

## V.

NOTES ON WOODEN TUMBLER LOCKS. BY J. ROMILLY ALLEN, Esq.,  
C.E., F.S.A. Scot.

The object of the following paper is to describe some ingenious wooden locks, which are still used in remote parts of Scotland at the present day. A few specimens of them are to be found in the Museum of the Society, and it is well that they should receive some passing notice before they share the fate of tinder-boxes and crusies, and become finally extinct. The examples in question belong to the class of tumber locks, and are especially interesting on this account, as being the oldest kind of lock of which we have any knowledge.

Wooden tumbler locks, differing but little in principle from the Scottish ones, have been used in Egypt, Persia, and other parts of the East for two thousand years at least, and probably longer. Mr A. H. Rhind, in opening the tomb of a Theban dignitary, found one of the passages closed by a massive door, remarkable "from its strength and perfect freshness of all its parts, including two wooden pin locks, of the kind now used in Egypt."<sup>1</sup> The locks mentioned in the Bible<sup>2</sup> were also probably of this description.

The historical data, however, at our disposal are so exceedingly meagre, and the specimens of early examples so few, that we are compelled to start with the locks as they exist at the present time, and endeavour to trace out the gradual development of the ideas which led to their invention. In working out this theory it must be distinctly understood that the scheme of development followed is not necessarily one which actually *did* take place, but one which *might* have taken place, and is in fact merely an arrangement of ideas, in which the simpler ones take precedence of those which are more complicated.

<sup>1</sup> A. H. Rhind's "Thebes," p. 94.

<sup>2</sup> Song of Solomon, v. 5 ; Nehemiah, iii. 3 ; Judges, iii. 23-25.

Thus it is assumed that a bolt was invented before a lock, and that a door without bolt, lock, or hinge was the earliest stage of the machine, of which the lock only forms a part.

It is the development of this machine, namely, a door and its fastenings, which we have now to study in order to understand the part which the lock plays in the economy of the whole. A perfect machine has been defined by Prof. F. Reuleaux as "a combination of resistant bodies, so arranged that by their means the forces of Nature can be compelled to do work, *accompanied by certain determinate motions.*"<sup>1</sup> The perfection of a machine in its different stages of development is therefore measured by the *definiteness* of the paths in which its various parts are compelled to move. A perfect machine must, in fact, perform the exact operation it is intended to execute in one particular way, and no other.

And now to apply this test to the machine in question. The earliest form of house door consisted probably of a few rough timbers placed in front of an opening in the wall, so that it could be pushed easily aside and then replaced after exit. A large stone at the bottom, or a bar across the middle, would serve to keep the door shut. A doorway with no trace of a hinge, and with holes on each side of the jambs for the bar in front to be shot into, may be seen at the Tappock of the Tor Wood, and also in some of the other Scottish brochs. When the pivot or hinge was invented the door became a machine, doing work by moving in a definite path. In this form it is found represented in paintings on the walls of tombs at Thebes.<sup>2</sup>

Instead of the detached bar in front, we now have a bolt fastened to the door itself, and shooting into a cavity formed in the jamb to receive it. The object of the bolt is to cause the door to come to rest in a definite position, *i.e.*, when shut; since this is its normal state. The bolt thus follows as a direct consequence of the hinge (with sliding doors we are not at present concerned). From a mechanical point of view, a door turning truly on a hinge with a hand bolt affixed forms together a perfect machine:

<sup>1</sup> Reuleaux's "Kinematics of Machinery," translated by Prof. Kennedy, p. 35.

<sup>2</sup> Sir G. Wilkinson's "Egypt," vol. i. p. 353.

for the door is constrained to move in a definite path, and can be brought to rest by means of the bolt in exactly the right place. We now have to consider the question of whether the bolt shall be placed on the outside or the inside of the door. If it is placed on the outside strangers have access to it as well as the owner; whereas if it is placed on the inside it will either be necessary always to have some one left within to open the door, or some means must be devised for moving the bolt from without. The notion of a key, and consequently also a lock, may have originated from the bolt being placed on the inside of the door with a hole through which a stick or looped thong might be pushed in order to move it. A lock, then, may be defined as a bolt sliding in a fixed frame, in such a manner that a special instrument or artifice is required to move it.

The chief varieties of locks as at present known may be divided into the following classes, namely—

1. Puzzle or keyless locks.
2. Barb-bolt locks.
3. Warded locks.
4. Tumbler locks.

*Puzzle or Keyless Locks.*—Puzzle locks are most frequently keyless, and depend for their security either on having their movable parts concealed by some artifice in the configuration of the exterior or on there being some unknown alteration in the arrangement of the outside parts which will allow the bolt to move. Perhaps an intricately knotted cord is amongst the earliest kinds of puzzle locks. One of this description is mentioned in the Odyssey as being used for fastening a citadel containing treasure. There are puzzle locks also, with keys, where the key hole is concealed by some cunning device in the workmanship of the outside. Sometimes the key itself is a puzzle by having a hidden movable bit which prevents its being inserted into the keyhole. Letter-ring padlocks and dial locks are not properly puzzle locks, but belong to the class of keyless tumbler locks; the tumblers being rings revolving round the bolt, and having letters on the outside by means of which they can be brought into such a position as to free the bolt when the keyword is known. The letter lock is supposed

to have been invented by Cardan, and was improved by M. Regnier, Director of the Musée d'Artillerie at Paris in the seventeenth century, who doubled the rings so as to enable the keyword to be changed. One of these locks is referred to in Beaumont and Fletcher's play of the "Noble Gentleman" thus—

"A cap-case for your linen and your plate, with a strange lock that opens with A·M·E·N." The letter lock is the earliest one in which the permutation principle is introduced. A good example of dial lock, which came from S. Lopham Church, Norfolk, will be found engraved in the "Journal of the Royal Archaeolog. Inst. for 1875," p. 253.

*Barb-bolt Locks.*—These locks have a spring attached to each side of the bolt, like the barbed head of an arrow, which prevents its being withdrawn until the springs are clipped together by a suitable key. Professor Duns has kindly allowed me to inspect several Japanese examples belonging to this class, which he possesses. In Persia these locks are made in the form of some animal, such as a lion or a horse.

There is a lock constructed on this principle in the Swansea Museum, which was dug up at Oystermouth Castle.

*Warded Locks.*—The security of a warded lock is made to depend on the number of fixed obstacles or wards placed between the key and the bolt. The object aimed at is to prevent any implement but one of a particular shape being able to get at the bolt so as to move it. This is done both by making the keyhole of special form and having obstructions within the lock which must be passed before the bolt can be got at. The best kind of wards are of a labyrinthine outline (whence the term "key pattern" applied to the Greek fret). But however complicated they may be, the wards themselves afford a means of ascertaining their shape and position, either by inspection or by introducing a blank key coated with wax. A false key or crooked wire is then used for picking. Warded locks date certainly as far back as Roman times, and notwithstanding their extreme insecurity they are still largely used in this country at the present day. The locksmiths of the sixteenth century appear to have wasted an extraordinary amount of ingenuity in increasing

the complication of the wards.<sup>1</sup> Church keys have sometimes wards in the shape of a cross.

*Tumbler Locks.*—To this latter class belong both the earliest locks of which we have any knowledge, and also the latest and most secure for which patents have been taken out within the last few years. A tumbler (slider, pin, or keeper) is an apparatus for keeping the bolt at rest in a definite position, and in the complete mechanism of a door and its fastenings the tumbler bears the same relation to the bolt that the bolt does to the door; for the bolt prevents the motion of the door and the tumbler fixes the bolt. The idea of a tumbler very likely may have originated in sticking a peg through the bolt to keep it in place when the door was closed. The simplest form of tumbler is that used in the Scottish wooden locks, and consists of a rectangular slider, which moves up and down in a vertical grove cut in the fixed part of the lock, and falls into a notch in the bolt, where it is kept by its weight until released by the key. In the Egyptian locks the tumbler is a circular pin of wood. The Scotch and Egyptian locks are merely bolts fitted with several tumblers, which are lifted by means of a suitable key, thus enabling the bolt to be moved. They may therefore be classified as *multiple tumbler locks*.

The difference between warded and multiple tumbler locks is this: in the former the object aimed at is to place as many obstructions as possible to prevent the key getting at the bolt to move it; whereas in the latter the idea is to present a series of obstacles to the motion of the bolt, which is prevented until they are removed. In multiple tumbler locks, to which class all wooden locks belong, the security depends on the number and position of the tumblers. They are therefore open to the same objection as warded locks, namely, that the tumblers themselves afford a means of ascertaining their number and position either by inspection or by means of a wax mould. These locks might easily be picked with a straight stick and a lump of clay, dough, or other plastic substance, which would take the form of the openings in which the tumblers slide and lift them at the

<sup>1</sup> See "South Kensington Handbooks," Spanish Industrial Art, p. 60. Wards made in the form of Cufic characters.

same time. The weak points of the multiple tumbler locks are—1st, that the lift of all the tumblers is the same; 2d, that although the tumblers require to be lifted to a certain height before the bolt is released, yet if they are raised still higher it makes no difference, and the bolt is just as free as before. Now in the year 1778, on the 31st of October, Mr Barron took out a patent for a tumbler, such that it required to be lifted to a particular height before the bolt could be moved, and if it was lifted the least bit higher the bolt was again detained.<sup>1</sup>

Hence, by placing a series of these tumblers side by side, it became possible to have a lock whose security depended not on the number and position of the tumblers, but on the different amounts of motion which it was necessary to impart to each of them before the bolt could be moved.

This is the principle of *permutation tumbler locks*, to which class all the best modern locks belong, but which stage of development was never reached in the wooden locks. In its latest and most improved form a lock consists of a series of movable parts, the arrangement of which can be altered in such a manner by means of the key as to allow the bolt to be thrown. The arrangement of the movable parts must, however, be capable of being changed in a great many different ways, only one of which will allow the bolt to pass. (A lock might be made so that a particular order of sequence must be followed in the movement of the tumblers; at present they are lifted almost simultaneously).

*Different kinds of Tumblers.*—There are several kinds of tumblers, to all of which the permutation principle is applicable. The chief species are as follows :—

1. The sliding tumbler.
2. The lever tumbler.
3. The revolving tumbler.

*Sliding Tumbler Locks.*—The Scottish and Egyptian locks belong to this class, as the sliders move up and down in straight lines.

The permutation stage of development appears never to have been

<sup>1</sup> See "Tomlinson on Locks" (Weale's Series), p. 49.

reached in wooden locks, and this principle was first applied to sliding tumblers by Bramah in 1784, just ten years after Barron had applied it to the lever tumbler.<sup>1</sup> Bramah's first model, however, had lever tumblers, but working in a plane at right angles to the face of the lock instead of parallel to it, as in previous locks.<sup>2</sup> This is mentioned to show that Bramah did not take a lock with sliders (such as the Scottish ones), and improve upon it by applying the permutation principle directly, but got at his invention by a round-about process, thus : he started with Barron's lock, which had permutation levers, altered the plane in which they worked to one at right angles to it, and then substituted sliders for the levers. The latest and most improved slider lock is Yale's American lock, patented January 29, 1861, and January 27, 1865. The tumblers are here as in the Scottish locks arranged in a straight line ; in the Bramah lock they are placed in a circle round the key.

*Lever Locks.*—In this class the tumbler, instead of moving in a straight groove, is centred on a pin, and moves in an arc of a circle.

The gradual improvements which led up to Barron's great invention of the permutation tumbler in 1774 are as follows :—The early iron locks trusted entirely to wards for their security, and the device for keeping the bolt fixed when it had been thrown consisted of a double notch bellied in the middle, which was made to catch the side of the frame by means of a spring at the top of the bolt. The bolt thus acts as its own tumbler. This is the ordinary and extremely insecure spring lock, still in use. It can always be known by the snapping noise it makes when the bolt is thrown. It can be picked without putting any instrument into the lock, simply by getting a tool round the end of the bolt and pushing it back. The first improvement was to have a tumbler separate from the bolt and centred on a pin of its own. It fell into a notch in the upper side of the bolt, out of which it had to be lifted by means of the key before the bolt could be moved. Barron then introduced an improvement which prevented the tumbler being ineffective when over lifted. This was done by

<sup>1</sup> See "Tomlinson on Locks" (Weale's Series), p. 164.

<sup>2</sup> *Ibid.* p. 71.

making an H-shaped hole in the middle of the bolt, instead of a notch in the top. He also added a second tumbler in front of the first. The last improvement was to make the H-shaped gatings in the tumblers instead of in the bolt, and to transfer the stud from the tumbler to the bolt; the number of the tumblers was also greatly increased, and they were placed one on the top of the other, instead of one in front of the other. Chubb took out his first patent for a lock of this type in February 3, 1818. When this stage had been reached it was supposed that a lock had been obtained, perfect in the sense that the possibility of opening it with any instrument except the proper key depended on chance alone, and that by increasing the number of tumblers, the odds against any one hitting on the right combination of heights for lighting the levers might be made so great as to render picking impossible. In 1851 a rude shock was given to this notion by Mr Hobbs, an American, who succeeded in picking both the Bramah and Chubb lock. His method is known as the tentative one, and depends on the minute imperfections of workmanship which must necessarily exist in even the very best kinds. Pressure is put on the bolt, and the stud thus brought hard against the tumblers, which are then gently lifted one by one, and as soon as the least inequality in the pressure is felt it is known that the stud is opposite the gating of the tumbler which is being tried. The process is repeated for each tumbler, and the bolt can then be thrown. Since 1851 Mr Hobbs, Messrs Chubb, Bramah, and others have introduced improvements, the object of which has been to prevent pressure being applied to the tumblers by the stud on the bolt.

*Revolving Tumblers.*—These move in a complete circle, as for example in the letter padlock, where the tumblers are rings moving round the bolt. This is just the converse of the Bramah lock, where the bolt plate revolves round the tumblers. The letter padlock is the earliest to which the permutation principle was applied, but being keyless it was soon superseded as soon as it was shown that the principle was applicable to other kinds.

*Classification of Locks.*

Multiple sliding tumblers.—Scottish and Egyptian wooden locks (1000 B.C.)



Permutation sliding tumblers.—*Bramah* (eighteenth century), *Yale* (nineteenth century).

Permutation lever tumblers.—*Barron* (eighteenth century), *Chubb, Hobbes, &c.* (nineteenth century).

Permutation revolving tumblers.—Letter padlocks (seventeenth century).

*Keys*.—There are two kinds of keys from a mechanical point of view—1st, sliding keys, which move forwards or sideways in a straight line; 2d, revolving keys, which turn upon a centre. The keys of the Scottish and Egyptian locks belong to the former class.

Having now fully discussed the subject of locks from a general point of view, the rest of the paper will be occupied by a description of the details of the examples illustrated.

The lock shown on fig. 1, which came from North Ronaldsay, Orkney, may be taken as a good typical specimen. It consists of the following combination of fixed and movable parts. In the first place, there is the fixed frame, which is fastened to the outside of the door by means of four stout wooden pins. The shape of the frame will be best understood by the perspective view shown on the diagram. It is a solid block of wood, 1 foot long by  $4\frac{1}{2}$  inches broad by 2 inches thick, which is hollowed out to receive the movable parts, thus; four vertical grooves, 1 inch deep and  $\frac{1}{2}$  inch

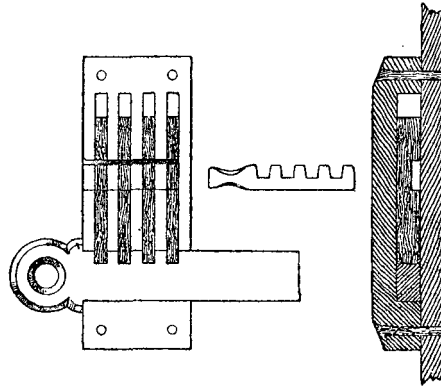


Fig. 1. Wooden Lock, North Ronaldsay.

wide, are cut to receive the tumblers at equal distances apart. A horizontal groove, 2 inches broad by 1 inch deep, is formed at the bottom of the tumbler grooves, to receive the bolt. There is a second horizontal groove,  $1\frac{1}{4}$  inch broad by  $\frac{3}{8}$  inch deep, higher up, just large enough to

allow the key to be inserted. Now come the movable parts. The bolt is 1 foot long by 2 inches by 1 inch, and has four notches cut in its upper surface for the ends of the tumblers to fall into. The key is 6 inches long by 1 inch by  $\frac{1}{4}$  inch, and has four lifting teeth on the top corresponding to each of the four tumblers. The tumblers are rectangular pieces of wood, 6 inches long by 1 inch by  $\frac{1}{2}$  inch, having notches cut in the sides to enable them to be lifted by means of the key.

The working of the lock is as follows :—When the tumblers are resting by their own weight in the notches of the bolt it is impossible to move it. The tumblers are lifted by means of the key, each tooth of which when it is inserted comes just under each one of the notches before described. The key is held with one hand and pushed first forwards as far as it will go, and then moved vertically upwards to the extent of the depth of the teeth of the key (which is equal to the throw of the tumblers). When this has been done the bolt is drawn with the other hand. Thus the Scottish locks require two hands to open them, whereas the Egyptian ones only require one.

The next batch of locks to be described differ from the preceding one in that the lifting teeth of the key project from the side instead of the top.

The rudest of these specimens is one belonging to the Museum (fig. 2), which was brought from St Kilda by

Mr Sands. It has two tumblers, apparently shaped with a penknife. The lifting pins on the key are of iron. The following detail should be noticed, namely, that the part of the tumbler, above the lifting notch, is cut away to the extent of the thickness of the key; the object being to prevent the lock being picked by means of a straight stick.

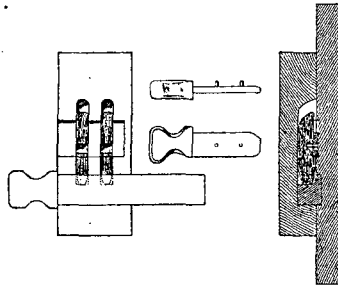


Fig. 2. Wooden Lock, St Kilda.

The next specimen (fig. 3) belongs to Dr Mitchell, who has kindly placed it at the author's disposal, and comes from Harris, in the Hebrides. The

lifting teeth are here also at the side of the key, but they are of wood, and cut out of the solid.

In order to prevent picking with a straight stick, instead of cutting away the top of the tumbler, there is a notch next the haft of the key and a corresponding obstruction at the mouth of the keyhole.

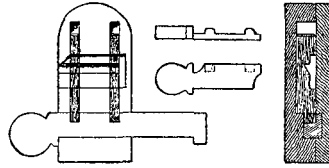


Fig. 3. Wooden Lock, Harris.

The last lock of this type here described (fig. 4) comes from the Faröe

Isles, and is now in the Industrial Museum. The author is indebted to the courtesy of Mr Archer, the Director of the Industrial Museum, for being permitted to draw it. It is a very pretty specimen, and has three tumblers. The key is of iron, and lifts from the side.

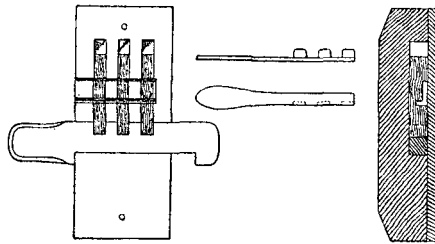


Fig. 4. Wooden Lock, Faröe Isles.

There is still a third type of Scottish wooden lock, which differs

from those already described in having double sets of tumblers in place of single ones. Two most ingenious examples of this kind will now be described. The first is in the Museum of this Society, and comes from Snizort, in Skye. It

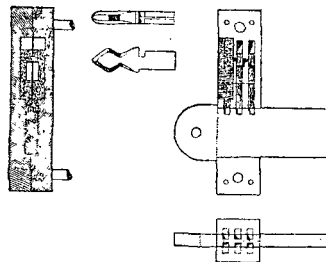


Fig. 5. Wooden Lock, Snizort.

(fig. 5) has six tumblers, working independently of each other, and consists

simply of two ordinary locks such as those already described, put face to face, with the bolt placed between them. The key is double, and has a notch next the haft to prevent picking with a straight stick, as previously explained. The keyhole is divided into two by a thin wrought iron plate. This is the only thing approaching a ward which appears in these wooden locks.

The next specimen to be dealt with (fig. 6) is by far the most ingenious and interesting of all. It is the property of Dr Mitchell, and was copied

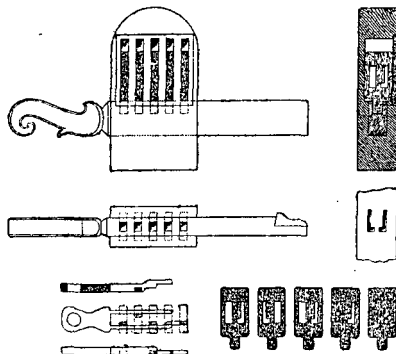


Fig. 6. Wooden Lock, Harris.

from a lock on a door in Harris, Hebrides. The key is double, but the tumblers are single, and are lifted alternately by each limb of the key. The forms of the different parts will be fully understood from the drawings. Each tumbler has two holes in it, one of which is rectangular and the other L-shaped. The

rectangular hole is to allow one side of the key to pass through, in order that it may lift the tumbler beyond. The L-shaped hole is to enable the projecting tooth, on the inside of the key, to catch under the lower part of the L, and lift the tumbler. The key would open the lock just as well if *both* of the holes in the tumblers were L-shaped, but the object of making one of them rectangular is to prevent a key with lifting teeth on the wrong side from opening it. The way in which the key twists at the end so as to get into the hole in the farthest tumbler is worthy of notice, and considerably increases the difficulty of picking.

Having now described the main features of the Scottish wooden locks, two illustrations of Eastern pin-locks will be given for comparison.

The first (fig. 7) was presented to the Industrial Museum by Messrs Chubb, and comes from Egypt.

The fixed frame, which is fastened against the door, consists of a block of wood,  $6\frac{1}{2}$  feet long by 2 feet by  $1\frac{3}{4}$  feet, with a cross groove cut in it for the bolt to slide in. In the top of this piece are bored three holes to receive the tumblers, which are merely round pins. After the tumblers are inserted the holes are plugged up at the top. The bolt is 11 inches long by 2 inches by  $1\frac{1}{4}$  inch, and has three holes into which the tumblers fall. The key hole and key-way are formed by hollowing out the *bolt itself* and in this respect the

Eastern lock differs from the Scottish lock and all others. The object of this is that the tumblers may be raised and the bolt drawn simultaneously. The Egyptian has thus the advantage over the Scottish

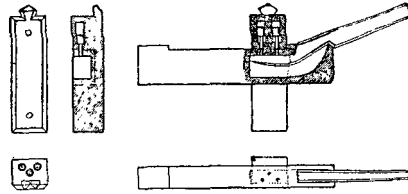


Fig. 7. Wooden Lock, Egypt.

lock that it can be opened with one hand instead of two, and also that the lock can be fastened to the inside of the door, a hole being left through which the hand is thrust. The method of hollowing out the bolt is deserving of notice. It is effected by making two mortise holes, one in the top of the bolt and the other in the side which goes against the door, and joining them. The key is thrust into this hole, and lifts the tumblers by means of three pins. Observe the notch at the back of the key, which helps to steady it and act as a fulcrum for leverage in drawing the bolt.

The second Eastern lock (fig. 8) is a model to a scale made from measurements taken by the author from an original example on the door of a house in a village near Rudbar, on the road between Resht and Kasvin, in Northern Persia. It much resembles the Egyptian lock just described. The key is of slightly different form, and has no notch at the back; the tumblers, two in number, are placed in a mortice hole instead of in circular holes bored from the top and plugged. All the locks in the village re-

ferred to were on the inside of the doors. One example had rectangular tumblers like the Scottish ones, but they were lifted by means of a key

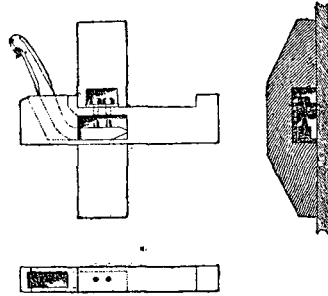


Fig. 8. Wooden Lock, Persia.

with round pins for teeth. The description of the details of these remarkable objects is now concluded, and it may not be out of place to mention that all the drawings have been carefully made from the locks themselves, and that they have never been before illustrated.

The geographical distribution is a point worth considering, and further information on the subject will be gratefully received. The locks with rectangular tumblers are still used in Skye, the Hebrides, Orkney, Shetland, and in the Feröe Isles, and Prof. Tomlinson adds also in Cornwall. The locks with circular pin tumblers are used at the present day in Egypt, Asia Minor, Persia, and Thibet.