

Innovation of Mechanical Machinery in Medieval Centuries, Part VI: Non-traditional Weapons

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Abstract

The Islamic civilization paid great attention to mechanical engineering applications in the field of military industries during the medieval centuries. This paper presents the role of the Islamic civilization in building industries for new generation of heavy duty weapons with new applications for sake of victory realization. This covers heavy weapons such as mangonels, cannons and rockets. Their effort served the humanity in reaching the correct proportions of gunpowder in the 13th century AC which led to the manufacturing of bombs, heavy super-cannons, rockets and torpedoes. They succeeded to manufacture submarines in the era of the Ottoman Empire.

Keywords

Non-traditional military weapons - Medieval centuries – Mangonels – Gunpowder - Bombs – Cannons – Rockets - Torpedoes.

I. Introduction

Inventions of weapons have utmost importance in the history of man kind. Muslims contributed to the revolution of heavy artillery and rockets applications during the medieval centuries. They introduced to the world weapons that lift its impact everywhere through their success to make victory. Zidan (1903) strengthened the historical fact Morocco people used the explosive weapons in Sarqusa war in 1118 AC and in the Arabic West by Sultan Abo Yousif in 1273 AC [1]. Aubada (1913) described the different types of the military ships used in the era of Fatimid and next Islamic states and their weapons including heavy weapons such as cannons and catapults [2]. Hindi (1961) described the personal weapons used by the Muslim fighters such as shields, spears and arrows operated by hand or foot and hand-hold bombs. He also described the group-operated weapons such as catapults, ziyar arcs, tanks and cannons [3]. Mahir (1967) stated that Ahmed ibn Tolon , the founder of the Tolonic state (868-905 AC) built a military navy having 1000 units including battleships of 1000 fighter capacity [4]. Al-Abbadi and Salim (1972) showed that Muslims in the medieval centuries were pioneers in building ships for their military navies. They stated that the navy of Caliphate Moawia ibn abi Sofian in 653 AC included 500 military ships used to open Cyprus, the Fatimid navy included 600 units and the Muslim seize of Constantinople in 717 AC was through using 1700 military ships [5]. Hunke (1993) supported the known information about the torpedo origin and that it was invented by Hassan Al-Rammah in 1280 AC and it was driven by rocket engines [6]. Mansour (2002) pointed out that there are three Arabic manuscripts, one in St Petersburg, two in Paris and one in Istanbul written in 1320 AC describing the first portable cannon with gunpowder which is the same as for modern guns. Those cannons were used in the battle of Ain Jalout against the Mongols in 1260 AC [7]. Hussain (2003) mentioned that Sultan Salahiddin (died 1193 AC) used a special engineering troop to set the heavy artillery equipment such as catapults, tanks, heavy bows, and oil artillery. Besides, they developed new type of bows that could shoot arrows in 5 different directions simultaneously [8]. Al- Jazzar (2007) pointed out that the Mamluks produced wheeled cannons in 1349 AC and used it in the battle of Mansoura (1250 AC) and succeeded to produce torpedoes [9]. Hinds (2009) clarified that the work of engineer Hassan Al-Rammah led to creating high grade gunpowder using

purification processes , and he designed the first rocket driven torpedo [10]. Al- Na'san (2012) pointed out that the cannon's expert Al-Rayyash Al-Andalusi (died 1638) wrote an important treatise about war machines and cannons in 1632. He described 32 types of cannons including mortars [11]. Mansour (2012) declared that the Syrian scholar Hassan Al-Rammah (died 1295 AC) wrote a remarkable book on military technology including the first documented rocket where a model of which was exhibited at the National Air and Space Museum in Washington [12]. Al-Nahar (2013) stated that Hassan Al-Rammah was the first scholar to describe the purification of Potassium Nitrate and set the correct proportions of the gunpowder which he used to manufacture torpedoes driven by rocket engines [13]. Hassaan (2014) presented in some details the innovation of some mechanical machinery in the medieval centuries. He covered windmills, water wheels, automatic foundations, water pumps, clocks, robotics, hydraulic control components and feedback control systems [14-16]. Joshi et. Al. (2015) introduced the work of Hassan Al-Rammah that it was the earliest known complete purification process for Potassium Nitrate in his book about military horsemanship and ingenious was devices [17].

II. Mangonels

- Mangonels are heavy group weapons known to different nations long time ago. The Muslims starting using the mangonel in the seize of Al-Taef (in Saudi Arabia) in 629 AC [18].
- It is a mechanical machine used as an artillery for throwing heavy stones and various types of bombs.
- Fig.1 shows a mangonel designed by Hassan Al-Rammah (died 1295 AC) and appeared in his military book 'The horsemanship and showdown' [19].
- The arm of the catapult is pulled through a mechanism consisting of a simple gear train, pulley and heavy ropes.
- It has a flat base for better stability on the ground.



Fig.1: Mangonel of Hassan Al-Rammah [19].

- Another model of catapults is that of Ibn Oronbugha Al-Zardakash (died 1462 AC).
- Alzardakash catapult is shown in Fig.2 [20].
- He named all the parts of the weapon in a 3D-engineering drawing.
- He presented a detailed description of the disassembled parts of the catapult and some assembly drawings with detailed explanation of preparing this weapon for use.
- He invented too many arrows and bombs that can be thrown by the mangonel.
- This model has also a flat base for better stability on the ground.

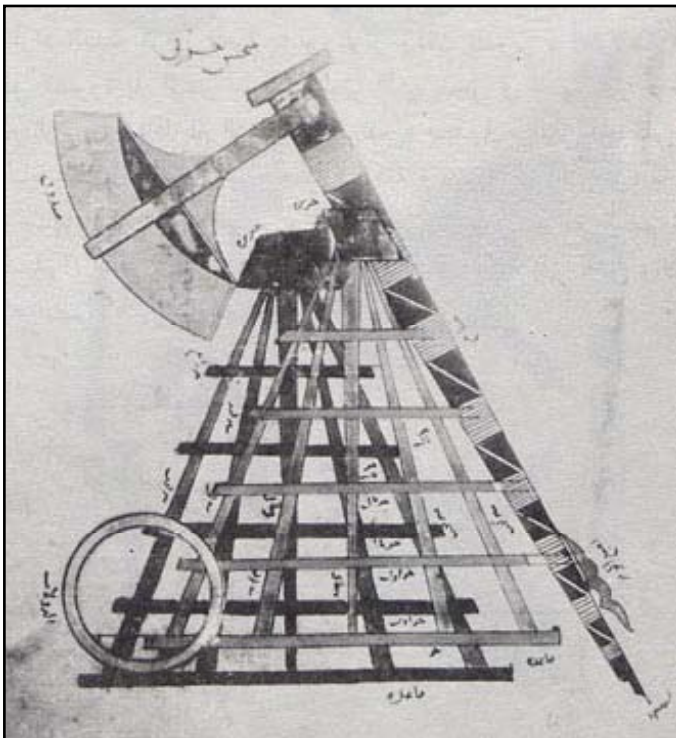


Fig.2: Al-Zardakash mangonel [20].

- Another improved model of the mangonel is the wheeled one shown in Fig.3 [21].

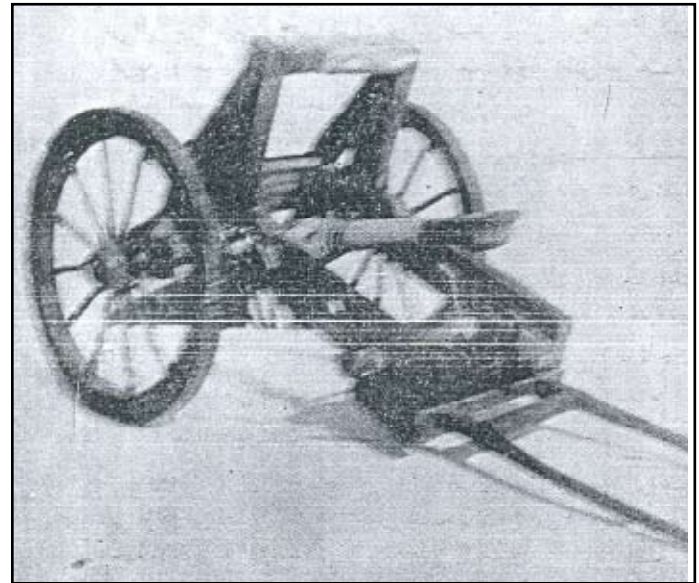


Fig.3: Wheeled mangonel [21].

- It is in display in the Egyptian Military Museum.
- Using wheels makes it easy to move the mangonel to the fighting sites.
- It can be withdrawn using animals.
- The fork-shaped front helps to fix it during use.
- A fourth type of mangonels is called slingshot mangonel. It is shown in Fig.4 [22].

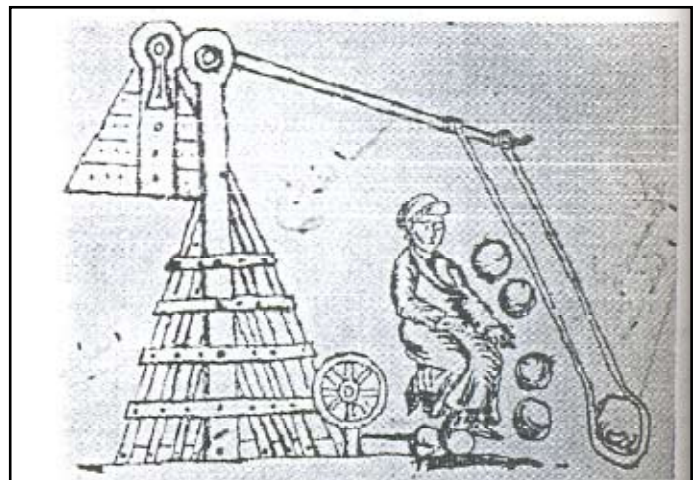


Fig.4: Slingshot mangonel [22].

- In this outstanding engineering design, a sling is added to increase the length between the object centreline and the beam pivot centreline.
- The beam can rotate 360 degrees to ease the assignment of the projectile location upon release.
- This innovative design provides more efficiency of the mangonel in terms of projectile maximum height and maximum horizontal span.

III. Gunpowder

- The invention of gunpowder made a real revolution in weapons industry.
- There is argument between historian scholars about the origin of the gunpowder.
- Some sources said that Chinese alchemists wrote a treatise

- in 1044 AC including formulas for gunpowder [23].
- On the other hand, Prof. Ahmed Al-Hassaan argued that the mixture used by the Chinese was weak and not explosive and the proportions were not the right ones [24].
- Hassan Al-Rammah (died 1295 AC) explained in one of his books the explosive gunpowder and its use [24].
- Al-Rammah presented 107 recipes for gunpowder , 22 of which were for rockets [25].

IV. Bombs

- Muslims in medieval centuries invented various types and sizes of bombs. This was because the need to defend the extended territories of the Islamic Empire in Asia and Africa. On the other hand, their success in establishing the correct proportions of gunpowder helped them a lot in this aspect. Here, I will try to present samples of their bomb types and applications.

(a) Grenade

- A grenade is defined as a small bomb thrown by hand or launched mechanically [26].
- Muslim military forces started using grenades before the 9th century AC. Fig.5 shows an Islamic ceramic grenade from the 6th – 9th AC centuries period [27].



Fig.5: Islamic ceramic grenade [27].

- This type is a burning type since they did not use gunpowder yet.
- It has a 146 mm height and a domed top with opening to load a flammable liquid and wick [27].
- Fig.6 shows another model of Islamic grenades from Khorasan dated 1000 AC [28].



Fig.6: Islamic ceramic grenade from Khorasan [28].

- It is produced from a dark grey ceramic with small wick hole and to be filled with petrol [28].
- The last model is due to the great military engineer Hassan Al-Rammah (13th century AC). The model is one of too many military inventions in his book "Horsemanship and showdown". Al-Rammah grenade is shown in Fig.7 [29].



Fig.7 : Hassaan Al-Rammah grenade [29].

- Al-Rammah grenade is manufactured from pottery and filled with burning materials and has wicks. His design is for a burning and not expulsion grenade.
- Ibn Oronbugha Al-Zardakash (died 1462 AC) was an expert in military manufacturing. He described a number of explosive grenades in his book 'The elegant in mangonel'. Figs.8, 9 and 10 are three grenades of his design:



Fig.8 : Al-Zardakash pottery grenade [30].

- This is a burning grenade in which eight highly flammable gradients are mixed with each other and filled the grenade from a small hole.
- A wick is ignited before throwing the grenade. It will not hurt the user since it is isolated from the grenade burning materials.

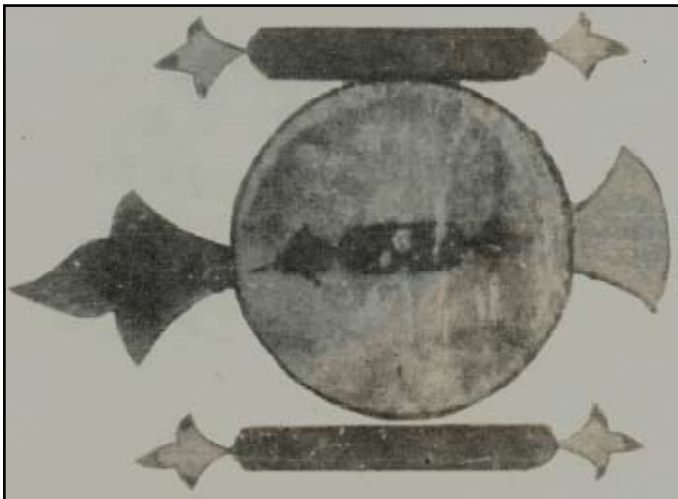


Fig.9 : Al-Zardakash pottery grenade with extra tanks [31].

- In the design of Fig.9, Al-Zardakash as a clever mechanical engineer increases the destruction effect of this grenade through the addition of three extra glass tanks filled with petrol and fixed at the grenade outside surface.
- The grenade main body is from pottery.
- It is of the burning type since 9 highly flammable constituents are mixed with each other to fill the main body of the grenade.
- Two wicks are used to ignite the grenade.



Fig.10: Al-Zardakash glass grenade with hand and chain [32].

- In the genius design of Fig.10, Al_Zardakash used a hand and chain with the grenade at its end to increase its initial throwing speed.
- By this technique he could increase the maximum height and span of the grenade.
- The grenade body is produced from glass and filled with 9 flammable constituents and provided by 7 wicks to ignite the grenade.

(b) Lime bombs

- The Muslim armies used the Lime bombs to make all kinds of troops unstable and unable to see or to breathe.
- Fig.11 shows one of the Lime bombs designed by Ibn Oronbugha Al-Zardakash [33].

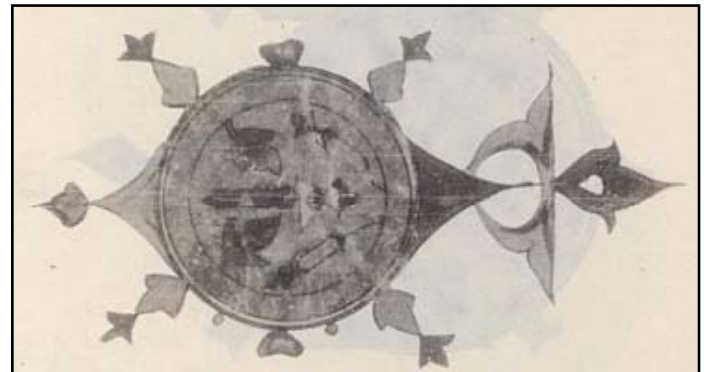


Fig.11 : Al-Zardakash Lime bomb [33].

(c) Biological bombs

- Because they are so genius, they used all the possible local facilities to make victory over their enemies.
- This bomb consists of a very large pottery bottle filled with killing insects such as snakes and scorpions.
- As the bomb is thrown on the enemies, it breaks down and the insects bite the soldiers to kill them.
- This bomb follows throwing the Lime bomb to cause the maximum possible effect on the enemy.
- Fig.12 shows a sample of the biological bomb designed by Al-Zardakash [34].

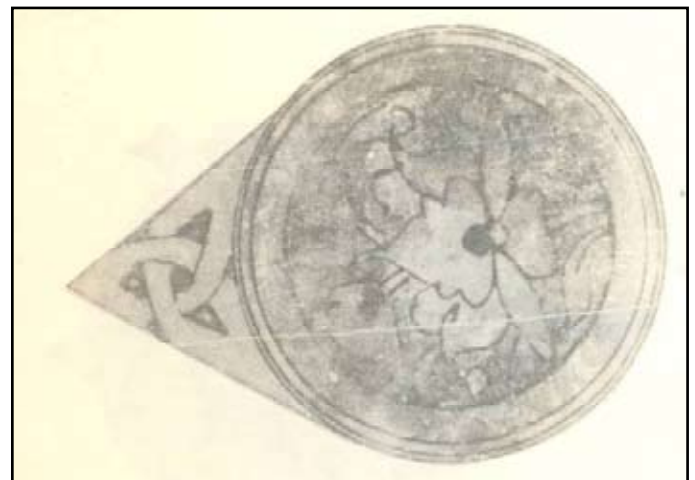


Fig.12 : Al-Zardakash biological bomb [34].

(d) Foetid bombs

- This is a very bad smell bomb thrown by mangonel.
- Al_Zardakash explained one of such foetid bombs with about 13 constituent with their quantities [35].

- His foetid bomb is shown in Fig.13.

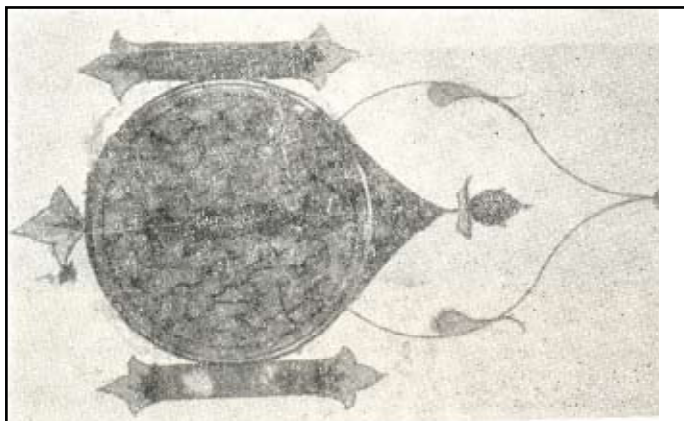


Fig.13 : Al-Zardakash foetid bomb [35].

(e) Collapsing bomb

- According to Dr. Ihsan Hindi, a collapsing bomb is one when hits the ground it explodes automatically and causes collapsing [36].
- Fig.14 shows a collapsing bomb designed by Al-Zardakash [37].

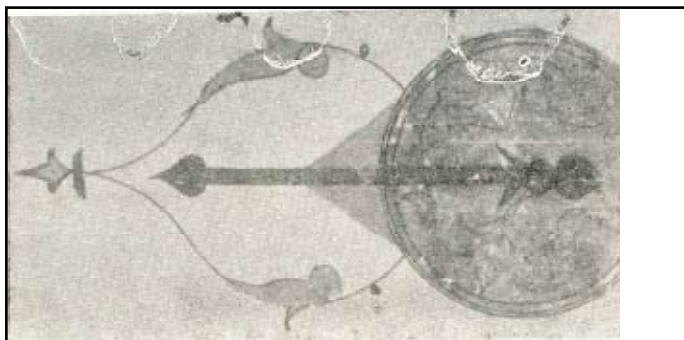


Fig.14: Al-Zardakash collapsing bomb [37].

- The bomb body is manufactured from pottery and filled either with burning materials or with small metallic balls or glass pieces.
- The bomb is driven by a number of rockets.

V. Rockets

- Rockets were invented as a logical step after the success of the Islamic states to use gunpowder in the military applications.
- Mamluks were the first state in the middle east to use cannons against the crusaders in the battle of Mansoura in 1250 AC [38].
- It has been recognized that Islamic cannons were used in the battle of Ein-Jalut between Mamluks and Mongol in 1260 AC [39].
- The Mamluks invented the wheeled cannons in 1349 AC [40].
- Sultan Mohammed II of Ottoman Empire used 68 giant cannons in the seize of Constantinople in 1453 AC [41].
- The Moroccans used 12 ton brass cannons against the Portuguese in 1534 in the battle of Asfy liberation [42].
- Al-Rayyash Al-Andalusi described in 1632 about 32 type of cannons including mortars [11].

(a) Mamluks cannons:

- Fig.15 shows two models of Sultan Qaitbay (died 1496) cannons [43].

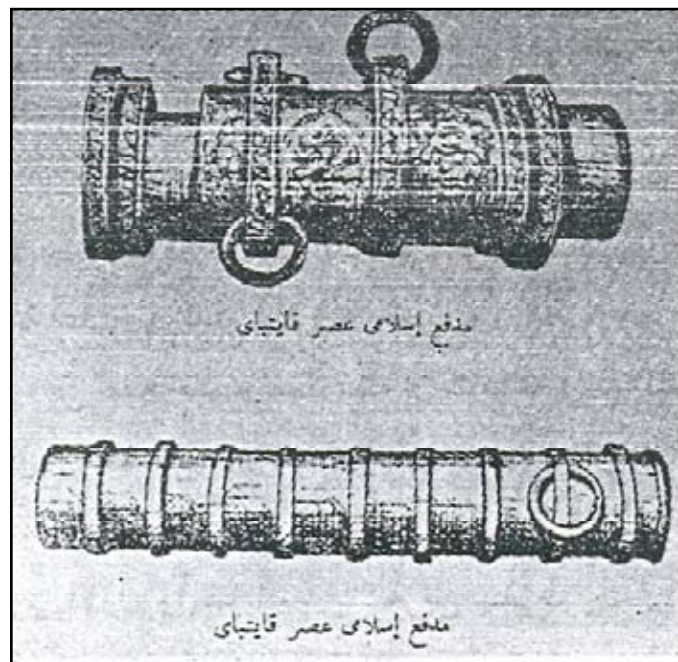


Fig.15 : Cannons from Qaitbay era [43].

- The cannons were manufactured by Ibrahim Al-Halabi in 1463.
 - It has the specifications [44]:
- | | | |
|------------------|------|-----|
| Length: | 2.85 | m |
| Barrel hole: | 1.85 | m |
| Mass: | 7.73 | ton |
| Projectile mass: | 180 | kg |

(b) Ottoman cannons

- Fig.16 shows a super-cannon of Sultan Mohammed the conqueror of Constantinople [45].
- It is now in the London tower.



Fig.16 : Mohammed the conquered cannon [45].

- Specifications [41,45]:
- | | |
|------------------|---------------|
| Material: | Casted bronze |
| Length: | 7.9 m |
| Mass: | 20 ton |
| Projectile mass: | 544 kg |

- One more model is that known as the Dardanelles gun shown in Fig.17 [46].



Fig.17 : The Ottoman Dardanelles gun [46].

- It consists of two parts threaded with each other.
- It was produced in 1464 by Munir Ali's foundry.
- It is in display at the superb Royal Armories Museum, Portsmouth, UK.

(c) Morocco cannons

- Morocco produced in 1534 a super-cannon to protect its peaches against the attacks of Portuguese and Spanish.
- A model of this cannon is shown in Fig.18 [47].

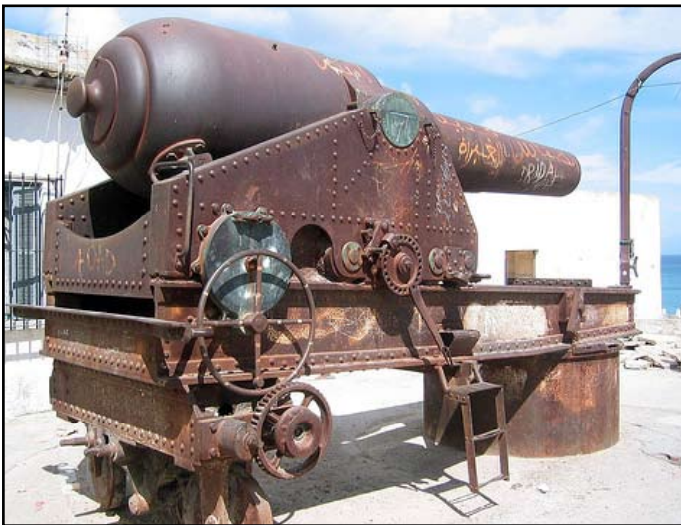


Fig.18 : The Maimuna cannon of Morocco [47].

- Specifications [42]:

Material:	Brass	
Length:	5	m
Mass:	12	ton
Range:	1	km

(d) Al-Rayyash cannons

- I devote this section to Al-Rayyash Al-Andalusi who died in 1638 because of his design of 32 types of cannons in his book about the war machines and cannons.
- He is called Al-Andalusi because he was from Andalus, and when it was fallen completely in the hands of Spaniards he immigrated to the Arabic west where he died in Tunisia [11].
- One of Al-Rayyash cannons as drawn in his book is shown in Fig.19 [48].

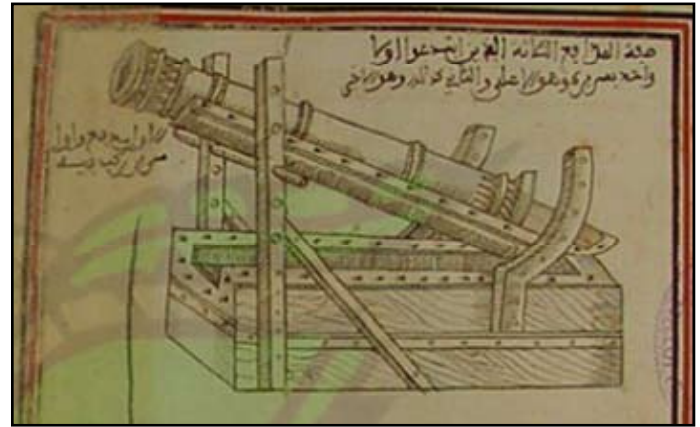


Fig.19 : One of Al-Rayyash Al-Andalusi cannons [48].

- The cannon is supported by a non-wheeled base.
- A protractor scale fixed at both sides of the base to adjust the orientation of the barrel.
- Two perforated columns and a bar are used to set the barrel in the desired position.
- Another type of Al-Rayyash cannons is the wheeled cannon shown in Fig.20 [49].



Fig. 20 : Al-Rayyash Al-Andalusi wheeled cannon [49].

- It has two wheels.
- The back structure helps to stabilize the cannon upon firing.

VI. Rockets

- A rocket is defined as a cylindrical projectile that can be propelled to a great height or distance by the combustion of its contents, used typically as a firework [50].
- Muslims were the first people to use rockets before the West as military weapons [51].
- The history will recognize great names in building military rockets such as Hassan Al-Rammah of the 13th century AC and Ibn Oronbugha Al-Zardakash of the 15th century.

(a) Al-Rammah rocket

- Fig.21 shows Al-Rammah rocket as appeared in one of his treatises [52].



Fig.21 : Hassaan Al-Rammah rocket [52].

- It consists of a cylinder (rocker body), concentric rod carrying a burning bomb and a number of rocket engines on the circumference of the rocket body.

(b) Al-Zardakash rockets

- There are different models and applications of Al-Zardakash rockets.
- Three samples of Al_Zardaksh will be shown:

Model 1: Rocket carrying a burning head (Fig.22) [53]

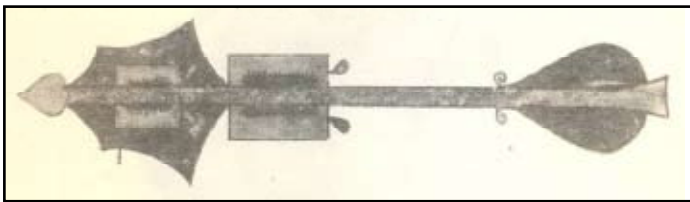


Fig. 22 : Al-Zardakash rocket with a burning head [53]

- The rocket is propelled by six rocket engines surrounding the rocket body.
- It has a number of fins at its end.
- I carries a burning head having seven constituents.
- There is one wick ignited before launching the rocket.

Model 2: Rocket carrying an explosive head (Fig.23) [54]



Fig. 23 : Al-Zardakash rocket with an explosive head [54].

- There is one rocket engine shown.
- The explosive head at the rocket front and the engine use explosive materials.
- His explosive mixture consists of gunpowder, coke and sulfur.
- The author assigned the right proportions used in this application.

Model 3: Rocket application: Number of rockets driving a giant collapsing bomb (Fig.14) [37]

- The collapsing bomb has a great destruction capacity.

VII. Torpedoes

- According to Oxford Dictionaries, a torpedo is defined as a self-propelled underwater missile designed to be fired from a ship or submarine or dropped into the water from an aircraft and to explode on reaching a target [55].
- A torpedo was designed and implemented by the Syrian scientist Hassan Al-Rammah [6,10,13,56].
- Al-Rammah torpedo is shown in Fig.24 as appears in his manuscript about horsemanship and showdown [57].

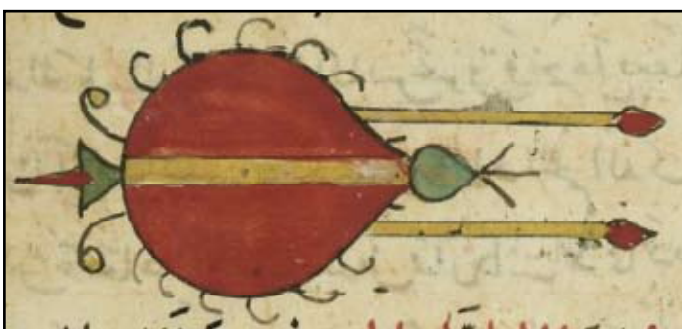


Fig.24 : Al_Rammah torpedo [57].

- He called it the 'crazy pilot' and its body takes the shape of an egg.
- The body is surrounded by curved fins in a direction not to resist the torpedo rush over the water surface.
- It is propelled by two rockets.
- It depended on using explosive compound from gunpowder, coke and sulfur.

VIII. Submarines [58, 59]

- It was reported that Ibrahim Afandi the chief engineer of the imperial factory of ships in the Supreme Astana has manufactured the first Ottoman submarine in 1719.
- This was in the era of Sultan Ahmed III.
- It was produced from steel and could carry human being.
- This was before the American scientist who built the first American submarine in 1776.
- Fig.23 shows a historical photo of Ibrahim Afandi submarine with some solders in front of it [59].



Fig.25 : Ibrahim Afandi submarine [59].

IX. Conclusions

- The Muslim scientists and engineers established an outstanding military revolution in the medieval centuries.
- They improved and invented heavy artillery weapons.
- They improved the design of known mangonels and added new applications to it to increase its destructive capacity.
- They could produce gunpowder in the 13th century AC with correct proportions as known nowadays.
- They succeeded to use the gunpowder to produce highly destructive weapons such as superguns, rockets and torpedoes.
- They could manufacture cannons as heavy as 20 ton with firing span up to 1 km.
- Military rockets were completely an Islamic invention used to destroy their enemies in a number of famous battles.
- Hassan Al-Rammah invented the military torpedo in the 13th century AC..
- The first submarine in the world appeared in the Ottoman Empire in 1719.

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