

LOST TREASURES: LOCKS

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Abstract

Locks have been widely used in our daily life. In this paper an attempt is made to study the history of locks and to give the kinds of locks and samples from past to present: Ancient Egypt, Chinese, Iran, Roman, Turk-Islam Locks. Ancient locks relied on the pin tumbler principle that many of today's locks use. Many early Roman Keys were made to be worn as rings, because clothing of Romans did not have pockets. It is hoped that this article can simulate more research and publications regarding the development of ancient locks.

Keywords: Ancient lock, key, lock, padlock

1. Introduction

Human history can be considered by many aspects. Security can be chosen as a study field. Human always wants to keep himself in security and save everything that he owns. The first application on this field, in human history probably started by taking shelter in a cave with only one entrance and hindering other beings to enter there. You can close the entrance of a cave with a big piece of rock.

However, such a kind of security isn't very serviceable in terms of continuity. As time passed, the mechanism which carries out the closing activity in the most useful way in terms of continuity and practice and is called 'a door' started to be used. A door, conceptually, is the moving (or semi-moving) part allowing a place to be come in or not whenever wanted.

The additional part uniting a door with a place between the door and the place is called a lock. Traditionally, a lock is composed of two parts. One of these parts is on the door and the other is on the place to be closed. The second element allowing those two parts of the lock to be united. The key moves in a way having the logic and process of inclusion transformation.

Although they have a big importance in our life, it is not possible to come across any information about doors and keys in written sources one of the important reasons is that the information about doors and keys is strategic and patent-based in terms of mechanism. But there are samples and catalogues in terms of decorative arts.

The mechanisms that our scientists such as Al-Jazari (1136-1206) and Takiyuddin b.Ma'ruf el-Rasid (932/1526) introduced show that the principles concerning with automatic control systems have been implemented through the ages and improved by transferring from generation to generation. The principles of today's robotic science date back to this period.

The working principle of the locks and keys heritaged from past to present in different stages and their shapes have always been observed changing. These changes are integrated changes and each stage is based upon the previous stage. Briefly, although these two unseparated structures have changed in shape, it is still an unchanged part saving the properties of humanbeing.

2. History of Locks

The Stone age people living in natural shelters and the nomadic people still surviving today used to save all their valuable belongings and treasures by burying into caves, tree hollows and different secret places. Then, the ropes made of mat grass or vegetable fiber were used to lock the doors and protect the residences. Different kinds of knots were improved. These knots were only able to be opened by the owner. Apart from those, according to the superstitions of the time, nobody dared to try even to scratch the knots for the fear that they and their families would be damned until Alexander the Great (B.C. 356-323) cut the legendary Gordion Knot with a sword blow disregarding all the beliefs before the Great East Expedition.

The development of locks arises psychologically from practical needs on safety for individuals, for groups, or for individuals within groups. Following the progressive development of the society and technology, the function of locks is getting complete. Not only the design of locks is greatly improved, but also the manufacturing of locks is more

precise. Furthermore the usage of locks has been extended from doors, chests, boxes...etc. (Hong-Sen Yan, 2003)

In historical process, it can be seen that there are many different traditional uses of locks. Such as for security and also in religion and folk beliefs. Especially in the popular culture of Iran, locks have an importance in their belief. Locks are thought to possess special powers to protect the user from harm or evil, and to assist in securing the fulfillment of certain wishes as well as in gaining happiness and good fortune. (Tanavoli and Wertime, 1976)

The first locks were introduced by the Egyptians 4000 years ago. It was made of wood, it is possible to study the improvement which the lock invention dating back to 4000 years ago has experienced stage by stage. The security system provided by metal lock, key and lock nail was first used by the Romans. Important improvements on locks and keys issue were observed in Turk-Islam period and information about them took place in transcriptional documents. Lock samples were given in the works of Bedi'üz-Zaman Ebû'l-İz İsmail bin er-Razzaz El-Cezeri ve Takiyuddin b.Ma'ruf el-Rasid (Tekeli and at all, 2002). Al-Jazari made a lot of machines working with water such as robots, clocks, pumps, and he published those he introduced and produced on request of Nasireddin Mahmut, the Ruler of Artukoğlu. There are still 15 known-copies of this book, five of which are in our country. The copy in Ahmed III Library in Topkapı Palace Museum was written Muhammed İbn Yusuf Osman from Hasankeyf (Çeçen, 1986).

In 1974, Donald Hill, like Wiedemann, translated the work into english and recommended it referring to Oxford Transcription (Hill, 1974). The book was published in english in the title of Al- Jazari's Book Of Knowledge Of Ingenious Mechanical Devices in 1973. The title of the book can be translated into our language as "Olağanüstü Mekanik Araçların Bilgisi Hakkında Kitap". This book was prepared in 50 orders and 6 chapters (Jazari, 1990). These chapters, subsequently, consist aqua clocks, automatic bowls offering wine, automats with human and animals, automats playing different instruments by itself, and the combination locks. Especially two lock mechanisms are mentioned, one of which is combination case lock in chapter 6 of order 3 and the other of which is a four-bolted case door lock introduced in the same chapter of order 4. (Bir and Kayral, 1993). The mechanism in combination case lock looks very like the combination locks in the cases in our time. To open this mechanism, four chipper cylinders, each with 3x16 letters, must be arranged (Bir and Kayral, 1993).

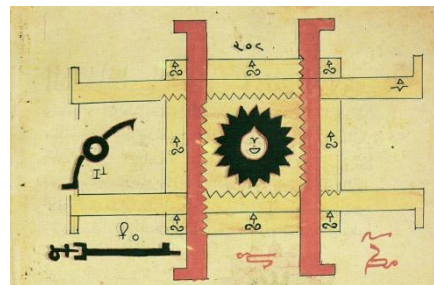


Figure 1. The original drawing of the lock mechanism of the four-bolted case door (El-Cezeri,1990).

Another lock sample in Turk-Islam World belongs to Takiyeddin b. Ma'ruf el-Rasid. Takiyeddin b. Ma'ruf el-Rasid known as the eye of Ottomans, looking at space, was born in Sam in 1521. He took up *phıkıh*, *hadis* and *tefsir* lectures from the well-known tutors of the time, and wrote on mathematics, astronomy and optic by establishing İstanbul Observatory in 16th century. One copy of *al-Truk al-Saniyya fi'l-Alat al-Ruhaniyya*, one of the most important works of Takiyuddin, is available in Kandilli Observatory. There are 52 pictures and 7 miniatures in the work consisting of one introduction and 6 chapters (İhsanoğlu and al all, 2006).

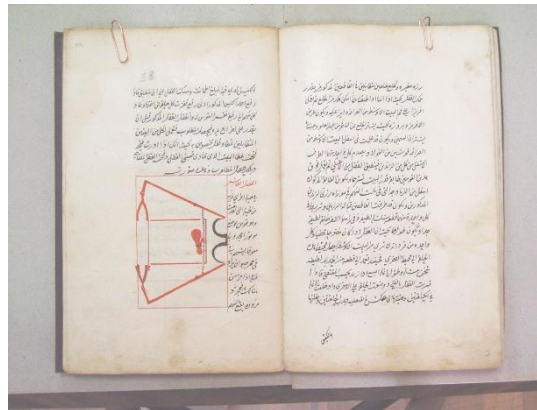


Figure 2. The chapter of the work named *al-Truk al-Saniyya fi'l-Alat al-Ruhaniyya* concerning with case lock mechanism.

In this study, especially, the lock mechanism aiming to frustrate the thief extending his hand to take a money bag full of money by catching his wrist is very interesting.

Moreover, worldwide we may encounter locks living on different structures. One of these structures are doors. They have big importance in terms of the historical process as well as artistically. So I want to give one of the living samples of the doors and locks in Turkmenistan, the door and the key of the tomb of Sultan Sanjar in 12th century. The mechanism of the lock is a kind of Egyptian locks sample.



Figure 3. The tomb of Sultan Sanjar and its door with the lock in 12th century

Metal padlocks were found in the excavation done in Russia, China, Iran, Türkiye, and East India in Far East and Near East (Needham, 1976). In the late 1500s, the moving parts of the locks were able to be replaced one on another by being processed in detail. This development in Middle age brought metal lock embroidery especially in the Province Nürnberg of Germany. Meanwhile, keys and locks were covered with extraordinary ornaments and the people produced the most beautiful samples by performing their skills on this field. Animal figures such as elephant, horse, dragon, and hippopotamus were used especially on padlocks and many mechanisms were improved in the quality of artworks.

One of the most important studies in order to improve the reliability of the locks belongs to the English. In 1778, an English inventor Robert Baron patented the lock working with a system with a double-effective tumbler (Philips, 2005). The tumbler working as a lever lies in a slot opened for a bolt in a normal location and hinders the bolt from moving. The bolt can only move if the key lifts the tumbler. Subsequently, in 1818, Jeremiah Chubb added a spring into the lock by improving this system. This spring was used to catch the tumbler in case of a strain. In 1784, Joseph Bramah invented a lock having a completely different mechanism from these two locks. The key of this mechanism opened with a light key, and also called Bramah Lock, was like a metal pipe grooved lengthwise on its end. The grooves match with a series of metal bolt and the bolts were pushed down depending on the length of the grooves. The key could only be turned in case all the bolts were pushed as long as required, and thus the main bolt could be moved (Tok, 2002).

In addition to these locks, there are combination locks widely used and improved in 17th century. In result of the researches and excavations held, these chiphered keyless locks were seen being used even in the Romans and the ancient Chinese. A different kind of the combination key appeared in the 17th century: 'lettered combination key'. This system is seen today in the combination locks used for the bicycles. A series of rings on which are these some letters and numbers are passed through an axle. When the rings are rotated so that they combine the code word or the code number, the slots line up (Philips, 2000). Consequently, the axle is released and the lock can be opened. This lock system, initially, was widely used.



Figure 4. Combination Lock Samples.

In the second half of the 19th century, this mechanism was started to be used in the doors of the steel rooms and cases. And in the 20th century, these locks were replaced by electronic combination locks.

In the 18th century, one of the remarkable innovations in lock field belong to Linus Yale. In 1848, Linus Yale introduced pin tumbler locks, by referring to the working principles of the

ancient Egyptian Locks. And in 1860, his son improved another different model of Yale Lock, cylinder middled lock (Weber,1984). This system started to be widely used in all over the world in the 20th century.

In the 20th century, apart from the Yale Lock, different kinds of lock systems also started to be widely used. One of which was electronic combination locks, being upper improved version of the combination locks. Moreover, different models of the lock mechanisms were also encountered. The working principle here is based on lock mechanisms (Rathjen, 1995). Also electronic combination locks have different kinds, some of which are as typing the code on the lock and introducing the card to the lock in order to open the door. Such kind of locks gradually have lost their reliability and led to upper version models. Therefore, the designers have improved the system called 'hybrid' in order to remove these problems. Hence, improved mechanisms on which the code is typed with the cards used as keys have been introduced. After the electronic key is inserted into the lock slot and only after the code is typed, the closed lock can be opened. Then, some of the problems faced with these locks have been to lose the card or forget the code. In order to prove the solution of these kinds of problems, studies have been done and biometric systems have been introduced.

2.1. Kinds of Locks and Samples from Past to Present

The words, 'kilit' and 'anahtar' in Turkish, are derived respectively from Anatolian Greek words '**Kleos**' and '**Anihpiri**' .

Used in many meanings in Turkish the word '**kilit**' is described in Turkish Language Foundation Turkish Dictionary as a 'a closure device working with a piece like a key or button able to be attached and removed'.

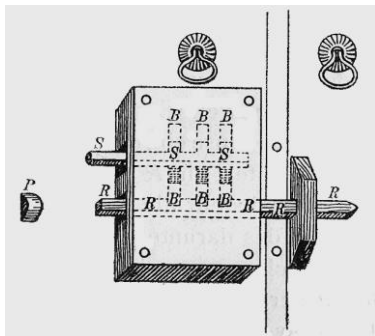
Pitt Rivers, having formed a collection on locks and keys since 1851 and exhibiting all them in his book of 'Primitive Locks and Key', discussed the source of the word '**lock**' in the first chapter of his book. According to Rivers, the word '**lock**' is derived from the Greek word '**kleidi**'. The reciprocal meanings of lock, key and the words concerning with these mechanisms in other languages were enclosed with the essay in a table.

2.1.1. Ancient Egypt Locks and Keys (Bir and at all, 2006)

The origin of the modern lock mechanisms dates back to Egyptian Locks. The locks belonging to this period is of a kind that we can come across its samples even today and its past goes back to Ramses II period (1292–1225).



Figure 5. Egyptian Lock and Key.



- S: The lock pushed into its slot in order to lift up the wedges.
- R: The bolt in closed location.
- B: The wedges released from the slots in the bolt.
- P: The support hindering the bolt pulled out from falling.

Figure 6. The inside structure of the lock in Cyprus Politiko Village (Bir and at all, 2006).

The Egyptian Locks are pawl keyed and wedged locks. There are two different types of these locks in bolted form. In the first type of locks, the key is inserted into the bolt and lifted up. In this case the pawls of the key go through the slots in the bolt and lift the wedges here up. Then the bolt is pulled with the key, and removed from its slot, allowing the door to be opened (see Figure 10). The bolt pulled can not depart out of the key box thanks to the salient part moving in the slot.

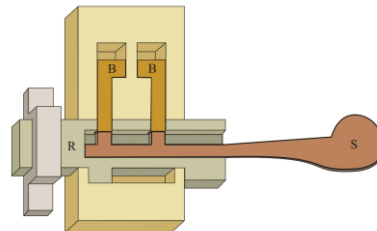


Figure 7. The cross section view concerning with the type of lock in which the bolt is released from the wedges by inserting the first type pawled key into the bolt (*R* bolt, *S* key, *B-B* wedges) (Bir and at all, 2006).

The key in the second kind Egyptian locks is inserted into a slot in the key box instead of a bolt and is lifted up as is in the first type of key *Figure 11*. In this case, the pawls of the key allows the bolt to be pulled by lifting the wedges up. By this change, the door bolt will not be weakened by the key hole and a more durable lock can be obtained against the outdoor kicks.

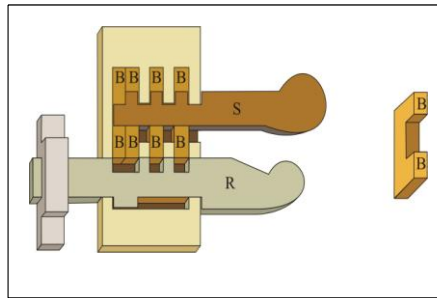


Figure 8. The lock in which the pawled key is released from the wedges by being inserted into the key box and a wedge drawing (*R* bolt, *S* key, *B-B* wedges) (Bir and at all, 2006).

2.1.2. Ancient Grek Doors, Locks and Keys (Bir and at all, 2006)

The more trade develops, the more trade centers setting far out like Troya but in need of protection appears (B. C. 3000-1800). In about 8th century B. C. in the legends *Ilyada* and *Odysseia* in which Homeros gets poem, important information on locks and doors is encountered (Bir and Kayral, 1992).



Figure 9. The key of Lusoy Artemis Temple (Arkadia) B. C. 5th century.

2.1.3. The Roman Time Locks and Keys (Bir and at all, 2006)

The most common lock type of this period is the springed locks. These locks were used in door, box and case locks. The keys belonging to these lock mechanisms were encountered in Pompei excavations.



Figure 10. Pompei door key

The working principle of the mechanism starts with a bolt movement. There is a pushing the bolt mechanism inside the door. And the spring in the mechanism allows the bolt to be pushed more easily. There is a hole at the end of the key inserted into the mechanism. This hole is done for the key to fit onto the extension. Apart from this, there is extension vertical to the axis at the end of the key. The function of this extension is to fix into the recession and to allow the bolt to be translated back and forward during the turning of the key to right and left. Another different aspect of this system is that the key sizes are dependable on the lock. The

purpose is to prevent a key from opening another lock. The system is shown by the following drawing:

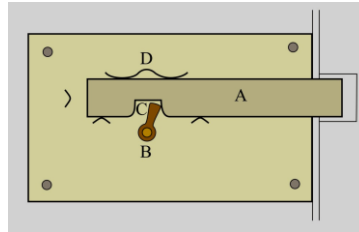


Figure 11. Springed revolving Roman Locks (open): A bolt, B thorn, C middle holed flanged key, D spring (Bir and at all, 2006).

2.1.4. Turk Islam Period Locks and Keys

According to the information obtained from the written documents belonging to Islamic period., Al-Jazari and Takiyeddin b. Ma'ruf el-Rasid discussed locks and keys in their works. Al-Jazari mentioned about the structure of the two locks, one of which is combination case lock and the other of which is a four-bolted case door in his work. And Takiyeddin b. Ma'ruf el-Rasid gave information about the lock that can be an example for the butterfly springed locks today and also called shame lock. The working mechanisms of these locks are shown below with the drawings and original figures given with their stages.

Al-Jazari's combination case lock¹ (Bir and at all, 2006)

An interesting combination case lock is explained in the 3rd order of the 6th chapter of Al-Jazari's "Kitab el-Hiyel". It is like a box in which valuable private properties were put and on whose lid there are 4 combination locks. 16 letters on the cylinders of the combination locks are ordered as the following.

In order to open this box resembling the combination locks on the cases where valuable properties are put today, it is necessary to arrange 16 letters in each of the 4 combination locks on the upper surface of the box by revolving 3 different cylinders or to know total $m = 3 \times 4 = 12$ letters. Since the number of the letters to be arranged is $n = 16$, the possible combination number is $n^m = 16^{12} = 281.474.976.710.656 \cong 2,8 \times 10^{14}$, in other words, the possibility to open this lock in the first trial is $p = 1/(n^m) \cong 3,55 \times 10^{-15}$ or zero.

¹ E. Wiedemann, F. Hauser; *Über eine Palasttüre und Schlösser nach al-Gazari*, Der Islam, C.11 s. 213-251

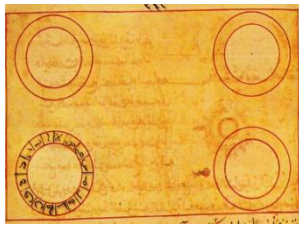


Figure 12. The upper view of the case box lid.

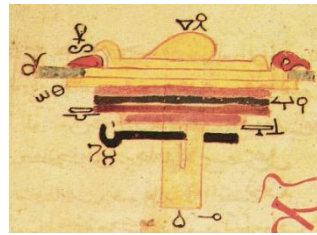


Figure 13. The original cross section of a combination lock cylinder.

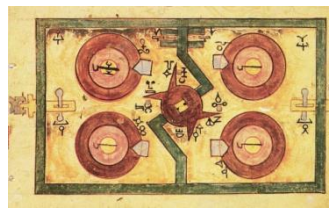


Figure 14. The lower view of the parts on the metal plaque under the chiphered cylinders.

Al-Jazari' s four-bolted case door lock (Bir and at all, 2006)

In the 6th chapter of Al-Jazari' s “Kitab el-Hiyel”, a lock mechanism attached to a wooden door and a bolt system depening on it is described as the 4th order. The order surprisingly resembles the rainforced locks of the doors of the places where precious properties are kept or thebolt systems on today' s steel case doors. With this lock system, it is aimed for the four door bolts to be inserted into the special slots in the door case or threshold by means of a key.

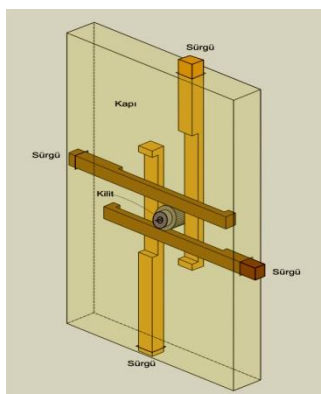


Figure 15. A general view of a four bolted case door lock.



Figure 16. A lock model of four bolted case door (Sezgin, 2003).

The bolts to be pushed into the slots one of which is on the door threshold and the other three of which are on the right, left and upper door cases are made of square crossed new wooden beams. Horizontal situated bolts are longer than the vertical ones depending on the door sizes and the location of the door lock. Since the bolts intersed where the lock mechanism is, the bolt crosses are mutually reduced in half through the distance where the bolts are pushed by the lock mechanism. Notches are made through the motion distance of the bolt on the outside or the low crossed part of the horizontal bolts and inside of the low crossed part of the vertical ones.

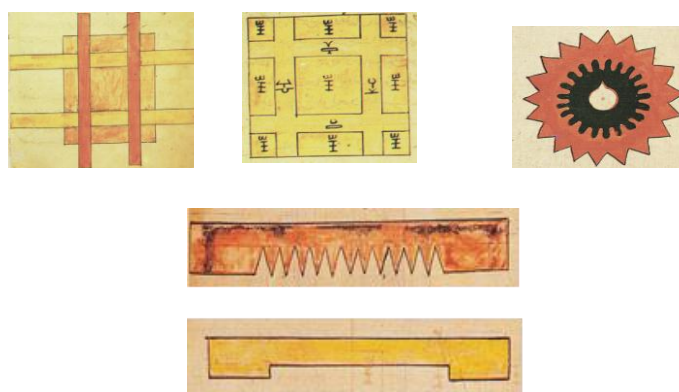


Figure 17. The original drawings concerning with the various parts of four bolted case door lock.

The bolts prepared are placed on a wedge where there are channels through which they can move easily. The open side of this wedge making up the cover of the lock mechanism is arranged as does it situate inside the door. First horizontal then vertical bolts are fit into the wedge as are all of the bolt notches introverted. A slot is made up for the key cylinder to be able to rotate easily in the hole digged in the middle of the bolts on the wedge. Notches fitting the other notches on the bolts are carved out surface of the steel cylinder placed into this slot. The notches on out surface of the cylinder are fixed into the notches on the bolt when the cylinder is placed into its slot. There is a round hole in the middle of the cylinder and a channel lying through the hole on one side of this hole. The end of the cylinder lying out from the wedge fits in a slot inside of a hole carved on the wooden door. The cylinder hole is fixed into the slot and so is the wedge on the door together with the bolts able to move independently.

In order to open the door, it is necessary to turn the cylinder by means of a key suitable for the hole and channel in the middle of the cylinder. When these kinds of keys are inserted into the key hole, the crank lever appearing when the jointed part is rotated 90° in its around allows the key to be turned more easily in its hole.

2.1.5. Traditional Keys and Locks from Ottomans to Today

Otoman Empire, having survived the longest ranging after the Roman Empire, won many significant victories since the 16th century and managed to add many castles into its borders via those victories. In this period, the keys of those castles used to be brought to the palace as war spoils and collected. The keys belonging to many castle doors such as Kâbe, Harsova, Ruscuk and Silistre Castle Keys are kept among the collections in Topkapı Palace Museum (Ünal, 1963). There are 27 silver, 10 wooden and 97 iron keys in the collection. Sultan Mahmud II made the castles restored in detail by making the silver casle keys introduced in this period (Aslanapa and at all, 1981).



Figure 18. The silver key of Silistre Castle.

There are many kinds of locks used in Ottoman Period and still today. These are bolted and tumbled door locks and springed, screwed and combination locks.



Figure 19. Handycraft screwed padlock.

The bolt and the tumbler is opened with a key in gate locks. But the structures of the springed padlock mechanisms are like the Roman Time lock mechanisms.

Moreover, another kind of key having a different spring mechanism is the key whose spring like a butterfly. The following Kâbe Lock and Key can be given as an example.



Figure 20. The Kâbe Lock and Key with a butterfly type spring in a key in and out position (The Kâbe Locks kept in Topkapı Place Museum, IRCICA Publications, İstanbul 1993).

2.1.6. Chinese Locks

Locks have been defined differently and entitled to different names in various areas. The dictionary Ci Hai defines this term as ‘a sealing device that requires a key to be opened’ and also ‘a device used to bolt doors and chests so to prevent people from opening them. It was named *jian* in the old times, now it is called *suo*’.

At the end of this section I want to give the lock mechanism terms in Turkish and other languages (Table.1). We can easily see that some terms in some languages are similar in use. This demonstrates that cultures languages affect each other.

In Stone Ages, we have always seen stones, bones, woods were using as the materials for making tools. According to the development of various materials in various periods, ancient Chinese locks were made of wood, bronze, red bronze, brass, silver, gold, steel and nickel. Chinese locks have three types: Broad locks, combination locks and pattern locks. On these locks Chinese characters have been used with special animal figures.

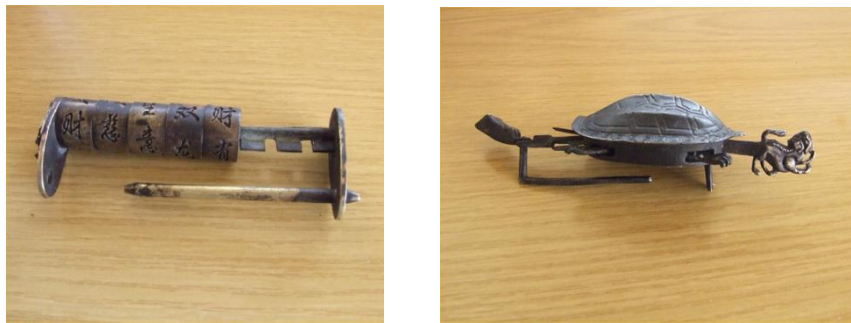


Figure 21. Chinese combination locks

In today’s padlock mechanisms, another kind of lock mechanisms seen widely is the screwed padlock mechanisms. In these kinds of locks, the end of the key is of a screw shape and does a rotation. The working principle of the screwed padlock mechanism is shown below together with their open and closed position by means of the figures and drawings.



Figure 22. Screwed padlock.

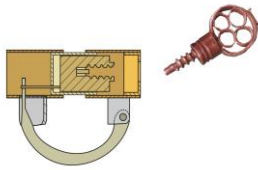


Figure 23. Closed position of screwed padlock (Bir and at all, 2006).

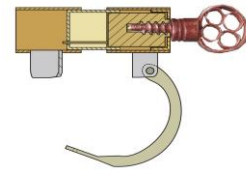


Figure 24. Open position of screwed padlock (Bir and at all, 2006).

TURKISH	LANGUAGE	KELİME
Anahtar	French	Clau
Anahtar	Old Spanish	Clav
Anahtar	Italian	Chiave
Anahtar	Portuguese	Chave
Anahtar	English	Key
Anahtar (Açk1)	Latin	Clavis
Anahtar (Açk1)	French	Clef
Anahtar (Açk1)	German	Schlüssel
Anahtar (Açk1)	Greek	Anakhtora
Asma Kilit	English	Padlock
Asma Kilit	Fransızca	Cadenas
Burgulu Anahtar	English	Screw Key
Emniyet Kilidi	English	Warded Locks
Hareket ettirmek	Sanskrit	Klu
Kale	Latin	Clausura
Kapak	Swedish	Lock
Kapalı yer	Latin	Clausum
Kapatmak	Latin	Claudo
Kapatmak	English	Close

Kilitlemek	Italian	Luchetto
Kilitlemek	English	Latch
Kapı Sürgüsü	English	Bolt
Kilit	Irish	Glas
Kilit	Gal Language	Clo
Kilit	German	Schloss
Kilit	French	Serrure
Kilit	Italian	Serratura
Kilit	Swedish	Las
Kilit	British Saxon	Loc
Kilit	Greek	Kleidi
Kilit \ Kale	Dutch	Slot
Kilit \ Kapı Mandalı	Icelandic	Loca
Kilit \ Kilitlemek	English	Lock
Kilit, sürgü	Latin	Claustrum
Kilitlemek	Itaian Greco	Klu
Kilitlemek	Danish Language	Laas
Sürgü	Italian	Verrou
Sürgü	Dutch	Bout
Sürgü	German	Bolz
Sürgü	Walloon	Ferou, Verou
Şifreli Kilitler	English	Combination locks
Tırnak	Latin	Clavus
Tırnak	French	Clou
Tırnak	Irish	Clo
Tırnak	Gal Language	Clo
Yay	English	Spring
Zincir	Latin	Catena

Table 1. The Lock Mechanism Terms in Turkish and other languages

Conclusions

For years making a lock is one of the most important factors uncovering the skills of people in handicrafts. Humanbeing caused these mechanisms to be keeping alive from generation to generation via the locks they made of stone, wood, iron, or other different types of mines. Today, locksmiths from different regions in our country still survive this tradition. They carry out this art inherited from their ascendants to today and the following generations. In our country, it is possible to encounter with lock samples made of wood, iron in different types. Furthermore, it is also seen that locks and keys from the past up to present have been collected by many collectioners. All around the world and especially in our country, many samples can be seen in some museums and also in the hands of our craftsmen. Such as a large number of lock samples are exhibited in Çengelhan Rahmi M.Koç Industry Museum.

I hope this study will gain different interpretation to the other studies in this field.



Figure 25. Wooden Gerede Lock and Key.



Figure 26. In sight of wooden Gerede Lock

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