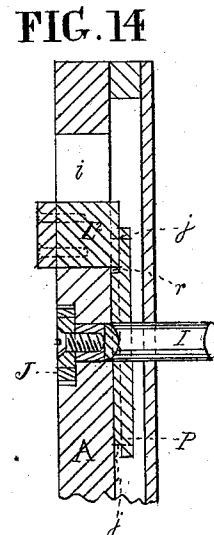
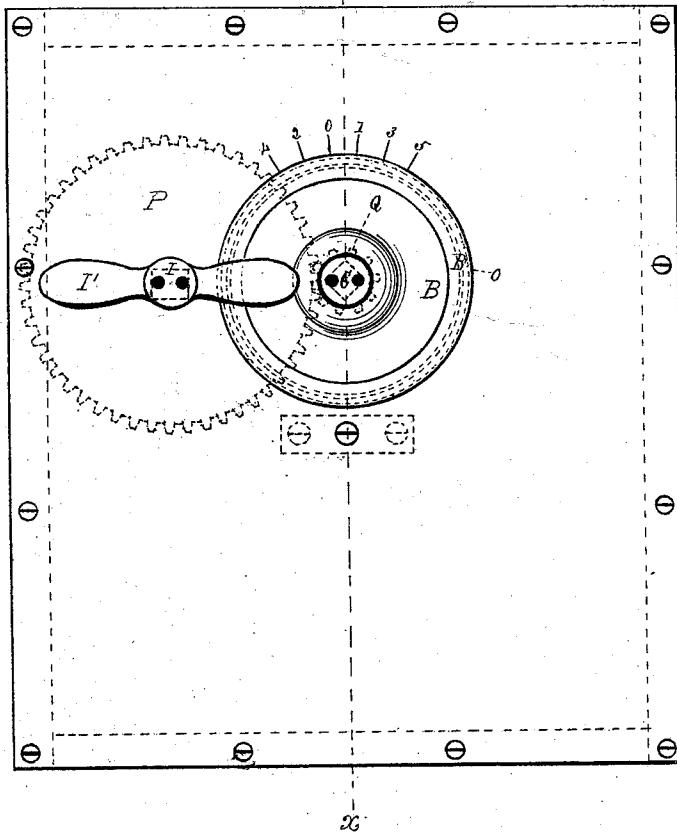
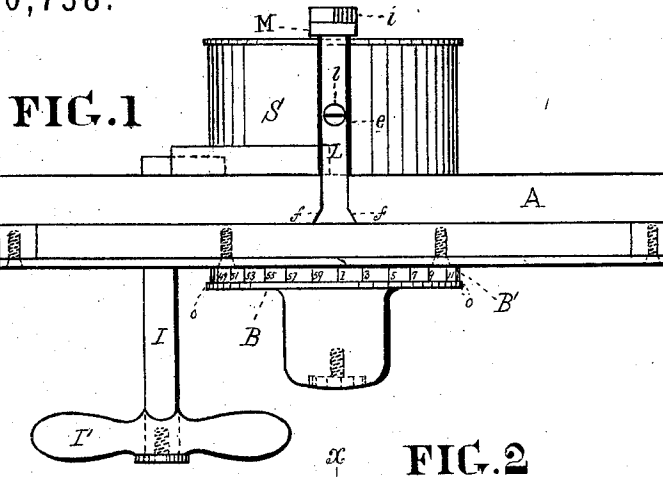


T. B. WORRELL.
Permutation-Locks.

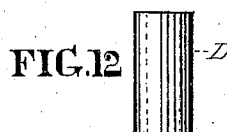
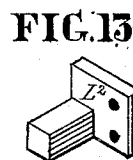
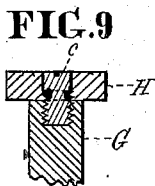
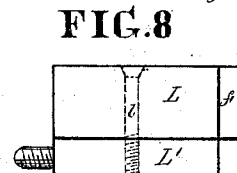
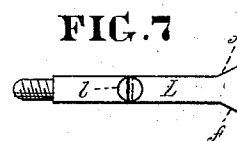
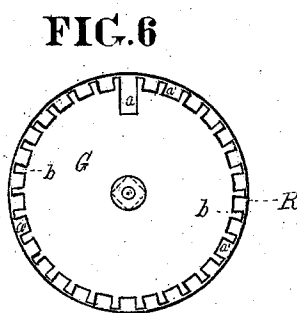
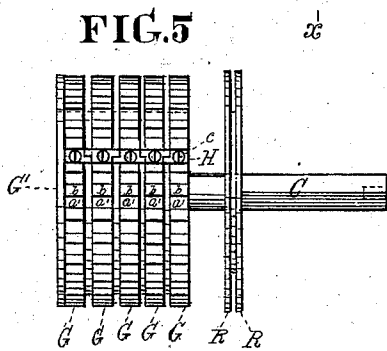
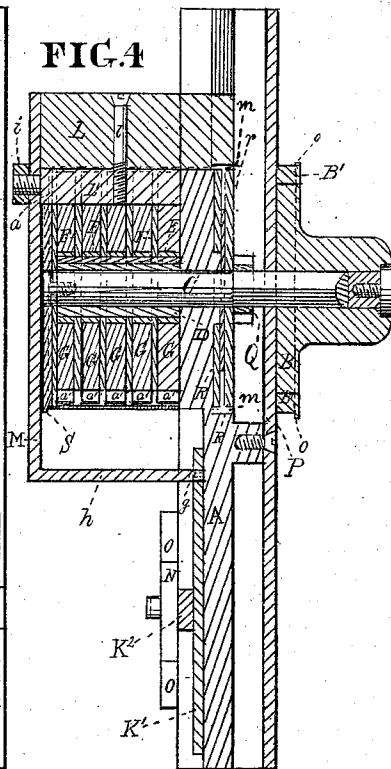
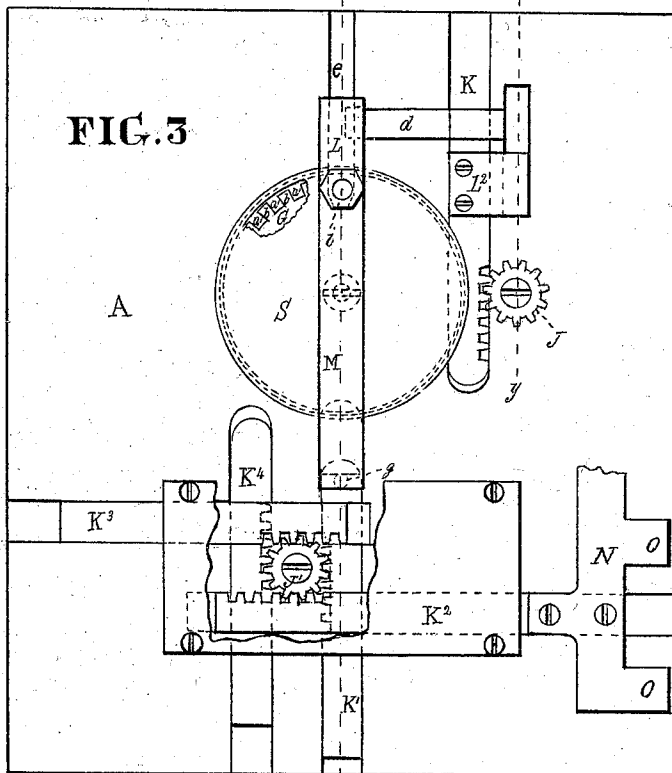
No. 150,738.

Patented May 12, 1874.



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UNITED STATES PATENT OFFICE.

THOMAS B. WORRELL, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN PERMUTATION-LOCKS.

Specification forming part of Letters Patent No. **150,738**, dated May 12, 1874; application filed March 26, 1874.

To all whom it may concern:

Be it known that I, THOMAS B. WORRELL, of the city and county of Philadelphia, in the State of Pennsylvania, have invented an Improvement in Bank-Locks, of which the following is a specification:

The first part of my invention relates to the construction of the tappet-slots and dog-slots of the combination-wheels or tumblers of equal width, and all the divisions between the slots of uniform width, and the tappets with projecting ends (for interlapping each other) of one-third the width of the slots, whereby, when the wheels are taken up, the divisions are in zigzag position in relation to each other, and thereby arrest the descent of the dog, and, the dog-slots and tappet-slots being of equal width, a burglar or lock-picker cannot, by feeling, determine one from the other. The second part of my invention relates to the construction of the dog in two pieces, held together by means of a screw-bolt or its equivalent, the lower piece only having connection with reciprocating racks carrying locking-bolts, so that if a burglar should attempt to remove the lower part by drilling through it, to cut off its connection with the combination-wheels, he would also cut off all communication between the bolt-spindle and the locking-bolts; or, if he should blow off or break the lock, he would also cut off all communication with the locking-bolts. The third part of my invention relates to the use of a supplemental dog for keeping the above-mentioned dog above the combination-wheels during the interval of its disconnection therefrom, it being held up by the periphery of a wheel in a recess of the bed-plate, or by any other suitable device. Another purpose of the supplemental dog is the prevention of a burglar or lock-picker feeling the combination-wheels at each revolution of the dial by means of the principal dog.

In the accompanying drawings, Figure 1 is a plan of a bank-lock embodying my invention. Fig. 2 is a front elevation of the same. Fig. 3, Sheet No. 2, is an elevation of the opposite side of the lock. Fig. 4 is a vertical section taken at the lines *xx* of Figs. 2 and 3. Fig. 5 is an edge view of the combination-wheels *G* and idle-wheels *R*, the latter being fast on

the spindle. Fig. 6 is a view of the same at right angles to Fig. 5. Figs. 7 and 8 are a plan and side elevation of the dog *L*. Fig. 9 is a cross-section on an enlarged scale through one of the tappets *H*, and a portion of one of the combination-wheels *G*. Fig. 10 is an isometrical view on an enlarged scale of one of the tappets *H*. Figs. 11 and 12 are an end and side views of the hub *D*. Fig. 13 is an isometrical view of the supplemental dog *L*². Fig. 14 is a vertical section through the bolt-spindle *I* and parts attached at the line *yy* of Fig. 3.

Like letters of reference in all the figures indicate the same parts.

A is the bed-plate, with which the several parts of the lock are connected. *B* is the dial-plate on the front end of the spindle *C*, which turns freely in the bed-plate and the hub *D* on the inside of the same, as seen in Fig. 4. The dial-plate *B* is provided with a detachable circumferential ring, *B'*, for containing the figures. The hub is fastened securely to the bed-plate. Anti-friction rings *E* and washers *F* are arranged on the hub *D* alternately. On the rings are placed the combination-wheels *G*, in the present case five in number; yet the number may be varied. The rings are somewhat thicker than the washers, to prevent friction of the sides of the wheels against them as the latter revolve. The combination-wheels *G* and driving-wheels *G'* have each a cross-slot, *a*, for the reception of the dog hereinafter described. And the wheels *G* have around their peripheries, at equal distances apart, slots *a'*, to receive the tappets *H*, the divisions between them being about equal to one-half the width of the slots, as seen in Fig. 6. And the tappets *H* have overlapping ends of one-third the width of a tappet-slot, *a'*, and a division, *b*, the ends being notched, as seen in Figs. 5 and 10. The advantage of this form of the tappet and construction of the wheels is, that when the latter are taken up by the driving-wheel *G'* the divisions *b* on the several wheels are in a zigzag position in relation to each other, and thereby prevent the descent of the dog, and as the dog-slots and tappet-slots are of equal width, it is impossible for a burglar or lock-picker to determine the latter from the former.

For the sake of illustration, suppose one of the tumblers or combination-wheels *G* to be perceptibly larger in diameter than the others; in such case it will be seen that every time the dog or fence is put down for the purpose of feeling, it will either stop upon one of the divisions of the large tumbler, or pass between two of them, until stopped by a division of one or more of the smaller wheels or tumblers. Now, as the slots and division are of equal width, and the fence or dog is prevented by the divisions of the smaller tumblers from reaching the base of any of the slots of the larger tumblers, it is impossible for the operator to distinguish between the proper and improper slot, while if the fence-slot were of greater width than the others, a careful operator would recognize the proper slot when reached, for the reason that such movement of said tumblers as had previously carried its divisions alternately under the fence would fail to do so when the proper slot should be brought under it.

This feature alone renders the lock practically unpickable, and it cannot be attained except by such relationship between the slots, divisions, and tappets.

The tappets are held in place by screws *c*, as illustrated in Fig. 9. A screw-thread is cut in the lower side of the tappets, as shown, and that portion of the stem of the screw outside of the tappet-seat when the tappet is screwed down is cut away to admit of the free action of the screw in drawing the tappet firmly upon its seat. When the tappet has to be removed, one thread of the screw, as it passes out of the wheel, connects with the threaded part of the tappet, to hold the two pieces together for convenience in handling in changing the combination.

I is the bolt-spindle, having on its inner end the pinion *J*, which gears into the vertical rack *K*, which has a horizontal arm, *d*, that connects, by means of a mortise, or otherwise, with the side of the fence or dog *L* for giving vertical movements thereto, the front end of the dog sliding in the vertical slot *e* of the bed-plate *A*. To prevent the dog being forced in by a burglar its outer end has an enlargement, made by the bevels *f f*, as seen in Figs. 1, 7, and 8. The said bevels fit against corresponding bevels in the front side of the bed-plate *A*. The dog has connection with the vertical rack *K*¹ by means of the vertical bar *M*, the pin *g* of the elbow *h* of the bar being placed in a corresponding hole in the upper end of the rack, and the upper end of the bar confined by means of the nut *i* against the outer end of the lower piece *L*¹ of the dog. The rack *K*¹ operates the bolt-pinion *J'*, which, in turn, operates the horizontal racks *K*² and *K*³, moving them in opposite directions, and the vertical rack *K*⁴. To any or all of the racks *K*, *K*², *K*³, and *K*⁴ cross-heads *N*, having bolts *O*, are secured, as shown, with the rack *K*²; and, hence, by turning the handle *I'* from right to left, as it acts through the intermediate parts above

described, it shoots the bolts outward into the door-frame for locking the safe, and by turning it from left to right it shoots them inward for unlocking them. The dog *L* is held in its elevated position, while the combination-wheels are being set, by means of the supplemental dog *L*², connected with the rack *K*. The supplemental dog has a vertical movement in the slot *i* of the bed-plate *A*, its lower edge resting upon the peripheral surface *j* of the gear-wheel *P*. (Seen in Fig. 14.) This wheel gears into the pinion *Q* on the dial-spindle *C*, and has five times the number of teeth of the latter, so that in turning it around to set the five combination-wheels five revolutions in one direction are the greatest number required to take up all the wheels. After the wheels have been taken up the dog *L* is brought down into the slots *a* of the combination-wheels *G* and the driving-wheel *G'* by turning the handle *I'* of the bolt-spindle *I* from left to right. The slot *r* of the wheel *P*, being then under the dog *L*², permits the descent.

As the dog *L* is the medium through which the locking-bolts are moved, if a burglar should break it he would destroy the means of communication between the bolt-spindle and the bolts; or, if he should force off the lock the same result would be produced, as the communication with the bolts would then be destroyed, leaving the door locked; or, if he should attempt to remove the lower portion of the dog by drilling through it, he would defeat his object, as the lower part is made separate from the upper part, and confined by means of a screw, *l*, which would be severed by the drilling; and hence the bolt-racks would be separated from the upper part of the dog *L*, as the connection is made by means of the bar *M*, which is fastened to the lower piece *L*¹ by means of the nut *i*; consequently all communication between the bolt-spindle and bolts would be cut off.

One or more idle-wheels, *R*, are placed in the recess *m* in the front side of the bed-plate *A* in the rear of the pinion *Q*, being fast on the dial-spindle *C*, so that if a burglar should drill through the door, (a mode adopted sometimes for aligning the combination-wheels,) he could not effect his purpose, because the introduction of the instrument he would insert would prevent the wheels turning. These wheels *R* may be used as combination-wheels, if desired, by constructing their edges like those of the combination-wheels and extending the front end of the dog over them. The dial *B* is provided with a circumferential bead or projection, *o*, so that, if a burglar should happen to be present at the opening of the safe, the projection would intercept the figures of the dial, unless he should approach so near as to reveal his intention of discovering the combination.

The dial is made in two pieces, as shown in Figs. 1, 2, and 4, for the purpose of removing the outer circumferential piece or ring *B'*, containing the figures, without having to remove the whole dial in carrying out the precaution

of removing the dial above mentioned. S is a cap over the combination-wheels. It has a slot in its upper side to admit of the passage of the dog L.

The numbers on the divisions of the combination-wheels are all even numbers, but the tappets coming between any two of them, the numbers counted in a combination for each wheel is an odd number. For instance, when a tappet is between 8 and 10, the number of the wheel is said to be 9, and so on of all the other numbers; and the odd numbers thus determined are like the numbers on the dial. The tappets H are respectively secured in the slots of the wheels at the numbers chosen for the combination.

Mode of locking and unlocking: Turn the bolt-knob from right to left. This operation shoots the bolts into their locking position, when the dial should be turned from right to left five revolutions, the number necessary to revolve the wheel P once, which places its slot *r* again directly under the supplemental dog; but said dog can descend but a short distance, when its progress will be arrested by the principal dog coming into contact with the combination-wheels whose slots were previously disarranged by the five revolutions of the dial. In this position of the lock it is necessary to continue the dial in the same direction but a fraction of a revolution, in order to bring the slot of wheel No. 5 to its proper position. The motion of the dial must then be reversed and turn four revolutions and a fraction in order to set wheel No. 4. This done, the original motion must be resumed, and three revolutions and a fraction made, in order to set wheel No. 3, and this alternation of the movement of the dial continued throughout the entire manipulation. By this it appears that, in setting a lock of five combination-wheels, it is necessary to turn the dial from left to right two revolutions more than from right to left—to wit, four to the right in setting wheel No. 4, and twice in the same direction for setting wheel No. 2—while, in setting Nos. 3 and 1, but four opposite revolutions. It is, therefore, shown that

in setting the entire combination it is necessary to make two revolutions more to the right than to the left. It will thus appear that the necessary manipulation for setting the combination-wheels will leave the slot of the recess-wheel out of position, which will prevent the shooting of the bolts. It will then be necessary to properly adjust the slot of the recess-wheel, which will inevitably displace several of the combination-wheels previously set; but, to obviate this difficulty, it is only necessary to advance the entire combination two revolutions beyond the point alluded to above, which will give the slot of the recess-wheel such position with regard to the supplemental dog as will bring it right by the necessary manipulation for setting the combination-wheels.

I claim as my invention—

1. The combination-wheels or tumblers G, having dog-slots *a* and tappet-slots *a'* of equal width, and the divisions *b* between the slots, about equal to one-half the width of the slots, in combination with tappets H, having projecting ends one-third the width of a tappet-slot, *a'*, and a division, *b*, substantially in the manner and for the purpose set forth.

2. The principal dog, made in two parts, held together by a screw-bolt or its equivalent, when, by separating the lower from the upper part of the dog, the connection between the bolt-operating spindle and the locking-bolts will be severed, substantially as described.

3. The wheel P and combination-wheels, arranged to be operated by the same spindle, in combination with the supplemental dog L², for keeping the principal dog above the combination-wheels during more than one revolution of the same, and thus prevent a lock-picker from feeling the combination-wheels at each revolution of the dial, substantially as set forth.

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