2 Sheets-Sheet 1.

# H. Isham,

## Permutation Lock.

No. 17,740. Patented July 7, 1857.

Fig. 8.



Fig. 6.

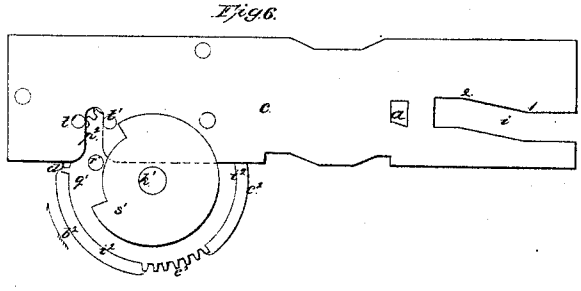


Fig. 3, B, b,

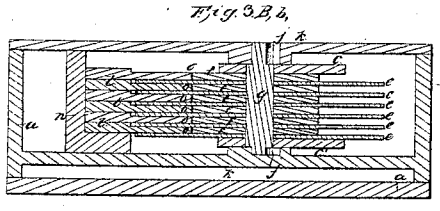


Fig. 2, A, a,

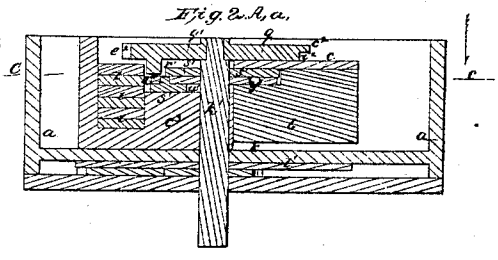
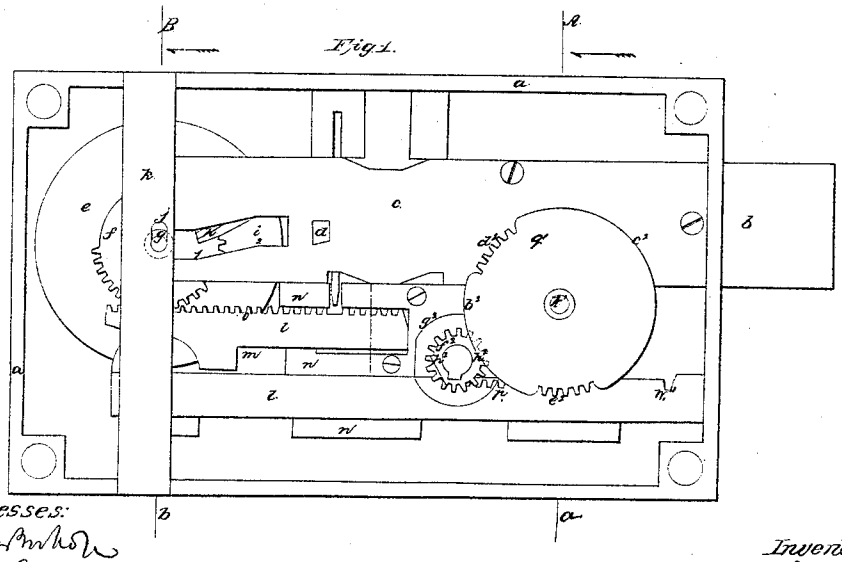


Fig. 1.



Witnesses:

Inventor

Henry Isham

2 Sheets-Sheet 2.

# H. Isham,

## Permutation Lock.

No. 17,740. Patented July 7, 1857.

Fig. 7.

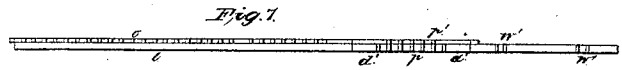


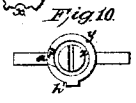
Fig. 11.



Fig. 12.



Fig. 10.



Figs. 4, C, C.

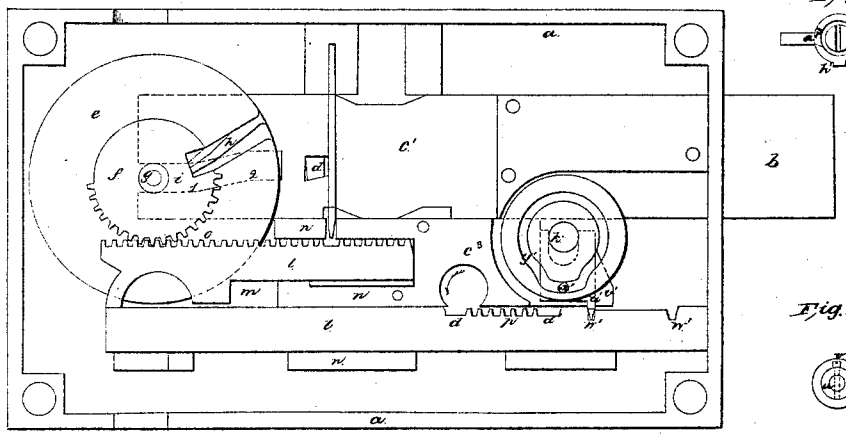
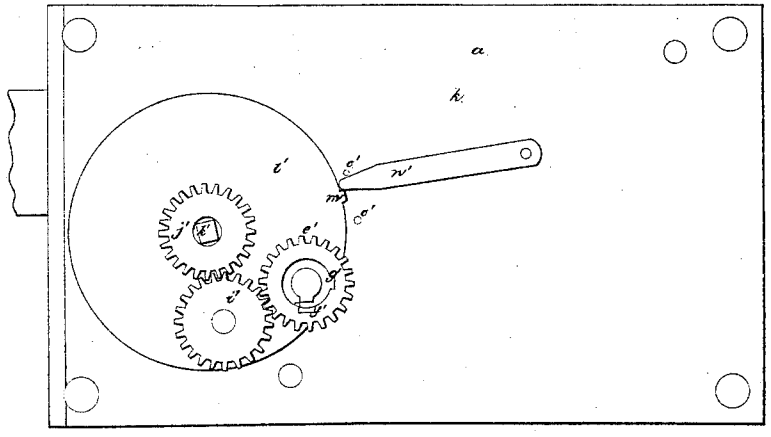
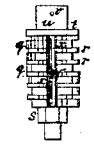


Fig. 9.



Fig. 5.







Witnesses:

Wm. A. Wilson

Bell Wilson

Inventor:

Henry Isham.

AM. PHOTO-LITHO. CO. N.Y. (OSBORNE'S PROCESS.)

# UNITED STATES PATENT OFFICE.

HENRY ISHAM, OF NEW BRITAIN, CONNECTICUT.

## LOCK.

Specification of Letters Patent No. 17,740, dated July 7, 1857.

*To all whom it may concern*:

Be it known that I, HENRY ISHAM, of New Britain, in the State of Connecticut, have invented certain new and useful Improvements in Combination or Permutation Locks for Doors, Safes, &c.; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a view of the inner face of the lock with the plate removed and with the bolt thrown out; Figs. 2 and 3 cross sections taken at the lines A, *a* and B, *b* of Fig. 1 and looking in the direction of the arrows; Fig. 4 a section taken in a plane parallel with the face and at the line C, *c* of Fig. 2; Fig. 5 a view of the front face with the outer plate removed; Fig. 6 is an inside face view of one of the cheeks of the bolt, and the mechanism by which it is operated; Fig. 7 a plan of the upper edge of one of the tumbler slides; Fig. 8 an elevation of the entire key; Fig. 9, separate views of the bit; Fig. 10, an end view of the handle; and Figs. 11 and 12, sepraate views of two of the rings composing the key.

The same letters indicate like parts in all the figures of the drawings.

In the said drawings (*a*) represents the case of the lock, which may be of any suitable form and construction, and (*b*), the bolt which works in a mortise in the end face of the case in the usual manner, and between suitable guides that it may move in a straight line when thrown in or out. The rear part of the bolt has two parallel cheeks (*c*, $c^1$) which may be formed by attaching two plates to the solid part of the bolt, or by cutting out of the solid metal to form an open space that the rotating tumblers, to be presently described, may be embraced between the said cheeks and admit of the working of the bolt as it is thrown in and out. A pin (*d*) is secured to the two cheeks and extends across from the one to the other, and is so located relatively to the rotating tumblers that the bolt cannot be thrown back except when the tumblers are in the required position.

The rotating tumblers (*e*) are composed each of a circular metallic disk, and to one face of each is secured a cogged sector (*f*). The whole series of tumblers are mounted on a central shaft (*g*) on which each one, with its cogged sector, turns freely and independently of the others. And in each tumbler a slot (*h*) is cut, extending from the periphery to within a short distance of the shaft, and this slot must be of a width which will admit the pin (*d*) to slide in it freely but accurately. The form of this slot in the direction of its length is peculiar and will be presently described.

The ends of the shaft (*g*) of the series of tumblers pass through slots (*i*) one in each cheek (*c*, $c^1$) of the bolt, so that the bolt may slide longitudinally on the shaft as it is thrown in and out without moving the tumblers longitudinally. And to prevent the throw of the bolt from moving the tumblers longitudinally the ends of the shaft (*g*) are fitted to slots (*j*, *j*) in two plates (*k*, *k*), one on each side of the bolt cheeks and secured to or making part of the lock case; and these slots are at right angles to the line of motion of the bolt. The slots (*i*, *i*) in the cheeks of the bolt are for a short distance at each end straight and in the direction of the line of motion of the bolt, so as not to move the tumblers; but the middle portion from the point 1 to 2 is oblique for the purpose of moving the series of tumblers down as the bolt is thrown out, and to lift them up as the bolt is thrown in. This arrangement is for the purpose of engaging the cogged sectors on the rotating tumblers with a series of sliding cogged racks operated by the key and to disengage them therefrom. As the slots in the cheek are partly oblique for the purpose of moving the series of tumblers up and down by the throw of the bolt, it follows as a necessity that there must be a corresponding obliquity in the slots of the tumblers in which the pin (*d*) of the bolt slides, that the said pin may slide therein without turning the tumblers as they are carried up or down to disengage or engage the cogged sectors (*f*) with the cogged racks.

Below the bolt and series of rotating tumblers there is a series of slides (*l*) called the tumbler slides, corresponding in number with the cogged sectors on the tumblers. They are slotted as at (*m*) to slide longitudinally between ways (*n*, *n*) attached to the lock case. The upper edge is provided with cogs to form two cogged racks, one (*o*) toward the rear end to engage the cogged sectors on the tumblers, and the other (*p*) to be engaged by the cogs of sector pinions on the key, and the part (*o*) is made thinner than the rest to enter and slide freely between the tumblers.

The key is composed of two series of rings

(q) and (r) fitted accurately onto a spindle and firmly held between a fixed shoulder (s) near one end, and the flange (t) of a thimble (u) at the other, which thimble is secured in place by a cross screw (v) the head of which projects from the periphery of the thimble. The two series of rings are feathered to a longitudinal pin (w), see Fig. 9 (elevation), held at its ends by the shoulder (s) and flanch (t), but they may be prevented from turning on the spindle in any other way. The two series of rings are all turned of the same diameter, and each ring of the series (q) is formed into a cogged sector extending about one-third the circumference, the other two-thirds being cut down to a diameter not greater than the bottom of the cogs, but the cogs on each sector must commence at a different distance from the feather than on the other rings of the series. The cogs must match the cogs on the racks (p) of the tumbler slides (l) to be presently described. The rings of the other series (r) are to be interposed between the cogged rings forming pairs consisting of one cogged and one non-cogged ring. And a segment of each ring (r) is cut down to the diameter corresponding with that of the bottom of the cogs of the rings (q) leaving on each a non-cogged segment corresponding in extent with that portion of the corresponding cogged ring which is not cogged and including one cog at each end of the cogged segment.

As the position of the cogged and non-cogged sectors relatively to the feather in any one pair differs from the other pairs it will be seen that the shifting of the pairs on the spindle will change the permutation or combination. For the purpose of inserting the key a section (x) of the non-cogged sector is cut out, and when the key is to be inserted that portion of the key must be down so as to pass freely over the cogs of the racks (p) on the tumbler slides (l). The key is made attachable to, and detachable from, the handle or shank (y), and for this purpose the cylindrical part of the thimble (u) fits in a socket in the end of the shank or handle, which socket is provided with a helical spring (z) see Fig. 10, the tension of which tends to, and does force the key out when liberated. An inclined groove (a′) is cut in from the forward end of the shank or key handle, of sufficient width to receive the projecting head of the screw (v) on the key spindle, so that by placing the socket of the key handle onto the end of the key spindle, and forcing it forward and turning the handle a quarter of a revolution the head of the screw enters and moves in the oblique groove, until it reaches the bottom thereof where the front edge is slightly notched, as at (b′), see Fig. 8, to receive the head of the screw to act as a catch to hold the key in the handle. The separation is effected by the reverse motion.

The key hole within the lock, is a hollow cylinder made in a solid block of metal ($c^3$) forming part of the lock case, and of such diameter and length, as to receive the entire key. The lower part of this block of metal is cut out that the racks (p) of the series of tumbler slides (l) may extend therein to be acted upon by the cogged and non-cogged sectors of the key bit. The object of the rack (p) is to enable the cogged sector on the key to move the tumbler slide back and forth to the required distance, and the opposite part (p′), see Fig. 7, to enable the non-cogged sector to control the slide at the end of each movement and prevent it from being moved back, and yet enable the cogged sector to move it in either direction at the required time. For this purpose the edge of the slide at and beyond each end of the rack is cut down as at (d′) for a short distance at each end. The upper edge of the slide at each end and beyond the parts (d′, d′) will be above the lower part of the periphery of the non-cogged sectors. From this it will be seen that the moment the cogged sector has carried the tumbler slide to the required distance the non-cogged sector comes into play, and while the key continues to be turned it acts as a stop to prevent the movement of the tumbler slide because its periphery is below the line of the upper edge beyond the parts (d′).

Between the two front plates that is, between an inner and an outer front plate there is mounted a cog wheel (e′) the eye of which constitutes the entrance hole for the key and of the size of the key hole before described. Two notches (f′) and (g′) are cut in the eye of this wheel at a quarter of a circle from each other, the one (f′) to permit the free entrance of, and the other to receive and hold a spur (h′), see Fig. 10, on the key shank. And this wheel engages the cogs of another wheel (i′) which in turn engages a third wheel (j′) on a shaft (k′) fitted to turn in suitable boxes in the lock case. The shaft (k′) carries a plate (l′) with a hole near its periphery of the size of, and corresponding with the key hole when the parts are in a position for inserting the key to unlock; but the moment the shaft is turned in either direction the plate covers the inner key hole to inclose the bit of the key. On the periphery of the said plate, which may be termed the movable escutcheon plate, there is a spur (m′) see Fig. 5, which, as the plate is rotated in either direction strikes against the end of an arm (n′) which vibrates between two fixed studs (o′, o′) to stop the wheel in the required position.

After the key has been inserted the handle is turned to the left a quarter of a turn which disengages it from the key bit, and then it is drawn back until the spur (h′) enters the other notch (g′) in the eye of the wheel (e′), leaving the bit of the key in its place within the lock,

and then, by turning the key, motion is imparted to the train of cog wheels above described which causes the escutcheon plate to pass between the key bit and its handle, closing up the key hole, and at the same time turning the shaft ($k'$) to impart the required motions to the other parts of the lock.

The first succeeding motion in locking is to throw the bolt out. To effect this, one of the cheeks ($c$) of the bolt is formed with a slot ($p^2$), see Fig. 6, cut in from the lower edge, the sides of which slot are at right angles with the line of motion of the bolt, and parallel with each other, except toward the lower edge, where they are made to flare outward. On the shaft ($k'$) before described, there is a wheel ($q'$) provided with a cylindrical pin ($r'$) projecting from its inner face, which pin fits accurately but freely, the slot ($p^2$) in the cheek of the bolt. When the wheel is rotated in the direction of the arrow, see Fig. 6, by the means before described, the pin ($r'$) enters the slot ($p^2$) and acting on the back edge thereof, carries the bolt backward to the extent of its range of motion in that direction, at which time the pin ($r'$) leaves the slot where the edge is rounded or flared. When the bolt is thrown forward to lock, the same operation takes place, but in the reverse direction.

In all permutation locks in which tumblers or like means are employed to check the back movement of the bolt until the proper key is inserted, it is important to prevent picking, that the bolt be so held that by the application of force it cannot be forced back against the tumblers, for unless that can be prevented, the process of picking, by what is termed feeling the required position of the tumblers cannot be prevented. To prevent the forcing back of the bolt on the shaft ($k'$) there is another wheel ($s'$) at a sufficient distance from the wheel ($q'$) to permit a portion of the cheek ($c$) of the bolt to slide freely between them. A segment of the said wheel ($s'$) is cut out to an equal distance on each side of the pin ($r'$), see Fig. 6, and on the inner face of the cheek ($c$) there are two projecting pins ($t'$, $t'$,) one on each side of the slot ($p^2$) and at such height above the lower edge of the cheek as to be in a line within the periphery of the wheel ($s'$). From this arrangement or relation of the parts described, it will be seen that while the pin ($r'$) is acting in the slot ($p^2$) of the cheek, to throw the bolt either in or out, the pins ($t'$ $t'$) on the cheek are free to pass by the wheel ($s'$) on account of the segment which is cut out, and hence the bolt can be thrown in or out; but as the pin passes out of the slot, at the end of the throw of the bolt, the cut-out segment passes by and then the periphery of the wheel ($s'$) intervenes and prevents the pins ($t'$, $t'$) from passing, and hence the bolt cannot be moved in the opposite direction, unless the cut-out section of the wheel be brought back to the required position. In this way the bolt is firmly held so that it cannnot be forced against the tumblers to feel when they are brought to the required position. An additional security against feeling the position of the tumblers consists in the employment of a stop to hold the tumbler slides ($l$) until the keyhole is covered. This is effected by a plate ($u'$) adapted to slide in suitable ways ($v'$) at right angles to the line of motion of the tumbler slides, the lower edge of which plate is fitted to enter a notch ($w'$) cut in the upper edge of each of the said slides. The plate is provided with a pin ($x'$), which is received in and actuated by a cam groove ($y'$) in a wheel attached to the wheel ($s'$) on the shaft ($k'$) before described, which cam groove is so formed that in turning the shaft to throw out the bolt, the stop plate ($u'$) is first elevated to release the tumbler slides, and after all the locking motions have been performed to force it down again to hold the said slides while the keyhole is open. The same effect is also produced in unlocking, so that the tumbler slides cannot be moved when the bolt is in the unlocked or locked position, thereby avoiding the possibility of taking an impression from which to make a false key.

In a former part of the description the construction and manner of inserting the key was described, as also the manner of separating the key handle from the bit, and putting in motion the train of wheels to turn the shaft ($k'$) and throwing the bolt, but before the bolt is thrown out it is necessary to impress the combination of the key bit on the tumbler slides, because the tumblers are depressed, as already described, by throwing out the bolt to make the cogged sectors ($f$) on the tumblers engage the racks ($o$) of the slides while the pin ($d$) of the bolt is yet in the slot of the tumblers, and hence the slides at the time of this engagement must be put in the promiscuous positions due to the combination adopted, so that when the bolt has been thrown out and the key turned back and withdrawn, the slots in the several tumblers will be put out of position and out of order to prevent the back movement of the bolt.

By inspection of the key it will be seen that the series of sector pinions are so arranged on the stem of the key that they are all on the same side of the axis, although the beginning of the range of cogs of no two of them are in the same line; there is however a non-cogged space extending through the whole length of the stem sufficient in width to admit of inserting and withdrawing the key notwithstanding the cogs of the series of slides project within the keyhole. Supposing the bolt to be thrown back or in the

unlocked condition and the series of rotating tumblers to be lifted up so that their cogged sectors are clear of the racks on the slides ($l$), with the pin ($d$) of the bolt inserted in the slots of the rotating tumblers so that they can not turn, in that condition the key is inserted and turned in the direction indicated by the arrow see Fig. 4 to the extent of half a revolution and there held. It will be observed that if the sectors of cogs on the pinions of the key commenced in the same line the semirevolution of the key would have carried all the tumbler slides ($l$) to the same distance, and that if the series of tumblers were then let down their cogged sectors would all become engaged with the racks ($o$) of the slides while in the same position and then to open the lock it would only be necessary to insert a pick to draw all the slides to the same distance to bring the slots of the series of tumblers in the required position to permit the bolt to move back, which could be readily done. But as the sectors of cogs on the key begin at different points the semirevolution of the key carries the tumbler slides each to a different distance. Each slide having thus been moved to a different distance, by the semirevolution of the key, the bolt is then thrown out by the means described. The continued outward motion of the bolt by the form of the slots ($i$, $i$) in the cheeks ($c$, $c'$) depresses the series of rotating tumblers and causes the cogs of the sector ($f$) on the tumblers to engage the racks ($o$) on the tumbler slides while the pin ($d$) of the bolt is still in the slots of the tumblers. In this way the rotating tumblers, while their slots are all in line, become locked or engaged with the slides which are out of line, that is after each has been carried to a different distance due to the position of the series of sector pinions on the key, and by this means the peculiar arrangement of the key is transferred to the tumblers in the act of throwing out the bolt so that the combination or permutation, however it may be varied, will be thus transferred to the tumblers by the act of throwing out the bolt to lock. The further outward motion of the bolt carries the pin ($d$) out of the slots of the tumblers to liberate and leave them entirely to the control of the rack slides, and at the same time the stop or hold fast plate, if one be used, is drawn out of the cogs of the slides so as to liberate and leave them to the control of the key. As the slides have been moved to different distances by the key at the time the tumblers became connected with them, and as the slots of the tumblers at the same time were all in line, it follows that after the slides are carried to the full extent of their motion, or if preferred brought back to their original position, the slots of the several tumblers will be all in different positions, so that if any attempt be made to throw back the bolt it will be prevented from moving back by the pin ($d$) striking against the periphery of the tumblers, and the only way in which it can be permitted to move back will be to bring the tumbler slides to the relative position in which they were at the time the tumblers were engaged with them, and hence the burglar is left entirely to the chance of getting the combination or permutation of the key by which the bolt was locked; and as the combination is on the key alone, that can be changed every day if desired, which change would be attended with serious inconvenience if it had to be made in the tumblers also as in the generality of permutation locks heretofore made.

It now becomes necessary to describe the manner in which the key bit is turned within the lock after the handle has been withdrawn to impart motion to the shaft ($k'$). The wheel ($q'$) before described, which carries the pin ($r'$) for throwing the bolt, has its periphery formed with two nearly opposite smooth segments ($b^2$) and ($c^2$) and two nearly opposite cogged sectors ($d^2$) and ($e^2$) to act on the cogs of a pinion ($f^2$) see Fig. 1. This pinion is held in place by a bracket ($g^2$), shown by red lines in Fig. 1, leaving the eye free to receive within it the shoulder ($s$) on the end of the key spindle which is provided with a feather to enter a corresponding notch in the eye of the pinion. Being thus connected, the rotation of the pinion will turn the key bit. The pinion has cogs upon its entire periphery on about one-half of its thickness, and on the other half of its thickness the cogs extend only on two opposite segments, the other two segments being cut out, as at ($h^2$, $h^2$) forming cavities to fit the periphery of the two smooth segments ($b^2$, $c^2$) of the wheel ($q'$) before described. And one-half of the thickness of the said wheel ($q'$) along the smooth segments is also cut away, as at ($i^2$), see Figs. 2 and 6, to allow the cogs on the parts of the periphery of the pinion ($f^2$) opposite its cut-out segments to pass freely. The cut-out segments of the pinion at each end extend over about one-half of the first cog at each end of the cogged segments for the purpose of aiding the reëngagement of the cogs of the wheel and pinion. Now from the above construction it will be seen that the moment the shaft ($k'$) is turned to throw out the bolt one of the cogged segments on the wheel ($q'$) engages one of the cogged segments of the pinion and turns it the required distance to turn the key bit and operate the slides to put them in the position required for the reception of the cogged sectors on the tumblers when they are depressed by throwing out the bolt which immediately follows. But so soon as the key bit has been turned to the required extent it is important to stop its

further movement for the time being, and to do this by a positive motion which will not only stop its further motion but prevent it from reacting, for accuracy of position is essential to avoid the use of springs which are objectionable in locks. This accuracy of positive intermittent and stop motion is secured by this arrangement, for the moment the pinion has been rotated to the required extent by one of the cogged segments of the wheel ($q'$) one of the smooth segments passes into one of the cut-out segments of the pinion which it accurately fits, so that although the wheel continues to turn the pinion is positively held from turning in either direction. In this way the wheel has perfect control of the pinion, the pinion of the key bit, and the cogged and noncogged segments of the key bit of the tumbler slides so that these latter are perfectly controlled in their movements and positions without the necessity of using springs which are not reliable. The continued rotation of the wheel effects the throwing out of the bolt by the pin before described; and then, the tumblers having been thereby connected with the tumbler slides, the next cogged segment of the wheel acts on the pinion again to turn the key bit in the same direction to carry the tumbler slides to the full extent of their range of motion in that direction. This latter motion is not essential to the locking, but it becomes essential with the view to safety. If carried only far enough to effect the locking it will be seen that no two of the tumbler slides would be carried to the same distance because the several cogged sectors of the key begin to act on the slides at different periods of the motion of the key bit. If this course were pursued for any length of time, with the same combination on the key which might occur from neglect or overweening confidence in the safety of the lock, each slide would become worn to the extent of its range of motion under the given combination, and then by gently moving each slide with a pick until the motion became slightly harder, which would be the case on reaching the part not worn, the range of motion of each slide might be determined from which to make a false key. But if the key bit be turned to a sufficient extent every tumbler slide will be carried to the full range of its motion, and hence each will receive an equal amount of wear which will cut off every clue to the combination used.

After the motions above described have been performed the key handle is again forced into reëngage the key bit which is effected by pushing and turning the handle to the right, and after engaging the key bit it is drawn out, the cutout portion of the key bit being at the bottom to admit of the withdrawal.

The object of using a train of three wheels to communicate the required motions to the mechanism, as before stated, is simply to reverse the movements of the connecting parts that the key handle may be turned in the same direction during all the motions required for locking and restoring the tumbler slides preparatory to withdrawing the key. If but two wheels were used the key handle would have to be turned in a reverse direction to restore the tumblers, which by neglect might be overlooked to the injury of the mechanism. To unlock, the key is inserted in the same manner as for locking, and then the handle is disengaged from the key bit and engaged with the eye of the wheel ($e'$), the required motions are then made to impress the key onto the tumbler slides to bring the slots of the several tumblers in line that the bolt may be thrown back.

It will be obvious to all skilled in mechanics that the construction of the several parts and their relative location may be modified without changing the principle or mode of operation of the several characteristic features which distinguish my invention from all other things before known, and from the lock secured to me by Letters Patent bearing date the 1st day of July, 1856, and therefore, I wish it to be distinctly understood that I do not limit myself to the special form or construction of the several parts so long as the same results are obtained by equivalent means.

I am aware that in permutation locks a stop has been employed to enter a notch in the bolt at the end of its outward motion to lock the bolt so that it cannot be pushed back except by first inserting the key and by the key first removing such stop. And therefore, I do not wish to be understood as making claim broadly to the use of a stop for locking the bolt in combination with the mechanism for throwing the bolt.

What I claim as my invention and desire to secure by Letters Patent, is—

1. Combining with the mechanism for throwing the bolt, or any equivalent therefor, a mechanism which rotates with the said bolt throwing mechanism, and which by such rotation at the end of the throw of the bolt interposes its periphery to the line of travel of the bolt, or some part of it, and thereby prevents the bolt from being forced back until the bolt throwing mechanism is brought to the required position for throwing back the bolt, substantially as described.

2. I also claim the combination of the non-cogged sector and the cogged sectors on the key bit, with the cogs and projections on the tumbler slides, substantially as described, or any equivalent therefor, where-

by the said slides are controlled by the key bit, as set forth.

3. And finally I claim the mode, substantially as described, of imparting an intermittent motion to the key bit and stopping the same while the mechanism, which imparts such motion continues to move, by means of the wheel and pinion having their engaging peripheries constructed substantially as described.

HENRY ISHAM.

Witnesses:
HENRY NASH,
S. E. CASE.