April 6, 1965 J. M. RICHARDSON 3,176,486

MANIPULATION RESISTIVE COMBINATION LOCK

Filed July 12, 1963 3 Sheets-Sheet 1

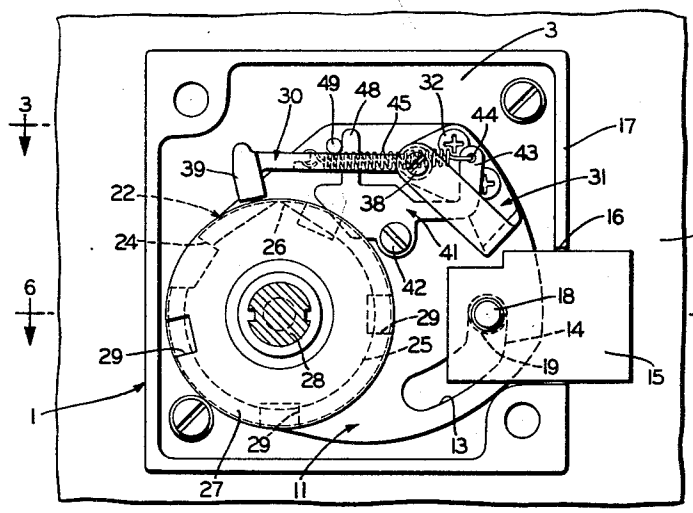


Fig. 1

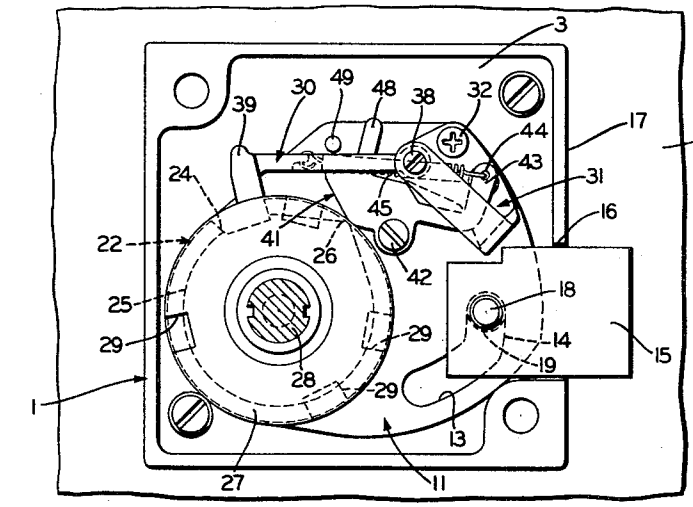


Fig. 2

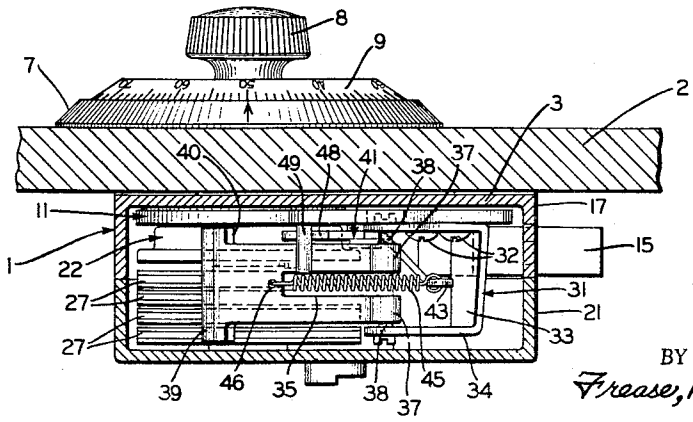


Fig. 3

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MANIPULATION RESISTIVE COMBINATION LOCK

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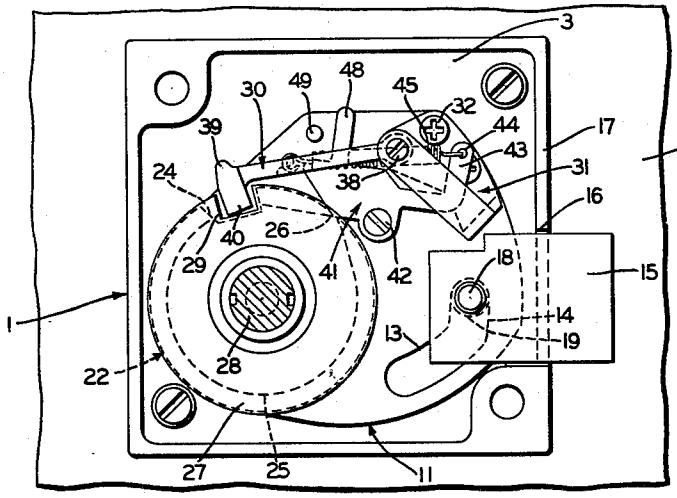


Fig. 4

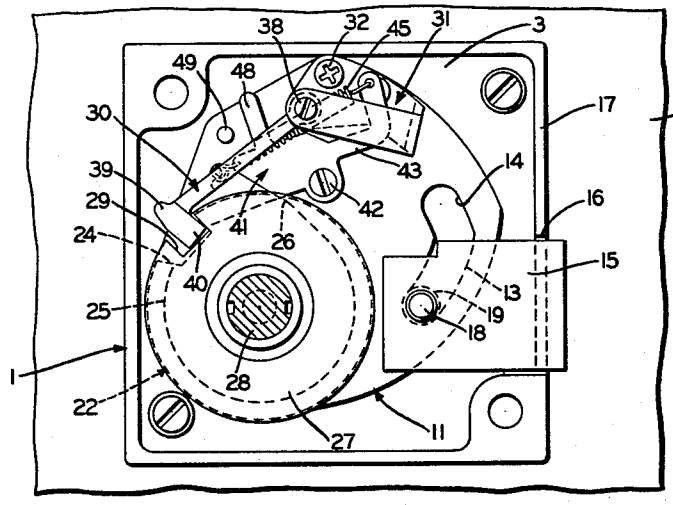


Fig. 5

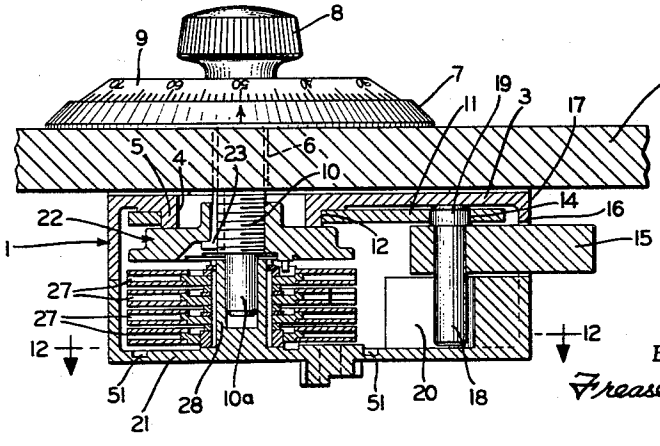


Fig. 6

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MANIPULATION RESISTIVE COMBINATION LOCK

Filed July 12, 1963 3 Sheets-Sheet 3

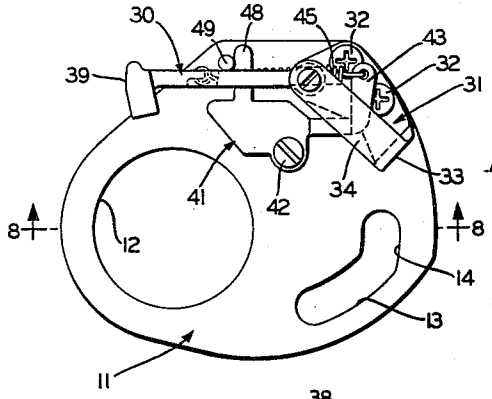


Fig. 7

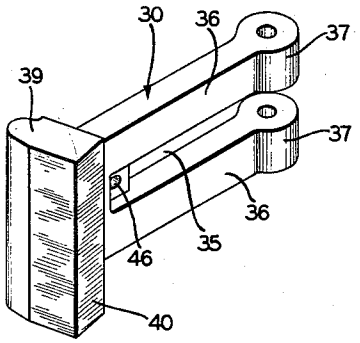


Fig. 10

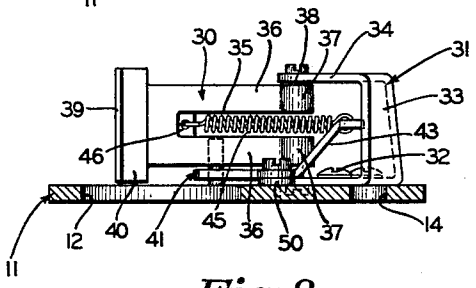


Fig. 8

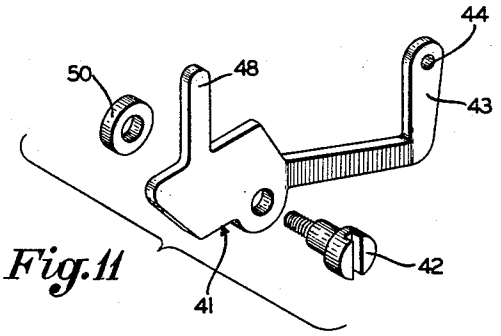


Fig. 11

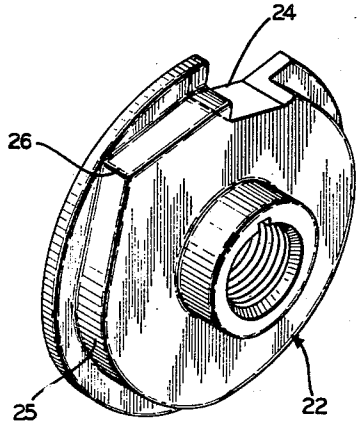


Fig. 9

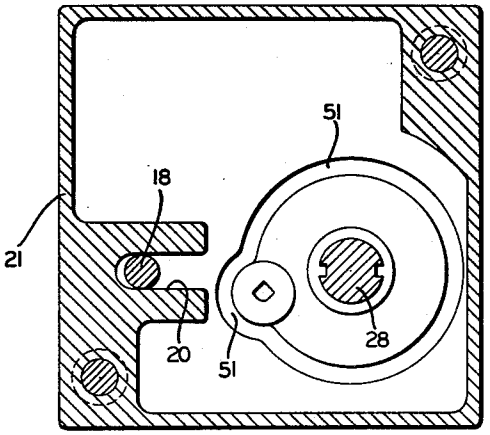


Fig. 12

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3,176,486

MANIPULATION RESISTIVE COMBINATION LOCK

Jack M. Richardson, Canton, Ohio, assignor to Diebold, Incorporated, Canton, Ohio, a corporation of Ohio

Filed July 12, 1963, Ser. No. 294,481
13 Claims. (Cl. 70—133)

The invention relates to combination locks having overcenter spring means for preventing detection of the combination of the lock by manipulation of the same, and more particularly to certain improvements upon and simplification of the mechanisms disclosed in Herlong Patents No. 3,045,466 and No. 3,045,467, dated July 24, 1962.

Each of these patents discloses the over-center spring means applied to a combination lock of the general type disclosed in Abbott and Miller Patent No. 1,956,304, dated April 24, 1934.

Combination locks of the general type disclosed in said Abbott and Miller patent comprise a housing with a plurality of coaxial cylindrical tumblers of equal diameters rotatably mounted within the housing. A spindle extends into the housing and has a knob on its outer end, rotatable within a dial ring, and a cylindrical driver cam, with an operating notch or gate in its periphery, is fixed upon the spindle beyond the tumblers.

Usual pin, lever and circular segment means coact between the driver cam and the innermost tumbler, and between each tumbler and the next outer tumbler, as disclosed in detail in said Abbott and Miller patent, whereby by manipulation of the dial and setting the combination, the gates or notches of the tumblers are aligned with each other and with the operating notch or gate in the driver cam for unlocking the lock.

Locks of this general type also include bolt means and an operating lever operatively connected thereto and having a driver lug or tongue depending from its outer end and a fence extending from the inner side thereof parallel with the axis of the tumblers.

When the tumbler gates are aligned with each other and with the fence, and the operating notch in the driver cam is aligned with the driver lug or tongue, the fence is permitted to drop into the tumbler gates and the tongue is permitted to drop into the operating notch of the driver cam, whereby the bolt means may be withdrawn from its extended locking position, or may also be extended to locking position, by suitable rotation of the spindle. After the bolt means is extended into locking position, the spindle may be spun in reverse direction to scramble the combination by turning the tumblers so that the gates are out of alignment with each other.

Locks of the general character of said Abbott and Miller patent are widely used today and have become standardized to a point where all common types of such locks operate on substantially the same broad principle. Through such standardization, these locks are now relatively inexpensive to produce, and are kept on such low-cost basis through the elimination of high precision in the manufacture thereof.

As far as is known, except for locks made under the above named Herlong patents, there is no combination lock upon the market today that cannot be operated by those familiar with the broad principles thereof, even though the particular combination is not known to them.

Of the above mentioned Herlong patents, the former discloses a lock enclosed within a rectangular casing and having a single reciprocating bolt, and the latter patent discloses a lock enclosed within a circular casing in which a rotary cam plate retracts and projects a plurality of lock bolts to unlocked and locked positions respectively.

In each of said Herlong patents, the over-center spring means includes a spring-connected trigger and lever actuator, the lever actuator being operatively connected to the operating lever which carries the fence for dropping into the tumbler gates and the tongue or driver lug for dropping into the operating notch in the driver cam.

A principal object of the invention is to provide a positively pick-proof combination lock of the type of said Herlong patents, in which the lever actuator is omitted and the spring connects the trigger directly to the operating lever, whereby the action of the lock is speeded up.

Another object of the invention is to provide a lock of the character referred to in which the lock is enclosed within a rectangular casing and provided with a single reciprocating bolt, in which the mechanism includes the best features of the circular lock mechanism disclosed in Herlong Patent No. 3,045,467.

A further object of the invention is to provide a lock of this character enclosed within a rectangular casing and having a single locking bolt retracted and projected to unlocked and locked positions respectively, by a rotary cam plate.

It is also an object of the invention to provide such a lock in which a stud on the reciprocating bolt is received in a cam slot in the rotary cam plate for retracting and projecting the bolt, said slot having a straight portion which receives the stud in the locked position of the bolt and thus prevents unauthorized driving or hammering in of the bolt.

Another object of the invention is the provision of a combination lock of the character referred to in which the inner or back wall of the casing cover is provided with an annular weakening groove surrounding the boss upon which the tumblers are rotatable, so that any attempt to open the lock by hammering or driving in the spindle will cause the casing wall to break at this point, permitting the tumblers to move inward and thus preventing further manipulation of the lock.

It is still another object of the invention to generally improve and simplify locks of this type.

The above and other objects, apparent from the drawings and following description, may be attained, the above described difficulties overcome and the advantages and results obtained, by the apparatus, construction, arrangements and combinations, subcombinations and parts which comprise the present invention, a preferred embodiment of which, illustrative of the best mode in which applicant has contemplated applying the principle, being set forth in detail in the following description and illustrated in the accompanying drawings.

In general terms, the invention may be briefly stated as comprising a combination lock of the rectangular-case type provided with a tubular sleeve or boss integral with the inner or back wall of the casing, a substantially circular weaking groove in said back wall surrounding the tubular sleeve or boss.

A series of rotatable tumblers having gates therein are rotatably mounted upon said tumbler sleeve or boss, and an axially aligned driver cam, having an operating notch therein, is mounted upon a spindle, the inner end of which is journalled within said sleeve or boss.

A reciprocating bolt has a stud received in a cam slot in a rotary cam plate, journalled within the housing concentric with the tumblers and driver cam. The slot in the rotary cam plate has an arcuate portion for projecting and retracting the bolt and a straight portion for preventing the bolt from being driven in by force.

An operating lever is pivotally connected at one end to a bracket rigidly mounted upon the rotary cam plate and has, at its free end, a fence adapted to drop into the gates of the tumblers when they are aligned with each

other, and an extension adapted to drop into the operating notch of the driver cam.

A trigger is pivotally mounted upon the rotary cam plate and a spring connects one end of the trigger to the operating lever for normally holding the same away from the tumbler. A cam nub, or high point, upon the operating cam is adapted to engage the trigger once during each revolution, to momentarily move the fence towards the tumblers, the spring immediately pulling the fence away from the tumblers and resetting the trigger the instant the trigger is released by the cam nub.

Having thus briefly described the invention, reference is now made to the accompanying drawings, showing a preferred embodiment of the invention in which:

FIG. 1 is an elevation of the lock, with the cover plate removed, showing the lock bolt in the extended or locked position, and the over-center, spring-actuated, operating lever holding the fence out away from the tumblers;

FIG. 2 is a view similar to FIG. 1, showing the parts in the position when the trigger is tripped by the cam nub on the driver cam so as to throw the spring over center pulling the operating lever downward therewith so that the fence momentarily touches the peripheries of the tumblers;

FIG. 3 is a section through the lock taken on the line 3—3, FIG. 1;

FIG. 4 is a view similar to FIG. 2, showing the gates in the tumblers aligned with each other and with the fence, and showing the fence dropped into the gates of the tumblers, and the driving lug located in the operating notch of the driver cam;

FIG. 5 is a view similar to FIG. 4, showing the tumblers rotated to position to withdraw the bolt to unlocked position;

FIG. 6 is a plan sectional view of the lock taken as on the line 6—6, FIG. 1;

FIG. 7 is a detached elevation of the sub-assembly comprising the rotary cam plate with the bracket pivotally mounting the operating lever thereon, the trigger pivotally mounted on the cam plate and the over-center spring connecting the trigger directly to the operating lever;

FIG. 8 is a section taken on the line 8—8, FIG. 7;

FIG. 9 is a detached perspective view of the driver cam;

FIG. 10 is a detached perspective view of the operating lever;

FIG. 11 is an exploded perspective view of the trigger, spacer washer and pivot screw therefor; and

FIG. 12 is a fragmentary elevation of a portion of the interior of the cover showing the annular weakening groove and the lock bolt stud guide groove therein, taken on the line 12—12, FIG. 6.

The improved manipulation resistive combination lock as illustrated comprises a rectangular casing indicated generally at 1, mounted on the inner face of a door 2, which may be the door of a safe or the like. The lock mechanism per se is of conventional construction, such as shown in said Abbott and Miller patent above referred to.

The construction comprising the present invention, namely the improvements upon the over-center spring mechanism for preventing manipulation, as disclosed in said Herlong patents, are incorporated in this conventional construction of rectangular casing type combination lock, and such improvements are hereinafter described in detail.

The front wall 3 of the lock case is provided with an aperture 4 formed therethrough and providing a hollow cylindrical boss 5. The case 1 is positioned on the door 2 so that the aperture 4 is in axial alignment with a smaller diameter aperture 6 in the door.

A dial ring 7 is mounted on the outer face of the door and a knob 8, with dial 9 thereon, is rotatable relative to the dial ring in usual manner, being mounted upon the spindle 10, which is journalled through the door, the threaded end thereof extending into the lock casing.

The rotary cam plate 11 has the circular opening 12 journalled upon the cylindrical boss 5 in the front wall of the lock casing. A cam slot is formed in the cam plate 11, comprising the arcuate portion 13 and the straight end portion 14.

A conventional, radially extend lock bolt 15 is slidably received through the opening 16 in the side wall 17 of the lock casing. A stud 18 is located through the lock bolt 15 and has a head 19 at one end thereof received in the cam slot 13–14 in the rotary cam plate 11. The other end of the stud 18 is slidably located in the horizontal guide groove 20 in the cover 21 of the casing.

The driver cam, indicated generally at 22, is threaded upon the spindle 10 and a key 23 may be provided for locking the cam upon the spindle. The usual operating notch 24 is formed in the periphery of the driver cam, to receive the driving lug, as will later be described. An annular boss 25 is formed on one side of the driver cam and provided with a cam nub or projection 26.

As in usual practice, the tumblers 27 are rotatably mounted on the tumbler sleeve or boss 28 which, as shown in FIG. 6, may be formed upon the inner or back wall of the cover 21 of the lock casing. As best shown in FIG. 6, the boss 28 is hollow and the reduced end 10*a* of the spindle 10 may be journalled therein.

The tumblers are of conventional construction and, together with the driver cam, form a series of tumblers as disclosed in detail in said Abbott and Miller Patent No. 1,956,304, and the usual pin, lever and circular segment means, disclosed in detail in said patent, or equivalent means, coact between the driver cam and the innermost tumbler, and between each tumbler and the next outer tumbler, as described in detail in said patent, whereby by manipulation of the dial and setting of the combination, the gates 29 of the tumblers 27 are aligned with each other and with the operating notch 24 of the driver cam 22 for unlocking the lock.

The operating lever 30 is shown in detail in FIG. 10. This operating lever is pivotally mounted upon the rotary cam plate 11, by means of the U-shape bearing bracket 31 which is attached to the face of the cam plate by screws 32. This bracket has the closed end 33 and the leg 34 spaced from the cam plate.

The operating lever 30 has the longitudinal slot 35 therein dividing the body portion thereof into the spaced legs 36. A bearing portion 37 is formed upon the end of each leg 36 and these bearing portions are pivoted upon the corresponding journals 38 carried by the main body portion and the legs 34 thereof.

A fence 39 is formed upon the other end of the operating lever 30 and adapted to enter the gates 29 in the tumblers when said gates are aligned with each other and with the fence. An extension at one end of the fence 39 forms a driving lug or tongue 40, for engagement in the operating notch 24 of the driver cam 22, as in usual and well known practice.

A trigger, indicated generally at 41, is pivotally mounted upon the cam plate 11, adjacent to the bracket 31, as by the screw 42. The trigger has an inwardly offset arm 43 extending outwardly from the cam plate 11 and terminating at a point located centrally between the main body portion and the leg 34 of the bracket 31.

An aperture 44 is formed in the end of the offset arm 43 for connection of one end of the coil spring 45, the other end of which is connected to the aperture 46, at the closed end of the slot 35, in the operating lever 30. The coil spring 45, being located through the slot 35 in the operating lever 30, permits the spring to move back and forth above and below the pivotal center 38 of the operating lever 30.

As shown in FIG. 1, the coil spring 45 is located slightly above the pivotal center 38 of the operating lever 30, so as to press the fence 39 upward, or away from the tumblers 27. A tail 48 is formed upon the trigger 41, on the opposite side of the pivot point 42 thereof from the

offset arm 43. This tail is held in contact with the stud 49, upon the cam plate 11, which acts as a stop to hold the trigger against further movement in this direction, as best shown in FIG. 1.

The trigger 41 is spaced from the cam plate 11 by the spacer washer 50 through which the pivot screw 42 is located. The trigger is thus held in the path of the cam nub 26 upon the periphery of the driver cam 22. With each rotation of the driver cam 22, as the operating notch 24 thereof is aligned with the fence 39, the cam nub 26 on the driver cam will engage the trigger, momentarily moving it to the position shown in FIG. 2, moving the spring 45 below the pivotal center 38 and causing the fence 39 to momentarily move toward the tumblers 27. The instant the cam nub 26 of the driver cam passes out of engagement with the trigger, the spring 45 will pull the parts back to the position shown in FIG. 1, again pressing the fence 39 away from the tumblers.

As best shown in FIGS. 6 and 12, an annular groove 51 is formed in the inner surface of the cover 21, substantially concentric to the tumbler sleeve or boss 28. This groove is for the purpose of weakening this portion of the cover 21, so that in the event it is attempted to pick the lock by hammering or driving the spindle 10 inward by force, this will merely result in breaking the cover at the weakened groove 51, so that the tumblers, mounted upon said sleeve or boss 28, will be driven inward therewith, thus preventing any manipulation of the lock.

In the operation of the lock, each time that the driver cam 22 is rotated to the position shown in FIG. 2, the fence 39 is thus momentarily moved toward the tumblers. If the tumbler gates are not aligned, the fence is immediately moved up away from the tumblers and the lock remains locked.

It is not possible to obtain a sense of feel, because the fence is thus only momentarily moved toward the tumblers, once during each revolution of the driver cam, and is held away from the tumblers by the spring 45 throughout the entire remainder of each revolution thereof.

Thus, this momentary movement of the fence, once during each revolution of the driver cam, is of no aid in the surreptitious determination of the locations of the tumbler gates.

If, at the time the driver cam 22 reaches the position where the cam nub 26 thereon engages the trigger, all of the tumblers 27 have moved to positions where their gates 29 are in alignment with each other, and with the fence 39, as shown in FIG. 4, the fence will enter the tumbler gates as shown in said figure.

Then by further rotation of the driver cam 22 in counterclockwise direction, as viewed in the drawings, the rotary cam plate 11 being then connected to the driver cam 22 through the driving lug 40 upon the operating lever 30, engaging the operating notch 24 in the driver cam, the rotary cam plate 11 will be moved to the position shown in FIG. 5.

Through the stud 18 of the bolt engaging the slot 13–14 of the rotary cam plate, the lock bolt 15 will be withdrawn, as shown in FIG. 5, the stud 18 being guided through the straight slot 20 in the cover 21, guiding the lock bolt in a straight path as it is retracted.

Upon reversing of the driver cam 22, through the knob 8 and spindle 10, the rotary cam plate 11 will be rotated in clockwise direction, as viewed in the drawings, moving the head 19 of the stud 18 back to the upper end of the cam slot 13–14 in the cam plate, as shown in FIGS. 1 and 2, thus projecting the bolt 15 outward to locked position.

It will be seen that in the locked position, the stud 18 upon the lock bolt 15 is located in the upper end of the straight portion 14 of the cam slot in the rotary cam plate 11. This prevents the bolt 15 from being hammered or driven inward by force in an unauthorized attempt to pick the lock.

As in the Herlong patents, the over-center spring mechanism prevents surreptitious detection of the combination by pressing the fence away from the tumblers at all times, excepting momentarily, during each rotation of the driver cam 22, when the cam nub 26 thereof engages the trigger and moves the trigger to the position of FIG. 2, momentarily moving the fence 39 toward the tumblers as the spring 45 moves down over center, after which the fence is instantaneously moved away from the tumblers by movement of the spring upward over center as soon as the cam nub 26 is disengaged from the trigger.

It will be obvious that locks of the type of Herlong Patent No. 3,045,466, in which the lock is enclosed within a rectangular casing, are improved by substituting the rotary cam plate and the type of trigger disclosed in Herlong Patent No. 3,045,467 for the corresponding parts of the former patent.

It will also be apparent that by eliminating the lever actuator of both of the Herlong patents, and connecting the spring directly to the operating lever, the action of the lock is speeded up.

It will also be evident that, as in each of the Herlong patents, the dial, or any added vernier device or extension thereto, cannot indicate to the pick-lock the distance between the surface of the fence in contact with the tumbler peripheries and the center axial line of the tumblers.

Furthermore, as in each of the Herlong patents, it will be seen that this lock cannot be manipulated by being run rapidly to wear down. If the lock is run rapidly until the cam nub 26 or the trigger, or both, are worn off so that the trigger cannot be operated thereby, the spring 45 will permanently hold the fence 39 outward away from the tumblers, as shown in FIG. 1, so that the lock cannot be operated.

It will also be obvious that this lock cannot be manipulated by driving the spindle inward by force, as this will result in breaking the cover 21 at the weakened groove 51, permitting the tumblers to move inward, and preventing manipulation of the lock.

In the foregoing description certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Moreover, the embodiments of the improved construction illustrated and described herein are by way of example, and the scope of the present invention is not limited to the exact details of construction.

Having now described the invention or discovery, the construction, the operation, and use of preferred embodiments thereof, and the advantageous new and useful results obtained thereby; the new and useful construction, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

I claim:

1. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, a reciprocable bolt, a stud on said bolt received in said cam slot, an operating lever pivoted at one end upon said cam plate, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers

when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

2. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, a reciprocable bolt, a stud on said bolt received in said cam slot, an operating lever pivoted at one end upon said cam plate, there being a longitudinal slot in said one end of said operating lever, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring located through said longitudinal slot and connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

3. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, said cam slot having a straight portion and an arcuate portion, a reciprocable bolt, a stud on said bolt received in said cam slot, said stud being located in the straight portion of the cam slot when the bolt is in extended position, an operating lever pivoted at one end upon said cam plate, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

4. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, a reciprocable bolt, a stud on said bolt received in said cam slot, there being a straight guide groove in the housing, said stud being slidable in said guide groove, an operating lever pivoted at one end upon said cam plate, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

5. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, said cam slot having a straight portion and an arcuate portion, a reciprocable bolt, a stud on said bolt received in said cam slot, said stud being located in the straight portion of the cam slot when the bolt is in extended position, there being a straight guide groove in the housing, said stud being slidable in said guide groove, an operating lever pivoted at one end upon said cam plate, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring connected directly to said other end of the operating lever and said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

6. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, said cam slot having a straight portion and an arcuate portion, a reciprocable bolt, a stud on said bolt received in said cam slot, said stud being located in the straight portion of the cam slot when the bolt is in extended position, an operating lever pivoted at one end upon said cam plate, there being a longitudinal slot in said one end of said operating lever, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring located through said longitudinal slot and connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

7. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, said cam slot having a straight portion and an arcuate portion, a reciprocable bolt, a stud on said bolt received in said cam slot, said stud being located in the straight portion of the cam slot when the bolt is in extended position, there being a straight guide groove in the housing, said stud being slidable in said guide groove, an operating lever pivoted at one end upon said cam plate, there being a longitudinal slot in said one end of said operating lever,

said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring located through said longitudinal slot and connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers, when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

8. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, a reciprocable bolt, a stud on said bolt received in said cam slot, there being a straight guide groove in the housing, said stud being slidable in said guide groove, an operating lever pivoted at one end upon said cam plate, there being a longitudinal slot in said one end of said operating lever, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring located through said longitudinal slot and connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

9. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a sleeve upon one wall of the casing, certain of said tumblers being rotatable upon said sleeve, a spindle for rotating said tumblers, the inner end of said spindle being journalled in said sleeve, a groove in said one wall of the casing surrounding said sleeve, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, a reciprocable bolt, a stud on said bolt received in said cam slot, an operating lever pivoted at one end upon said cam plate, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt.

10. In a combination lock, a casing, lock means within the casing comprising a fence, a series of rotatable tumblers having gates into which said fence enters upon alignment of said gates and said fence, a cam nub upon one of said tumblers, a cam plate rotatably mounted in said casing, there being a cam slot in said cam plate, a reciprocable bolt, a stud on said bolt received in said cam slot, an operating lever pivoted at one end upon said cam plate, said fence being fixed to the other end of said operating lever, a trigger pivoted upon said cam plate, a spring connected directly to said other end of the operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage the trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of the fence by said tumblers rotates said cam plate to retract said bolt, a sleeve upon one wall of the casing, certain of said tumblers being rotatable upon said sleeve, a spindle for rotating said tumblers, the inner end of said spindle being journalled in said sleeve, and a groove in said one wall of the casing surrounding said sleeve, whereby impact against the outer end of said spindle will cause said one wall of the casing to break at said groove.

11. In a combination lock, a casing, lock mechanism within the casing comprising a fence, a series of tumblers mounted for rotation about a single axis and having gates into which the fence enters upon alignment of said gates and said fence, bolt mechanism including a reciprocable bolt, an operating lever pivoted at one end upon said bolt mechanism, said fence being fixed to the other end of said operating lever, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of said fence by said tumblers retracts the reciprocable bolt, a sleeve upon one wall of the casing, certain of said tumblers being rotatable upon said sleeve, a spindle for rotating said tumblers, the inner end of said spindle being journalled in said sleeve, and a groove in said one wall of the casing surrounding said sleeve, whereby impact against the outer end of said spindle will cause said one wall of the casing to break at said groove.

12. In a combination lock, a casing, lock mechanism within the casing comprising a fence, a series of tumblers mounted for rotation about a single axis and having gates into which the fence enters upon alignment of said gates and said fence, bolt mechanism including a reciprocable bolt, an operating lever pivoted at one end upon said bolt mechanism, said fence being fixed to the other end of said operating lever, a cam nub upon one of said tumblers, a trigger pivoted upon said bolt mechanism, a spring connected directly to said other end of said operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage said trigger once during each revolution of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers, when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of said fence by said tumblers retracts the reciprocable bolt.

13. In a combination lock, a casing, lock mechanism within the casing comprising a fence, a series of tumblers mounted for rotation about a single axis and having gates into which the fence enters upon alignment of said gates and said fence, bolt mechanism including a reciprocable bolt, an operating lever pivoted at one end upon said bolt mechanism, said fence being fixed to the other end of said operating lever, a cam nub upon one of said tumblers, a trigger pivoted upon said bolt mechanism, a spring connected directly to said other end of said operating lever and to said trigger for holding a portion of the trigger in the path of said cam nub and for normally pressing said fence away from said tumblers, said cam nub being arranged to engage said trigger once during each revolution

of said one tumbler for momentarily moving said fence toward said tumblers, said spring immediately pressing said fence away from said tumblers, when said trigger is released from said cam nub, said fence being movable incidental to rotation of said tumblers after said fence enters the gates thereof, whereby said movement of said fence by said tumblers retracts the reciprocable bolt, a sleeve upon one wall of the casing, certain of said tumblers being rotatable upon said sleeve, a spindle for rotating said tumblers, the inner end of said spindle being journalled in said sleeve, and a groove in said one wall of the casing surrounding said sleeve, whereby impact against the other end of said spindle will cause said one wall of the casing to break at said groove.

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