The use of rocket cars and their accessories; About making the rocket cars; advantages and benefits of rocket cars; keeping military rockets from air moisture, etc.*

Sixth chapter: *The use of rockets in the field and in conquering fortifications and cities; the use of rockets in siege warfare, etc.; table of power and strength of a division of rocket troops together with rocket cars and rocket cavalry; table of rocket cavalry, horses, rocket cars and cars of ammunition cars.*

Seventh chapter: *List of plates and pictures of this noble manuscript.*

Eighth chapter: *Equipping and preparing the rocket cavalry.*

Ninth chapter: *About loading the ammunition horse.*

Tenth chapter: *Movements of the rocket cavalry in line of march and in action.*

Eleventh chapter: *Movements of rocket cars in line of march and in action.*

Twelfth chapter: *Principles and movements of rocket troops in line of march and in action*

Thirteenth chapter: *The use of rockets in siege, etc.*

Fourteenth chapter: *The use of rockets for destroying fortresses, etc.*

Fifteenth chapter: *The rocket ambushade*

Sixteenth chapter: *The use of rockets in the attack and in the defence of a fortress, etc.*

Seventeenth chapter: *The use of rockets by rocket troops, etc.*

Epilogue: *The different compositions of rocket ammunition, etc.*

A QĀJĀR-PERIOD MANUSCRIPT ON CANNONS AND ROCKETS

Another interesting Qājār-period manuscript is titled *Resāle-ye Qurxāne* [*Treatise on Arsenal*] that is written by Mohammad Bāqer Tabrizi in 1257 Hegira (1841 C.E.). This manuscript is kept in the National Li-

brary of Iran with the Number 1766. The first part is about the gunnery tools of cannons and consists of different chapters. This part offers a detailed account about how cannons were loaded and shot. Additionally, it provides information about how gunnery tools were made and how they functioned. It also talks about mortars and howitzers. The second part is about the rockets and their accessories. This part offers valuable information about war rockets and how they were shot. Finally, the third part is about the fireworks (*ātašbāzi*) that are used during celebrations.

Before going into explaining different types of ordnance, a short excursion will be given regarding the related terminology. Generally, cannons were long guns which shot or fired solid and non-exploding projectiles. These projectiles were meant to smash and shatter their target by the velocity of the firing and mass of the projectile which would travel in a flat parabola. A cannon is called *tup* and a cannon projectile or shot is called *golule-ye tup* in Persian. There were also other types of cannon balls such as grapeshot, which is called *kise-ye sācme* in Persian, and a later improvement canister shot (a tin cylinder filled with musket balls) which was used against living targets* and called *quti-ye sācme* in Persian.**

* For an example of a canister shot see [27, p. 142].

** In English, one distinguishes between two types of anti-personnel projectile: canister shot and grapeshot. A canister shot included many small iron round shot or lead musket balls which were placed in a metal can. Upon firing, the metal can broke up and scattered the shot among enemy ranks. A grapeshot functioned in a similar manner but it had a canvas bag containing the shot, generally of a larger caliber. In one type of the grapeshot, a coiled bar held the shot and the shot was spread by a fused charge similar to a shell [18, p. 219].

Other types of guns were mortars, *xompāre* in Persian, and howitzers, *qapus* in Persian, which were shorter and stouter than cannons. They fired shells (exploding projectiles). Mortars were used in stationary situations such as sieges whereas howitzers were mounted on carriages and could be used on battlefields (for defending a prepared position) and static situations. Howitzers and mortars were used to fire exploding shells but also grapeshot. They could also fire incendiary shells or light balls (*golule-ye ātaši*), smoke balls (*golule-ye dudi*), stink balls, message balls (*golule-ye qarāvol*) and carcasses (*golule-ye miyānx-āli*). Swivel guns (*zanburak*) were smaller caliber cannons used in static defense, naval actions and on the backs of camels.

In the first part of the manuscript, Tabrizi talks about different artillery tools and projectiles such as different types of time fuses (*māsure*)*, time fuse oil (*roqan-e*

māsure), primer (*taraqe*), artillery portfire (*mahtāb*), flannel saucisson (*rismān-e pan-be*), cannon match (*fatile-ye tup*)***, paper carcass shell (*golule-ye kāqazi*), canvas bag for cannons (*karbās*), priming rod (*six-e tup*)****, rammer (*sombe*), pull rope (*tanāb-e dastkeši*), cannon sponge (*kohnekeš*), handspike (*čubleng*)****, mortar's quadrant (*daraže-ye xompāre*) and gunner's level (*tarāz-e tup*)*****. In the second part of the manu-

* Bundles of flammable, explosive and anti personnel materials.

** Time fuses were used for hollow balls or shells, and not for solid shots. These hollow balls were filled with gunpowder so that they could be exploded into fragments by reaching their target. Early time fuses had a combustible material burning for a period of time before starting to ignite the shell filling. The problem was to measure and record the time precisely. In the 18th century, the «single-fire» was developed after one found out that the windage between the shell and the barrel allowed the flash from the propelling charge to go around the shell. Because of this invention in Europe, one did not need to light the fuse before loading the shell. Around this period, one made time fuses of beech wood by boring and filling them with black powder and cutting them to the necessary lengths. The British also found out a minimum safe length for pre-cut fuse lengths of 4, 4.5 and 5 seconds in 1779 [19, pp. 164, 184-186, 202].

*** In historical contexts, one can differentiate between slow match, black match and quick match. A slow match was made of a hemp or cotton rope saturated with an oxidizer such as potassium nitrate. This type of fuse burned slowly and was used for lighting matches on matchlock guns or fuses on black powder cannons. A black match consists of cotton string coated with dried paste of black powder and glue and was used to fire ancient cannons. A quick match burned very quickly and was a type of black match covered with a loose paper wrap or a pipe and was used in fireworks. For making cotton quick matches for European fireworks see [20, pp. 66-68].

**** A priming iron is a pointed iron rod which is used to clear the touchhole of the pieces of powder or dirt or to pierce the cartridge so that it may catch fire sooner.

***** This functioned as a gunner's handspike like a big pinch bar which was used to manhandle cannon, to move the carriage and to lift the breech of the cannon. This was also called trail of a handspike which was a long stout handspike used in moving the trail of a gun carriage.

***** A gunner's level enabled the artillerymen to elevate a cannon by measuring the level. Similar to a gunner's quadrant, a gunner's level had a plumb bob which provided a reading based on a scale. But the difference was that unlike a gunner's quadrant, it did not need to be inserted into the cannon's mouth and hence exposing the artilleryman to hostile fire. Moreover, it was set up safely at the breech end of the barrel.

script, Tabrizi talks about the rockets such as iron-cased rocket (*fešang-e āhani*), military shell rockets (*fešang-e goluledār-e sarbāzi*), carcass rockets (*fešang-e bigolule*) and grapeshot from military muskets (*sāčme-ye tofang-e sarbāzi*). The third section of the manuscript deals with fireworks and describes the making of different types of fireworks such as star (*setāre*), European mortar (*xompāre-ye urupāi*), firework spinner (*ferfere-ye farangi*), etc.

The following table shows the detailed contents of this manuscript. In the manuscript only the major parts/sections are numbered not the individual chapters as shown in the translation below:

Part one: Artillery

Chapter 1: About producing artillery tools:

Chapter 2: About the mouth of mortars and howitzers.

Chapter 3: About the weight of gunpowder.

Chapter 4: About the weights of projectiles of different cannons based on the weight [system] of eight Abbāsi.

Chapter 5: About making the «time fuse».

Chapter: About cutting the time fuse for different shells that are shot by the mortar.

Chapter 6: About making time fuse oil

Chapter 7: About making the primer.

Chapter 8: About making the portfire of the artillery.

Chapter 9: About weaving the «cannon match» that is woven from the «cotton string [rope] [flannel saucisson]».

Chapter 10: About making the portfire stick.

Chapter 11: About making the «canister shot» of the cannon which has two different types.

Chapter 12: About the raw silk string for sewing the bag and fastening the grapeshots.

Chapter 13: Chapter: About making «paper carcass shells» that is required for lighting at times.

Chapter 14: About the measurements of the «wooden plate of the carcass shell».

Chapter: About the length and width of iron-sheet strakes that are cut for shells.

Chapter 15: About the size of the canvas bag of cannon that is made of «shawl of Kermān».

Chapter 16: About the size of the container for transporting ammunition that is used to transport shells and grapeshots during journeys.

Chapter 17: About the costs of one artillery car of six horses as determined in the Royal Armory of Azarbaijan.

Chapter: About the equipment which is necessary as escort during journeys

Chapter 18: About the «priming rod» that is used to pierce the bag [through the vent] if the primer does not pierce it.

Chapter 19: About making the cannon rammer.

Chapter 20: About «pull rope».

Chapter 21: About cannon sponge.

Chapter 22: About the «handspike» that is used in some cases.

Chapter 23: About the «mortar's quadrant».

Chapter 24: About «gunner's level».

Part Two: About war rockets

Chapter 1: About making rockets that are shot at the enemy during the battle.

Chapter 2: About 6-pounder iron-cased rocket.

Chapter 3: About 1-pounder English rockets.

Chapter 4: About the «military shell rocket».

Chapter 5: About the «carcass rockets».

Chapter 6: About making the «grapeshots from military muskets».

Chapter 7: About sewing [preparing] «military equipment».

Part three: About «artificial firework» and its composition

Chapter 1: About the composition of the star and its composition.

Chapter 2: About making the European mortar.

Chapter 3: About gold-throwing tree.

Chapter 4: About making «octagonal (eight-sided) tree» based on European models that is used during artificial firework.

Chapter 5: About making the pasteboard of four-sided tree with four holes.

Chapter 6: About making the pasteboard and the wood of eight-spoked tree.

Chapter 7: About the «tree with four spokes and Saxon wheels».

Chapter 8: About making «firework tree with candles» with one hundred candles.

Chapter 9: About «flame-throwing tree».

Chapter 10: About making the wood of pišmajles.

Chapter 11: About making the «wooden frame» with high-flying «sky rockets».

Chapter 12: About making the «big wheel»

Chapter 13: About making the «wooden frame for the firework jar».

Chapter 14: About making the «European hat of Iranian style».

Chapter 15: About making the «horizontal wheel».

Chapter 16: About making the «tree with three wooden balks» [which has fourteen triangle or polumna] rockets and six rockets with four openings.

Chapter 17: About making a wooden frame that is called water.

Chapter 18: About making the «wheel with candles».

Chapter 19: About the «wheel in the pattern of Modovov».

Chapter 20: About making the «hat and frock».

Chapter 21: About making Saxon wheels.

Chapter 22: About making European firework spinner.

Chapter 23: About «Iranian mortar» which is made of twenty four sheets of paper.

Chapter 24: About making «sycamore tree».

Chapter 25: About making the «rocket with five woods».

Chapter 26: About the pot and the measure of its composition.

Chapter 27: About flamethrower which is ignited by holding it in the hand.

Chapter 28: About making the «wooden plank of esm» that is used in some firework.

Chapter 29: About the weights of «ingredients of firework».

Chapter 30: About the paper of the pasteboard of firework.

Chapter 31: About making the «moon bowl».

Chapter 32: About the firework moon.

Chapter 33: About the prices of the equipment for making firework.

CONCLUSION

As shown above, there are many Persian manuscripts on different types of firearms. In this article, thirteen Persian manuscripts on firearms were introduced briefly. Three of them, namely a manuscript on casting bronze cannons, *Resālei dar Fešāng* [Treatise on Rockets] and *Resāleye Qurxāne* [Treatise on Arsenal] were discussed more in detail. The whole translated and annotated versions of these texts will be published in the book *Persian Fire and Steel: Historical Firearms of Iran* by the author of the article soon. More detailed analysis of the manuscripts will reveal not only the knowledge of Iranians during the Safavid to the end of the Qajar period about the firearms, but it also reveals the trade relationships between European powers, Russia and Persian at that time and also related Persian terminology on firearms of the period.

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