Journal of Science and Knowledge Horizons
ISSN 2800-1273-EISSN 2830-8379

The history of Mnjanah clock in the Islamic Magreb during the Middel Ages

1Bouaroua Bakir ,university ghardaia (Algeria) *, bouaroua.bakir@univ-ghardaia.dz
4 https://orcid.org/0009-0009-3448-7404

Date of send: 20 / 04 / 2024	date of acceptance: 29 / 05 /2024	Date of Publication: 30/06/2024

Abstract:

The research is concerned with dealing with the history of the calendar and time calculation in the Islamic Maghreb, through the use of the Mnjanah instrument. The research begins by studying quick glimpses of the tools of ancient civilizations, and how they were transferred to the Greater Islamic Maghreb, then we study the most important names of the machines through various sources and references, and we discuss the Eastern and Maghriban machines, and the way they work, as their driving energy varies from one clock machine to another, as some of them move through water or air or that move through sand and even through mercury. From there, we discuss the Andalusian Mnjanahs, their most prominent types, and their most important and famous makers, and then we move on to the temporal Mnjanahs of the far Maghreb in the Zayani and Hafsid eras.

Keywords: Manjanh ;Time; Clock ; Manufacture ; Islamic Maghreb; Maghriban machines; clock machine

***Bouaroua Bakir**

Summary:

The research is concerned with dealing with the history of the calendar and time calculation in the Islamic Maghreb, through the use of the Mnjanah instrument. The research begins by studying quick glimpses of the tools of ancient civilizations, and how they were transferred to the Greater Islamic Maghreb (the Middle Maghreb "Algeria", the Far East "Morocco", and Andalusia), and this is through Scientific cultural communication, then we study the most important names of the machines through various sources and references, and we discuss the Eastern and Maghriban machines, and the way they work, as their driving energy varies from one clock machine to another, as some of them move through water or air or that move through sand and even through mercury. From there, we discuss the Andalusian Mnjanahs, their most prominent types, and their most important and famous makers, and then we move on to the temporal Mnjanahs of the far Maghreb in the Zayani and Hafsid eras, and we focus on those mentioned in the source books, and perhaps the most important of them are: the Mnjanah of the Kutubiyyin Mosque, Al-Qarawiyyin, and clocks by very famous scholars such as Al-Qarastouni's Clock, Al-Fasiyah by Ibn Al-Fahham, Al-Lajja'i Clock, and Al-Shama'in Market Mnjanah.

Finally, we move to the land of the Central Maghreb to study the Zayani Mnjanah, and we discuss some of its most prominent men, such as: Ibn al-Fahham, who is the most prominent and famous maker, and from there we discuss the method of making the Zayani Mnjanah and the interpretation of its movement through the source texts in an attempt to understand how it works.

We can reach some important conclusions, such as:

The Maghribans in the countries of the Islamic Maghreb in the Middle Ages contributed to the development of time calculation in a distinctive way. After taking its basic principles from the land of the Islamic East, they contributed to the development of this science, and they manufactured complex time machines for calculating time, the most prominent of which is the Mnjanah device, which appeared significantly in the courts of the rulers. In the land of the Islamic Maghreb, which shows the support of the rulers and their interest in its industry, the Maghribans developed in this field to the point that they sometimes surpassed the the easterns, and this is as confirmed by the inimitable Andalusian scholar Ibn Khalaf Al-Muradi.

Introduction :

Humans have been interested in calculating time since ancient times. Research has shown the interest of ancient civilizations in calculating time and determining periods in order to organize different human activities. Different time machines gradually appeared, and they were operated by various means and energies available through the shadow of the sun, using sand, and also mercury and water. The shapes of these clocks have developed due to the sciences of engineering and tricks until they have become a huge form in size and hugeness, and they are used in various seasons and at times of the day and night. Similar to the countries of the Islamic East, the land of the Maghreb has witnessed important developments in this field, and the local Mnjanah has formed a distinctive form in it. To the development and emergence of clocks, time calculation and calendar.

In the Middle Ages, there were fine engineering industries in the Islamic Maghreb based on the science of tricks, as well as strange artifacts such as the wondrous tree of Ibn Tashfin, the strange chicken, the illuminated lantern, and the transportation of structures using well-dressed clothes. However, the origin of the books of tricks did not have clear indications, as is the case in the land of the East. Ibn Khaldun mentioned the book of the sons of Musa al-Mashriqi and al-Jazari, and the book al-Bahir fi Aja'ib al-Hail by Abu Aamir al-Andalusi, and he mentioned that it was within people's reach in his time without detailing it, certainly due to lack of specialization (Ibn Khaldun, 1988 AD, p. 539), which led some of them to conclude that The sciences of tricks were in the Islamic Maghreb inspired by the East.

A glimpse into pre-Islamic Mnjanahs :

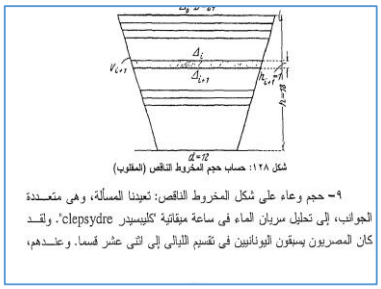
The Mikata (timekeeper) is an ancient cultural invention in its origin, as it is attributed to the ancient Egyptians, Greeks, Indians, and Egyptians, and this is before it was transmitted to the Greeks. It was stated in Shifa' al-Ghaleel what it says: "Binkam", a Greek word for what the star hour is estimated from the sand. It is the Arabic of the people of the time and the masters of the situation (Al-Khafaji, 1998, p. 94).

This invention was also known to Christians. Yaqut al-Hamwi mentioned the Antioch clock similar to the shape of a Mnjanah, saying: "On one of the doors of this church is a clock cup that works day and night, always twelve hours, and it is one of the wonders of the world" (Al-Hamwi, 1995, p. 267).

> As for Al-Qazwini, he described the Constantinople Clock, saying: "With it is the Cup of Hours: there are twelve doors in it, each door has a shutter an inch long, according to the number of hours. Whenever an hour of the night or day passes, a door opens and a person comes out of it, and he does not remain standing until the hour is completed. At

that time, that person entered and closed the door, and another door opened and another person came out of it in this example (D.S., 605).

Also, many water clocks were known in Iran, the Al-Mustansiriya Clock in Baghdad, the Giron Clock of Damascus, Egypt in Cairo, and of course also in the Islamic Maghreb, and we will focus on them as they are the subject of our study.



شكل ١٢٨: حساب حجم المخروط الناقص (المقلوب)

٩- حجم وعاء على شكل المخروط الناقص: تعيدنا المسألة، وهى متعـددة الجوانب، إلى تحليل سريان الماء فى ساعة ميقاتية 'كليبسيدر clepsydre'. ولقـد كان المصريون يسبقون اليونانيين فى تقسيم الليالى إلى اثنى عشر قسما. وعنـدهم،

Then, in the context of translation, the bankam was transmitted to the Muslims, so that the form adopted by Al-Jazari is noted to be somewhat inspired by the ancient Egyptian bankam (Theophile, 2008, p. 255).

Some types of these clocks are still in operation. Al-Shidyaq (2014, 28) mentioned their existence in the 19th century, when he noticed them in the greatest church called “Sun Joan” in Malta, which is “in the form of a church bell in the form of a clock, with which people control their affairs when they hear it.” Its beats (Echidiaq 2017, December 28)

Shawqi Dhaif writes about the Swiss clock, and compares it to the clock of Ibn al-Fahham al-Tilmisani, saying: Whoever visits the city of Bern, the capital of Switzerland, his Swiss escort will take him before 12 o’clock to the scene of a large clock installed on a tall tower, and in the upper part of it is a clown ringing two bells just before the clock rings its bell, announcing 12, and immediately A rooster crows on the left and moves one of his wings. Facing him is a statue of a lion still moving his head, a statue of a mayor moving his staff, and a group of bears circling around. At exactly 12 o’clock, the clock strikes and the rooster crows and moves one of its wings as if it is about to fly. This Swiss watch, which the Swiss are proud of having been invented by one of their citizens in the year 1530 AD, is neither more wonderful nor more innovative than the watch of Ibn al-Fahham, which he invented a century and a half before, which indicates his keen intelligence on the one hand and perhaps the well-being of the Algerians in Tlemcen on the other hand (1995, vol. 10, p.: 64).

The Maghribans learned the arts of tricks and watchmaking from Andalusia, and worked so hard that they sometimes surpassed their oriental masters. For example, in the chapter on oriental excellence, we mention here Fakhr al-Din Radwan bin al-Saati, who wrote a book in the year 600 AH, in which he mentioned his father’s clocks, numbering 112 clocks, and described them accurately, and mentioned how they are made, how they are added to their sister instruments, how they become faulty, and how they are then repaired. The researcher Muhammad Ahmad Dahman wrote a book about him that he investigated but did not publish, and he passed away in Damascus in 1988 AD. The most famous of them, of course, is the famous Al-Jazari (d. 607 AH), who left a description of ten hours, but it

appears that Khalaf Al-Muradi surpassed him, as he left thirty-one pictures in a perforated manuscript. Only 40 percent of it remains (Bouarwa, 2009, 188), which indicates the strength of the Moroccans despite their lack of writing skills.

Names of the Mnjanahs clock:

It is important to get to know the majanana, and perhaps the most important step is to define its term, and learn about the derivatives of its name, so that we can identify its essence through sources and references, compare knowledge, criticize the data, and analyze it, especially since the names of the synonymous majanana are many; Among them are: - Al-Mandala (Al-Wansharisi, 1990, vol. 2, 464), - Al-Badr, - Al-Mizan for knowing the times, - Al-Mikana, - Al-Manqala, - Al-Banqam (Ibn Rasheq, 1981, vol. 2, p. 300), - Al-Banqan Al-Farisi, - Al-Miqatah (Habush, 1991, 22) Among the types of miqats we find: the famous miqatah in Damascus, also called: Al-Mankab, which is sandy (Timur, 2002, vol. 5, 406), and mentioned by Al-Jabarti (Douzi, 2000, vol. 10, 118), and it is also known as: maqana; The status of i.e. magana and Magana (Dozy, 1981, p. 617), and of course the famous name, which is Al-Mangana (Al-Muqri, 1997, vol. 4, p. 599).

As for its name in Turkish, it is: Menkjali: which is the same word as the previous one, with the Turkish addition “ji” added to it (Dozi, 2000 AD, vol. 10, 118). It is also known as the ticking clock as Pasha Mubarak said, and Al-Qalqashandi is unique in calling it Al-Bajjani (Al-Qalqashandi, 2012, vol. 5, 162).

The words Manqana and Manjanah are Persian in origin, as Douzi confirms, and their root is bankakaan, پانگان, so Arabicized bankam, which is what Haji Khalifa confirmed in Kashf al-Zunun, and from it came the science of bankamat.

The bankan instrument consists of a copper vessel in the shape of a cup, 160 cm long and 30 cm in diameter. It is what some of them call “the bath pot,” in which water is boiled for washing, and at the bottom of it is a small body the size of a rosary, from which water comes out in a specified amount into another barrel called a Taffaf or Fawasha.

Hence, the later people came and transferred the benkam to the glass hourglass, which is in the form of two cups, with the sand branching from one to the other. Maghriban still call the wristwatch “manjana” and “mangala” and “maqana,” in addition to “mangala” among the Berbers, and another group calls it a cup, and this was mentioned by Yaqut. Al-Hamwi (Douzi, 2000, vol. 8, 123).

The origin of the manganat of the Islamic Maghreb :

The Mnjanah is a time machine and was made by many Maghribans, Andalusians, and even the The mangala is a time machine and was made by many Maghribans, Andalusians, and even the orientals. The mangala clock is still known to this day in the countries of Tunisia, Algeria, and Morocco.. The Mnjanah clock is still known to this day in the countries of Tunisia, Algeria, and Morocco.

In fact, the Maghribans did not leave much literature on the making of Mnjanah, this science that falls under what is known as the science of weights and tricks. However, they left us either traces that remain alive, or through various historical sources and references (Batiwi, 2017, 107), even if the sources do not It is mentioned about how it was transmitted to Morocco, but the origin of the idea of the Mnjanah in the land of the Islamic Maghreb is the wondrous tree of Ibn Tashfin I (718-737 AH / 1318-1337 AD). It is one of the things made with mechanical tricks - as Al-Tansi mentioned - from a tree, and it was mentioned by Yahya bin Khaldun (d. : 780 AH/1387 AD), and on its branches there are many types of chirping birds made of silver studded with jewels (Ibn al-Sabah, 2011, p. 45-46, p.) And the highest of them is a falcon. If the tree is blown, the birds will chirp with their well-known voice, until the air reaches the falcon. Those birds fell silent (Al-Tansi, 2011, p. 141), and it is similar to the tree that Al-Muqtadir Al-Abbasi presented to the Roman ambassador when he received him in the year (103 AH / 736 AD) (Al-Jilali, 2014, 251).

Andalusian Mnjanah:

The watch industry has witnessed development in Andalusia, and its types include dials and marbles known as slabs (Rashed, 1996, p. 164). There are two Toledo clocks known as the Toledo watches by their owner Al-Zarqali. Andalusia witnessed a leap in this industry with Ibn Khalaf Al-Muradi, who wrote a book on the subject and called it: : The Book of Secrets in the Results of Thoughts, in which he placed 31 devices that move with water and mercury, and it contains various statues and wheels that move at a known rate to determine time (Bouarwa, 2009, p. 187).

Mnjanah in Andalusia is a scientific breakthrough. Many Andalusians made it, including: 1): Abbas Ibn Firnas, 2): Ibn al-Saffar, 3): Ibn al-Aadmi, 4): Ibn al-Zarqala, 5): Ibn Khalaf al-Muradi, 6): Ali al-Maliki al-Andalusi (Al-Babani, 1992, Part 4, 712).

1): Abbas Ibn Firnas (d. 274 AH/887 AD) :

He was known for inventing the admired limbالطرف المعجبة , and Asbagh, the head of the carpenters in the palace, helped him in making it (Al-Kattani, 1981, 293), and he was called the wise of Andalusia (Al-Muqri, 1997, 347). He was an outstanding of his group with an abundance of tools and arts. He was a loyaliste of the Umayyads and his home was in the barbarians of Takarna, and he was a skilled philosopher. He was a poet with knowledge of astrology, and he was the first in Andalusia to invent the manufacture of glass from stones and the first to decipher the Book of Offerings by Hebron. He was the owner of fire engines, a great inventor and resourceful, to the extent that magic and the work of chemistry were attributed to him. He was often criticized for his religion, and he deceived himself in flying his corpse, so he covered himself with feathers on a scarf. The

silk was prepared for it to fly into the air from the direction of Rusafa, and it took hold in the air and soared in it until it fell at a long distance (Bin Saeed, 1995, vol. 1, p. 333).

As for his watch, he used the branch of trickery to make it. He made the Mincana (Samso, 1990, p1300) or the Clepsydre (Laplace, 1863, 68) to calculate time. He gave it to the Umayyad prince Muhammad ibn Abd al-Rahman (238-273 AH) in Cordoba, and when he completed it He wrote the following verses:

Indeed, I am the best tool for religion
if you miss the time for every prayer.
And you did not see the sun of the day,
nor did you see the stars of a dark night
By the oath of the Imam of the Muslims, Muhammad,
the times of every prayer were revealed (Hunka, 1993, 124).

He also made an astronomical instrument called the Dhat al-Halaq, which represents the spheres and the celestial dome of the Andalusian prince Abu Abd al-Rahman al-Awsat (176-238 AH/792-852 AD), and it appears that it became a model to be followed for making instruments even in the Maghreb, in the 5th century AH/11 AD) (University, 1997, p. 119), and it is based on calculating and measuring the degrees of the shadow and its angles, which represent the prevailing division of time. As for its shape, it is: circular divided into equal distances. It inspired those who came after it to make accurate water, mercury, or solar clocks, and the Honka call it: clock The Journey (Honke, 1993, pp. 141-142).

As for the rest, I only found mention of their names as Manjanahs makers, without mentioning the details, based on what I came across in the various sources or references.

Types of Mnjanahs through sources and their driving energy :

The Mnjanahs may be operated by water, as narrated by Ibn Jubayr Al-Andalusi and confirmed by Julio Samso (Al-Jayyousi, 1999, 1300). There are water clocks that are placed on running surfaces, and others that regularly dip their rollers with pots into water tanks, so the rollers move the clock.

Al-Ghazali divided The Mnjanahs into two main types:

1: A fixed, non-mobile type, such as that described by Ibn Jubair

2: A portable type with a size of 1.5 square meters, and kings used to give it as gifts, such as the watch that Harun al-Rashid gave to King Charlemagne, Emperor of France.

However, various Mnjanahs have been found that run on energy other than water. In general, the name of the Mnjanahs is given to a time calculating machine, and it has different shapes, including:

Small and large machines, the purpose of which is to recognize the passing time clocks, and they canويمكن ، تمر التي الزمانية 5 ص

We divide the types of manganese into the following:
1- Al-Mnjanah Al-Jalasiya: One of its characteristics is that it is a long type with weights that descend to the ground.
2-Mnjanaht Al-Hayt: One of its characteristics is that it is of the type that sticks to the walls.
3- Mnjanaht Al-Shun: One of its characteristics is that it is of the hidden type that is hidden in the pockets.
4- Mnjanaht El yad: One of its characteristics is that it is of the type that is fixed to the wrist.
What we can deduce from this division is that the driving energy varies from one Mnjanah to another, and from here we conclude that there is a tool that moves with sand, as Al-Muqri said, or in El Quawamis (Ibrahim, 2004, p. 71), and from that the following verse has emerged that makes the tool move with sand.
The poet Lisan al-Din al-Khatib al-Andalusi said in Mnjanaht al-Raml:
The Mnjanah of sand is a lesson and a wisdom
And the evidence is that everything is finished
The heart of a boy's life runs with her running
It was as if a lifetime had passed when it was released
(Al-Salmani, 2003, p324)
When I improvised that, those present spoke more and said:
He looked at the sand in Mnjanah it he started
Its destiny is a lifetime that ends with you
By God, if the sand valley could supply it
It was of no use until they were gone
(Al-Muqri, 2003, vol. 1, 309)
There are clocks that run in the shadows, as historian Ihsan Abbas narrates, with reference to the timekeeper of Ibn Firnas, which shows that he - an artist craftsman - excelled in making various clocks that run using various natural resources, such as shade and sand (Bouarwa, 2009, 174), which are types of sundial.
Maghriban Mnjanahs (Morocco)

The Mnjanah of the Kutubiyin Mosque

In the minaret of the Koutubian Mosque in Marrakesh, which was built in the time of the Almohads and after the fall of Marrakesh, we find a tall minaret measuring 110 cubits of stone. It is a wondrous and enormous minaret, as described by Ibn Battuta (1996, vol. 4, p. 299). On the door of its mosque are time clocks that rise fifty cubits in the air. It has a function similar to a ticking clock, and it is called The Mnjanah. At the end of each hour, a cymbal weighing one hundred dirhams comes down, moving bells with a loud voice that can be heard from afar. However, in the time of the writer, it was idle and did not work or rotate (Al-

Qurashi, 2003, vol. 4, 197). I wonder if she regained her movement after that or not?

Al-Qarawiyyin Mnjanah

History books have preserved that the first person to build a time clock in Al-Qarawiyyin was Abu Bakr Al-Zanati in the year 345 AH, and it is known in documents as Hawalat al-Habsiya or as Hajjat al-Waqf, and this is the time of the death of Sultan Yaqoub bin Abdul Haqq (d. 1286 AD).

Sultan Muhammad bin Abdullah Abu Marouf (d. 642 AH / 1244 AD) borrowed the astrolabe of the Al-Qarawiyyin Mosque and made two models, one of which he gave as a gift to the Mosque of Fez, and the other to the Andalusian Mosque. The original was returned with the timeekiper Ali bin Yusuf to Al-Qarawiyyin, and he had a "with an engraving" smithy containing 12 craftsmanship, including: The course of the moon, and the number of days of the lunar and Gregorian month, and this instrument is called: with engravings; To indicate a Moroccan scientific instrument. It was seized by Judge Abdelkader Boukhris, along with the muhtasib Hajj Abdelhakim, who handed it over to the caretakers of the al-Qarawiyyin hermitage on the tenth of Rabi' al-Thani, 1177 AH (Al-Aghhi, 1962, vol. 9, p. 40).

The clock of Ibn al-Fahham (685 AH/1287 AD)

The water clock was made by Ibn al-Fahham al-Tilmisani in the year 685 AH/1287 AD, and this was at the suggestion of the jurist and judge of Fez, Abu Abdullah Muhammad bin Abi al-Sabr Ayoub bin Kannoun. He made a water clock that ran at night and during the day, in clouds and in the clear, similar to the clock of the Mustansiriya school in Baghdad, so he made it from pottery. The brass in the second minaret of the minaret, and water fills a basin to a certain amount, indicating in its lines to know all the times, including the times of prayers. What distinguishes it is that it was small in size and simpler in structure, as if it were a wristwatch for its era, as it was possible to move it from one place to another (Al-Tazi, 2000, Part 2, p. 323), and the clock is pottery that runs on water, and has copper lines indicating the hours that passed during the night and day. It was said that it was made of ceramic in a shape that resembled a kitchen oven at that time, and the way it worked was with water, as we find a quantity of it on the face of a copper plate. In the form of a basin with holes and strings, water comes out of the holes in a limited amount until it reaches the marked lines that indicate the time hours, thus knowing the times of prayers during cloudy weather, and the device is currently obsolete (Al-Manouni, 2000, 352).

The clock of Abu Abdullah Al-Sanhaji Al-Qarastouni (717 AH / 1317 AD)

There is a water clock of Abu Abdullah Muhammad bin Abdullah Al-Sanhaji, during the time of the Marinid Sultan Abu Saeed Othman bin Yaqoub (1310-1331 AD), after it was drawn for him by Muhammad bin Al-Sadiniyya Al-Qurtassouni

thanks to his use of the science of drawing (which is the subject of planning astronomical instruments). The science of drawing is a branch of Astronomy, which includes, in addition to drawing; Adjustment (calendar), meeqat, and astrology. As described by Carlo Nellino, some benefactors donated to it in the year (717 AH/1317 AD). It was located inside a room overlooking the door of the aforementioned Zenat hermitage and time. Its components were cedar wood, pottery vessels, and copper pipes through which water flowed, and inside it were graduated lines to measure time. The writer of Myrtle Flower mentions a strange way of making it, saying: They placed a screen of cedar wood in one of the rooms, and inside it two pottery bodies, one higher than the other, and put water at the top of them, and at the bottom of them a copper tube covered with gold, into which water descends in a limited amount. He made " The inside of the branch is hollow" On both sides of the branch, he drew zodiac signs, the Gregorian months, hours and their minutes, and in the middle of it was a ruler on which the hours and their minutes and the times of night and day were drawn. This ruler hung outside the branche, ascending and descending in that hollow, and at the bottom was a hollow copper body in the shape of a "citrus." ", hanging from the side of the "Glory", and at the moment the water rises from the lower body to the top, the ruler moves and shows the required time. When night and day complete, the instrument returns to its original state for calculating time.

The matter continued like this until Abu Abdullah Muhammad bin Muhammad bin Al-Arabi came to organize its affairs, and he renewed it in 747 in the year 1346 AD, where he mastered its manufacture better than its predecessor during the time of Caliph Abu Anan Al-Mutawakkil, where he added valuable additions to it, as he added to it an astrolabe grid from which he knew the times of day and night, and placed with it Hourglasses and a set of astrolabes for calculating time (Al-Jaznai, 1991, pp. 51-52), and some of its remains are still buried near the cave of Manar Al-Qarawiyyin (Al-Manouni, 2000, 359).

In the year 749 AD, Caliph Abu Anan (1348-1385 AD) ascended the minaret and saw the Mnjanah, so he ordered that it be occupied. Ibn Anan was interested in religious rituals, and one of the most beautiful rare ones is the following: He ordered the installation of a wooden pole at the top of the minaret in Al-Qarawiyyin after his visit to this minaret, with a flag spread over it. The times of daytime prayers, and the installation of a lantern (lighthouse) with a flowering lamp that is lit during the night prayers. He said - as he dictated his instructions regarding this installation, explaining his action - in order to prove this from afar and those who did not hear the call, and he mentioned that he placed a blue flag in the minaret to warn of Friday prayer (Al-Salawi , 1997, vol. 3, 206), and a white flag for daytime prayers (Al-Jaznai, 1991, p. 31).

Manjanat al-Fassiya by Ibn al-Fahham (758 AH/1357 AD)

Abu Anan al-Marini's (1348-1385 AD) interest in time prompted him to manufacture a copper minjarah in Fez (Al-Jazna'i, 1991, p. 40). It was called the Fasiya by the modified timer Ali bin Ahmad al-Tilmisani in the year 758 AH (Ibn al-Qadi, 1993, p. 31). It works with gears connected to a large mill driven by water flowing beneath the clock (Al-Jarari, 1961, p. 23).

It is composed of copper hoops and bowls, and it corresponds to his new school in the city of Fez, in the palace market, known as Al-Mutawakkiliyah, known today as the Bou-Inaniya school, and the hoops and bowls (Benabdallah, 1983, 235) exist until today, as the investigator Abdel-Wahhab bin Mansour said.

The work of the manjanah is that at every hour of the day, the cymbal falls into a bowl and opens into a string, and it remained like this until the date of the fourteenth of Jumada al-Awwal of the year 785 AH (Al-Jaznai, 1991, p. 56).

The Clock of Al-Luja'i (763 AH/1361 AD)

A water clock invented by Abu Zaid Abd al-Rahman bin Salim al-Lajja'i (d. 763 AH/1361 AD). He made it on 21 Muharram 763 AH/November 20, 1361 AD, by order of Sultan Abu Salem Ibrahim bin Abi Ali (1359-1361 AD), and it closely resembles the modified al-Jazari clock (Al-Tazi, 2000, vol. 2, p. 346), which is the size of his room, 242 cm high and 120 cm wide (Abtawi, 2017, 110). Among his works, as witnessed by Ibn Qunfud al-Qasantini, is an astrolabe attached to the wall with a diameter of 71 cm. Its sheet moves with water, and its movements indicate an angle. On the height of the sun, how long the day has passed, and the height of the stars at night (Al-Constantini, 68). Fortunately, this innovation is still preserved despite it being inoperable, and the following words were written on the device: "Praise be to God, I made this magician with its astrolabe, which is one of its perfections. The order of Sultan Abu Salem Ibrahim bin Al-Hassan bin Saeed bin Youssef bin Abdul Haq Al-Marini, (Al-Manouni, 2000, p. 359).

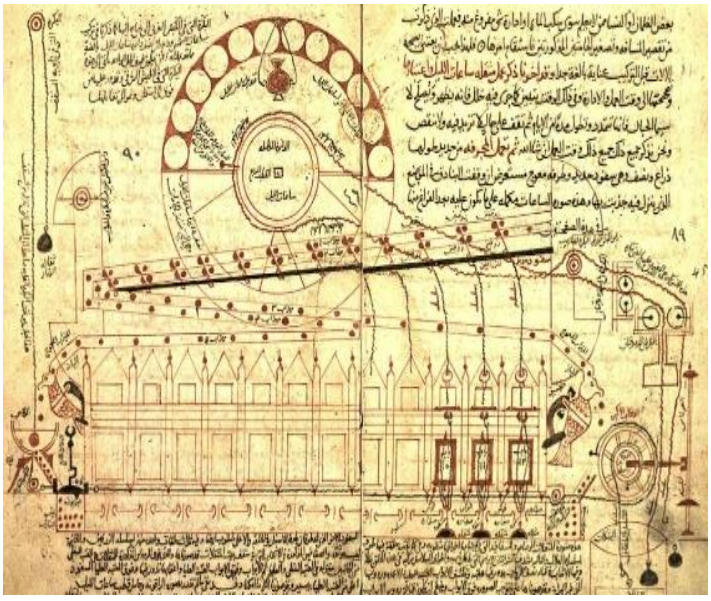


Figure 2: Hydro Manjanahs and their engineering

.Reference: Dahman, 1981, p. 156

Al-Shamain Market Manganet

There is also a Mnjanah in the Chamain market in Fez, and the end of the Marinid period and the rise of the Wattasids appeared, from the direction of the villagers, in the street known as Darb al-Manjanana. Thus, as it was said among the people, it may have been there for some time (Othman, 1993, p. 397), and it contained thirteen bowls placed on hollow bonds of cedar, bond topped; Twelve small windows, and balls are dropped, as in Mnjanah, on the bowls, announcing the passage of hours. It is similar to the Mnjanaht El katiba in Marrakesh, or the Damascus clock described by Ibn Jubayr.

Spending on Mnjanaht continued during the Marinid era and the rule of the Wattasids until it stopped, as the year 961 AH was marked by the disappearance of the cash registers for the treasuries located to the left of the outside of the Shama'in market (Ibn al-Majzoub, 2003, vol. 1, p. 36), but today these treasuries have been lost and no trace remains of them. Except for the description through source books (Hajiyat, 1974, p. 180), and perhaps someone will make it one day, and I will be the one to accomplish that, God willing (the researcher who wrote the article).

Mnjanahs, of the Central Maghreb (Algeria)

The manjana clock is a time-keeping machine with a geometric shape. It is considered the first high-tech machine in Tlemcen. It is something that resembles a tree with singing birds. It is almost likely that the manufacture of the manjana and interest in it occurred after the year (763 AH/1361 AD), starting with the Palace of Al-Mashwar. In Tlemcen, it has the same clock cycles that Ibn al-Khatib mentioned in Granada and was famous for marking the nights of the Prophet's birthday in the year 1362 AD (Azroudi, 2017, 199). Researcher Jamal Aissani believes that the Mnjanah of Tlemcen was made at the time of the Marinids' takeover of Tlemcen between (753-760 AH / 1352). -1358 AD) and not the time of Sultan Abu Hammou II (760-791 AH / 1358-13 AD), based on a poem received by Abu Abbas Ahmad bin Abdul Mannan on the occasion of the Prophet's birthday, which he recited in the year (785 AH / 1356 AD) to Sultan Abu Annan (749-59 AH). 1348-1357 AD), and he says that it is very similar to the time of Al-Jazari (d. 607-1210 AD). When Abu Anan invaded and ruled between (1348-1385 AD) Tlemcen, he brought with him the craftsmen, and he also honored the craftsmen of the Central Maghreb, as he gave generously to Ibn Al-Fahham, and he was granted an annual donation of a thousand gold dinars, distributed in installments to the general public of their country, as he estimated, after he built a clock for him in front of his school (Yahya Ibn Khaldun, 1904, vol. 3, 225).

2): Al-Fahham Abu Al-Hassan Ali Ibn Ahmed Abu Al-Abbas

Abu Al-Hasan Ali Ibn Ahmad Ibn Al-Sheikh the noble Abi Al-Abbas Ahmad, known as Ibn Al-Fahham Al-Tilmisani, the jurist, geometric and arithmetic modifier, Abu Al-Hasan Ali Ibn Ahmad Al-Sanhaji (Ibn Battuta, 1996, vol. 4,

295), whose teacher is Abu Abdullah Muhammad Ibn Yahya Ibn Ali Al-Najjar (749 AH/ 1384 AD) He was a genius in astronomy. Ibn Khaldun described him as the most knowledgeable man of our time in the various branches of mathematics. He was in charge of installing the time marbles in Tlemcen. He was one of the most knowledgeable people of his time in teachings and did not delve into what did not concern him. He settled in Fez for a period, and to him is attributed the clock of the Manjana (Ibn Marzouk, 2008, p. 192), and in addition to that, he invented many mechanical works, such as the mangala or mnjanah.

Yahya bin Khaldun narrated about him that he was "the most knowledgeable of our time in the arts of teachings, the tribe of a righteous ancestor, through whom the famous engineering works of the Maghreb, and his kings rewarded him with a thousand pieces of gold distributed among the workers of their country every year" (Yahya bin Khaldun, 1904, vol. 1, 156).

Despite the shortness of his life, he was attested to be a pioneer in the rational sciences, which he taught to students and scholars. Yahya Ibn Khaldun said about him that "he prevailed among the people of his time after the death of his sheikh in the rational sciences" (1904, vol. 1, 119), and his student Lamqri al-Jedd said about him; He is "a genius" (Ibn Maryam, 1908, 153), and Ibn Khaldun praised him as "the sheikh of teachings" (Ibn Khaldun, 1988, vol. 7, 471).

Al-Zayaniyya manganah during the Prophet's birthday

The use of the manganah is known to Sultan Abu Hammu in birthday celebrations, and only to the Zayanis, as their neighbors used it for the same purpose as well. As for their neighbors, the Marinids in the Far Maghreb and the Banu al-Ahmar in Andalusia were also doing the same thing, although the Zayani court gained greater momentum, as it was characterized by more apparent, clearer, and more flamboyant activity (Ben Adi, 2010, 25).

As for the Zayanis, history books tell us that it was used by them, such as Abu Malik Abd al-Wahid al-Zayani (814-827 AH/1411-1423 AD), to celebrate the night of the Prophet's birthday, following the example of his father (Bu Ayyad, 2011, 236).

The Sultan of Tlemcen, Abu Hammou Musa, used to celebrate the Prophet's birthday on the eve of the birth in his palace in a big way. The celebration took place by inviting people, both public and private, to a joyful party filled with delicious food, furnished with various carpets, incensing the air with various types of perfumes and sprays, and distributing the most delicious food to the attendees. The voice of praise of the Messenger, may God bless him and grant him peace, begins with his poem, then the poets who follow him, and it contains great, famous invocations and sermons of the type of One Thousand and One Nights (Al-Milli, 1986, vol. 2, p. 487). The celebration lasts for twenty-four days, in the presence of the legend of the manganah, in which it does its work every day and night.

In all of this, there is placed in the chest near the Sultan's seat the wondrous wardrobe of the manganah, which has been given the most amazing description. It was said about it: "Near the Sultan, may God Almighty be pleased with him, there is a wardrobe cabinet that was decorated as if it were a Yemeni suit, with doors that were hollow according to the number of hours of the night, so no matter how many hours passed, the clicking occurred according to its calculation." At that time, one of its doors opened, and from it emerged a maid who was portrayed in the best form. In her right hand was a piece of paper containing written notes on that hour with her name. She placed it gently in the hands of the Sultan, with her left hand on her mouth, like one who pledges allegiance to the right of the caliphate. This is their condition until dawn and the call of the muezzin, " Come to success."

In fact, the installation of the manganah constitutes a motivation and incentive for psychological satisfaction and admiration for the innovations of the sultans and their guests, and a pleasure to follow the ringtones, tones, and geometric movements, every hour of time passes at night, as it is one of the ritual manifestations that have been practiced in the Zayani court since the year (910 AH / 1337 AD). It remained present in the Zayani imagination and remained inherited in a very formal manner (Ghazali, 2020, pp. 171-172).

The work system of the Zayanid manganah

As for the method of work in the historical source, what it says: "And he meant Sultan Abu Hammu, who would stand on the night of the birth of the Prophet Muhammad, may God bless him and grant him peace, and celebrate it in a way that is above all other seasons. Spread out, and wax like cylinders, and the dignitaries of the city on their ranks, surrounded by two boys wearing colored wicker hoods, with incense burners and incense burners in their hands, each of them getting his share, and a well-crafted manganah's cupboard, with a wicker at the top of it carrying a bird that has hatched under its wings, and in which a number emerges from an opening at the root of the wicker, ascending, and from its chest. Opening doors, according to the number of God's temporal hours. Their two ends are accompanied by two large doors, and above all of them is the head of the treasury. A fuller moon travels on the equator along the path of its counterpart in the sphere, and the beginning of every hour is equal to its swinging door. Then from the two large doors are two eagles with a cymbal in the mouth of each one of them, which it throws into a hollow basin with a hole in the middle. it takes it into the closet, and the bird rings and bites one of the chicks, and its parents whistle at it. Then the door of the golden watch opens and a cute, determined maid emerges from it, with in her right hand a file containing the name of her time in order, and in her left, placed on her mouth, like a pledge of allegiance to the caliphate" (Al-Muqri, 1939, vol. 1, p. 145).

Interpretation of the work of the manganah

In fact, there is a lot of detail in the form of the manjanah through what has been written about it and also through the scarce pictures that have reached us, as well as quotations from poetry and poets at every hour of the night, the joyful birth of the Prophet (Farroukh, 1981, vol. 6, 122), but it is clear that the form of the manjanah E' Zayaniyya. Its likeness is like a strange tree, because of its intertwining and being a complex time machine.

The main body of the clock, the ticking clock, contains several ten small doors and two large doors, and in it, as the writer says: "it follows," meaning that adjacent to the two ends of these ten doors are two large closed doors, which are longer than the first doors and wider, and in each door is a female servant, and these doors are according to the number of hours of the night in time (Bin Abdullah 2000, 133), and is surrounded by beautiful and beautifully crafted silver statues.

It is noted that in the chest of the closet there are "closed" doors closed according to the number of hours of the night, while in its upper part there is a "grove", that is, a twisted tree carrying a bird, and under its wings are two young chicks, and "the two chicks are strutting around" (Bin Duraid, 1987, vol. 2, 790).) A snake emerging from a "porthole" hole in the root of the canopy is trying to ascend gradually, waiting to pounce on its prey of chicks, and above all of them, without the top of the cabinet, is a model of the shape of a full moon, walking on the equator of its counterpart in astronomy, "Wissamet," that is, parallel to the beginning of every hour, with its closed "shaking" door. And the lunar sphere is in the zodiac path depicted and shows the position.

It is noted that in the chest of the closet there are "closed" doors closed according to the number of hours of the night, while in its upper part there is a curling tree carrying a bird, and under its wing are two young chicks, and "squatting" with it, that is, the two chicks are lurking (Bin Duraid, 1987, vol. 2, 790), a snake penetrating from the hole in the root of the tree, trying to ascend gradually, waiting to pounce on its prey of chicks, and above all of them, without the top of the cabinet, is a model of the shape of a full moon, walking on the equator of its counterpart's path in astronomy, and parallel to the beginning of every hour, with its "quivering" closed door, and the lunar sphere is in the path of the illustrated zodiac, It shows the lunar position of that night, and now, after an hour of time has passed, the time clock moves when two "eagles", who are birds of prey, swoop down from the two large doors, and it is noted that each one of them has a "cymbal" on their fingernails, that is, a copper ball that it throws into the "bowl" - the cymbal among the Arabs is the tambourines that sounds like a jingle As for the one with the strings, it is an Arabized intruder, and it was said that the one with the strings is the wanj. Al-Shahrudh: An innovative instrument invented by

Hakim ibn Ahwas al-Safdi in Baghdad in the year three hundred AH (Al-Khawarizmi, 1989 AD, p. 260). It is a hollow copper bucket with a hole in the middle that leads into the closet and "rings," meaning it emits a distinctive sound. Here the coiled robotic snake pounces on someone. The two chicks, then the father begins to whistle to frighten the attacking snake, and then the door of the current (current) hour opens and a doll emerges from it in the shape of a slave girl, closing her mouth with her left hand, as if shyly announcing the hour (Daif, 1995, vol. 10, 64), and extending her right hand to the Sultan as if pledging allegiance to the caliphate. And in the portable paper we find a book that mentions the hour of time that has passed, in the form of elegant poems and compositions.

Ibn Khaldun wrote them on the tongue of the maid in verses suitable for ten hours of the night (Yahya Ibn Khaldun, 1904, vol. 1, pp. 206-212), which is what other poets did, such as Al-Muqqari and others, and this is like: His saying at the end of two hours of the night:

And two hours of the night have passed *** It thanks you like Riyadh thanks the rain (Al-Muqri, 1939, vol. 1, 246), and so the matter goes on every hour until dawn breaks, and the party ends.

It appears from the above that the Zayanis use the day that begins with sunset as an analogy to sunrise, so the hour begins at zero and the manjanah's hour follows the command to gradually increase.

Here we record that Tlemcen, in the eighth century AH (14 AD), dominated some engineering industries based on the science of tricks, including the manufacture of large Manjanahs. The historian of Tlemcen, a descendant of the Zayaniyya state, says: This precise description of the details of the wondrous clock, its function, and the movements it makes as each hour passes, indicates On the development of the mechanical industry in Tlemcen, and it is considered one of the important inventions (Filali, 2002, 283).

Conclusion:

- The Manajanah is an ancient invention developed by Muslims in the East and West throughout history. The Maghribans were influenced by the manjanahs of the oriental arabs, so they made them in their various countries in the Middle Ages.
- The works of the Near, Middle and Far Islamic Maghreb and Andalusia are distinguished by their form, work, number and art.
- The industrial skill of the Magribans, using the science of tricks and calculations in making this huge time machine, was evident in the various countries located in Andalusia or in the land of the Maghreb (Algeria, Tunisia, and Morocco).
- There is a problem with the terminology of the Manjanahs, especially its types and driving energy. I focused my research on water clocks with weights,

although the sources and references mixed a lot between the two terms, as we can find the manjanahs designations for sun and sand clocks as well.

- The forms of the manjanahs are numerous and their names are numerous through many sources, which indicates a clear brilliance in scientific activity in modification and timing.
- The driving energy in the mnjanah is multiple, the most famous of which is mechanics, but some of it is driven by the power of wind, water, and mercury as well.
- The Zayanid manjanah became famous during the Prophet's birthday for its joyful, festive character, and was characterized by a wonderful working system, which prompted the sultans to use it in their courts.
- The Manjanahs were numerous and the sultans were interested in them, and their effects still exist to this day, including the Fasian Manjanah.
- Ibn Khalaf Al-Muradi excelled over Al-Jazari in watchmaking, and this is clearly shown in his important but incomplete manuscript.

Sources :

-Abu Bakr Muhammad ibn al-Hasan ibn Duraid al-Azdi (d. 321 AH), Jamharat al-Lughah, 1987 AD, edited by: Ramzi Munir Baalbaki, Dar al-Ilm Lil-Millain, Beirut, 1st edition, vol. 2, 790.

-Ali Al-Jaznai, Picking the Myrtle Flower in the Building of the City of Fez, ed.: Abdel-Wahhab bin Mansour, 2nd edition.

-Qunfud al-Qasantini Abu al-Abbas Ahmad al-Khatib d. (1408 AD) Ibn Anis al-Faqir and Izz al-Haqir, (1965), edited by: Muhammad al-Fassi, Ulf Faur, published by the University Center for Scientific Research, Faculty of Arts, Rabat. Agdal Press, Rabat.

-Abu Al-Abbas Ahmad bin Yahya Al-Wansharisi, The Arabized Criterion and Al-Jami' Al-Maghrib, (1990), edited by: Muhammad Hajji et al., Dar Al-Gharb Al-Islami, vol. 2.

-Abu Abdullah Muhammad bin Al-Hasan Al-Kattani Al-Tabib, Similes from the Poetry of the People of Andalusia (1981), ed.: Ihsan Abbas, 2nd edition, Dar Al-Shorouk, Beirut.

-Abu Abdullah Muhammad bin Marzouq Al-Tilmisani (d. 781 AH), Al-Manaqib Al-Marzouqiya (2008), edited by: Salwa Al-Zahri, Al-Najah New Press, Casablanca, Kingdom of Morocco.

-Ahmed bin Ali bin Ahmed Al-Fazari Al-Qalqashandi (d. 821 AH), Subh Al-A'sha Fi Sinaat El Incha, Dar Al-Kutub Al-Ilmiyyah, Beirut, vol. 5

-Ahmed bin Yahya bin Fadlallah Al-Qurashi Shihab Al-Din (d. 749 AH), Masalik el Absar fi Mamalik Al-Amsar, (1423), Cultural Complex, Abu Dhabi.

-Shihab al-Din al-Salawi (d. 1315 AH), Al-Iqtisaa fi Akhbar al Maghreb El Aksa (1997), ed.: Jaafar al-Nasiri Muhammad al-Nasiri, Dar al-Kitab, Casablanca.

-Ibn Manzur, Lisan al-Arab, (2015), Dar al-Jawzi, Cairo, Egypt.
-Al-Abbas bin Ibrahim Al-Semlali, El Alam bimen Hal bimarakech wa aghmat, (1993)according to: Abdel-Wahhab Ibn Mansour, Royal Press, Rabat, 2nd edition, vol. 7.
-Ibn Maryam Al-Tilmisani, Al-Bustan fi Zhikr Al-Awliya wa Al-Ulama in Tlemcen, (1908), Al-Thaalabi Press, (lithograph edition).
-Zakaria bin Muhammad bin Mahmoud Al-Qazwini (d. 682 AH), Athar el Bilad wa Akhbar El Ibad, (eds.), Dar Sader, Beirut.
-Salma Khadra Al-Jayousi, The Arab-Islamic Civilization in Andalusia, Part 2, Center for Arab Unity Studies, Beirut, 1999.
-Shihab al-Din Abu Abdullah Yaqut bin Abdullah al-Rumi al-Hamawi (d. 626 AH), Mu'jam al-Buldan, Dar Sader, Beirut, 2nd edition, 1995 AD, vol. 1.
-Shihab al-Din Ahmad bin Muhammad al-Muqqari al-Tilmisani (d. 1041 AH), Nafah al-Tayyib min Ghosn al-Andalusi Eratib, (ed.) edited by: Ihsan Abbas, Dar Sader - Beirut - Lebanon, vol. 3.
-Muhammad bin Abdullah Lisan al-Din Ibn al-Khatib (d. 776 AH), Al-Ihtah fi Akhbar Granada, (2003) Dar Al-Kutub Al-Ilmiyyah, Beirut, vol. 4.
-Muhammad bin Abdullah by Al-Wati Al-Tanji Ibn Battuta (d. 779 AH), The Journey of Ibn Battuta (Touhfat Enodar fi Gharaib el amsar wa ajaib El Asfar), (1417 AH), Academy of the Kingdom of Morocco, Rabat, vol. 4.
-Yahya bin Khaloun, Baghiyat al-Ruwad fi Dhikr al-Maluk al-Bani Abd al-Wad, (1991) ed.: Alfred Bell, Pierre Fontana Press, Royal Edition, Rabat, Sharqiya, Algeria, vol. 3.
-Muhammad Al-Mukhtar bin Ali bin Ahmed Al-Alghi Al-Susi (d. 1383 AH), Al-Ma'soul, (1381 AH - 1962 AD), Dar Al-Najah, Casablanca: Morocco, vol. 9.
-Abu Al-Hasan Ali bin Musa bin Saeed Al-Maghribi Al-Andalusi (d. 685 AH), Al-Maghrib fi Hali Al-Maghrib, (1955) edited by: Shawqi Deif, Dar Al-Ma'aref, Cairo, 3rd edition, vol. 1.
-Shihab al-Din Abu al-Abbas al-Muqari al-Tilmisani (1041 AH), Azhar al-Riyadh fi Akhbar al-Qadi Ayyad, ed:Mustafa al-Saqqa, Ibrahim al-Ibiari, Abd al-Azim Shalabi, Press of the Authorship, Translation and Publishing Committee, Cairo, vol. 1, vol. 5.
-Shihab al-Din Ahmad bin Muhammad bin Omar al-Khafaji al-Masri al-Hanafi (d. 1069 AH), Shifa al-Ghalil fi Kalam al-Arab min al-Dakhil, (1988) edited by Muhammad Kashash, Tripoli, Dar al-Kutub al-Ilmiyyah.
-Abdul Rahman bin Muhammad bin Muhammad, Ibn Khaldun (d. 808 AH), Al-Muqaddimah, ed.: Khalil Shehadeh, Dar Al-Fikr, Beirut, 2nd edition, 1408 AH / 1988 AD.

-Muhammad bin Ahmed bin Yusuf, Abu Abdullah, the writer Al-Balkhi Al-Khwarizmi (d. 387 AH), Mafatih El Ouloum, ed.: Ibrahim Al-Abiyari, Dar Al-Kitab Al-Arabi, 2nd edition.
-Muhammad bin Muhammad bin Abdul Razzaq Al-Husseini, Abu Al-Fayd, nicknamed Murtada, Al-Zubaidi (d. 1205 AH), Taj Al-Arous, edited by: Ali Shiri, Dar Al-Fikr for Printing, Publishing and Distribution, Dar Al-Fikr, 2nd edition, AH., vol. 8.
-Al-Tanisi Muhammad bin Abdullah, History of the Banu Zayan Kings of Tlemcen, an excerpt from Nazm al-Durr and al-Uqayan, in the statement of honor of the Banu Zayan, ed.: Mahmoud Agha Bouayad, Moufm Publishing, Algeria, 2011.
-Abu Ali Al-Hasan bin Rashiq Al-Qayrawani Al-Azdi (d. 463 AH), Al-Umdah fi Mahasin Al-Chir wa Adabih, ed.: Muhammad Muhyi Al-Din Abdul Hamid, Dar Al-Jeel, 5th edition, 1401 AH / 1981 AD.

References :

-Fouad Ephrem Al-Bustani (d. 1906 AD), Farhang Abjadi = Al-Munajjid Al-Abjadi [Arabic/Persian Dictionary], Trans.: Reza Mahyar, Publisher: Al-Islamiya, Tehran, 1370, Sharjah Biennial, vol. 1.
-Shawqi Dhaif, History of Arabic Literature, (1995), Dar Al-Maaref, Egypt, vol. 10.
-Othman Othman Ismail, The History of Islamic Architecture and Applied Arts in the far Maghrib, the Era of the Marinid State and the Beni Wattas State (1993), 1st edition, vol. 4.
-Theophile Obenga, Geometry in Ancient Egypt, Africa's Contribution to Global Mathematics, (2008) Trans.: Hussam al-Din Zakaria, issue: 1222, National Center for Translation.
-Taher Jalil Haboush, The First Arabs Through the Ages, the Abbasid Era, 1991, Iraqi Scientific Society, vol. 4.
-Abd al-Haqq Ibn al-Majzoub al-Hasani, 1427 AH/2003 AD, The Social Condition in Fez in the Twelfth Century AH through the Ismaili Hawala, Kingdom of Morocco, Publications of the Ministry of Endowments and Islamic Affairs, Part 1.
-Abdul Hamid Hajiyat, Abu Hammu Musa Al-Zayani, his life and works, (1974), National Publishing and Distribution Company.
-Abdelaziz Benabdallah, Cosmic and Experimental Sciences in Morocco (How They Developed Over a Thousand Years), Rabat, 2000. - Jamil Aissani et al., Aspects of Observational Techniques and Observatory Tools in the Islamic Maghreb.
-Abdel Aziz Ben Abdallah, Jurisprudence Teacher (1983), Dar Al-Gharb Al-Islami, Beirut, Lebanon.

-Abdel Aziz Filali, Tlemcen in the Zayani Era, (2002) Movem Publishing and Distribution, Algeria.
-Abdullah Al-Jarari, Arab Progress in Science and Industries, (1961), Dar Al-Fikr Al-Arabi.
-Abdul Hadi Al-Tazi, Competition between the Kingdom of Fez and the Kingdom of Tlemcen in the social, industrial, and scientific fields, (1033), Al-Qafila Publishing House. and distribution, Algeria.
-Abdul Hadi Al-Tazi, Al-Qarawiyyin Mosque, the mosque and university in the city of Fez, an encyclopedia of its intellectual and architectural history, (2002) Knowledge Publishing House, Rabat, vol. 2.

University theses

-Azroudi Nasira, The Development of Astronomy in the Middle Maghreb during the Middle Period, doctoral thesis, Djilali Yabes University, Sidi Bel Abbes, supervised by: Shakhoum Saadi, 2016-2017 AD.
-Abdel-Aali Ghazali, The Tlemcen-Zayani Society, A Study of Customs, Traditions, and Customs from the 7th Century AH/31 AD until the 31st Century AH/31 AD, PhD thesis, supervised by: Sidi Muhammad Naqadi, 1211 AD - 1441 AH/1212 - University Year 1441.
-Nouria Ben Adi, Literature in the Second Zayani Era (749-952 AH), a thesis for a doctoral degree in ancient Maghriban literature, Abu Bakr Belkaid University of Tlemcen, supervised by Ahmed Murtad,2010 1431 AH.
-Bouarwa Bakir, The History of Astronomers in Andalusia during the Umayyad Period and the Era of the Taifa Kings (138-484 AH/775-1088 AD), 2009 AD, Dar Sanjak al-Din, Algeria.
-Muhammad Al-Manouni, Papers on the Marinid Civilization, 1420 AH/2000 AD, Faculty of Arts, Rabat, Morocco, 3rd edition. (Bin Duraid, 1987).
-Saad Abdullah Saleh Al-Bishri, Scientific Life in the Era of the Caliphate in Andalusia, (316-422 AH / 755-1030 AD), (1779 AD), Institute for Scientific Research and Revival of Islamic Heritage, Mecca, Ministry of Higher Education, Kingdom of Saudi Arabia.
-Ahmed bin Al-Qadi Al-Miknasi, Djadwat El Iktibas fi Dikr Men Hal Min Elalam Madiat Fez
-in Mention of the Solution of the Flags in the City of Fez(1973)Dar Al-Mansour for Printing and Papers,vol 3
-Mahmoud Agha Abu Ayyad, History of Beni Zayan, Kings of Tlemcen, 2011, an excerpt from Nazm al-Durr wa al-Uqayan Fi Bayan Charaf Beni Zayan of Beni Zayan by Muhammad bin Abdullah al-Tensi, Movem, Algeria.
-Abu Hamid Al-Ghazali, The Book of Forty in the Fundamentals of Religion in Beliefs and Secrets of Worship and Ethics, 1424 AH/2003 AD, edited by:

-Abdullah Abdul Hamid Arwani, Muhammad Bashir Al-Shaqfa, Dar Al-Qalam Al-Awal.

Articles :

-Journal of Andalusian Studies, Ibn al-Sabah al-Andalusi, Hajj Abdullah (1933), Nachr El khbar wa Tadhkirat al-Akhyar, published by Jum'a Tunis Shaykha, issues: December 45-46, 1033 AD, Tunisia.

-Hespéris tamuda / Université Mohammed V., Faculté des lettres et des sciences humaines · September 2017.

-Muhammad Batioui (2017), The Science of Weights and Tricks in the Middle Islamic West, a study of one aspect of the Arab tradition in theoretical and applied mechanics, Mohammed V University, Rabat.

Foreign references :

-Roshdi Rashed , Encyclopedia of the History of Arabic Science (1996)vol 1 Ed4, by,in collaboration with, RÉGIS MORELON, P 164.

-Pierre Simon marquis de Laplace, l'Histoire de, l'Astronomie, (1863)Mallet Bachelier , impri, Ed2 , Paris

-Dozy (R),supplément aux dictionnaires Arabes,Tome 2, Leyde, E.J.Brill, 1881.