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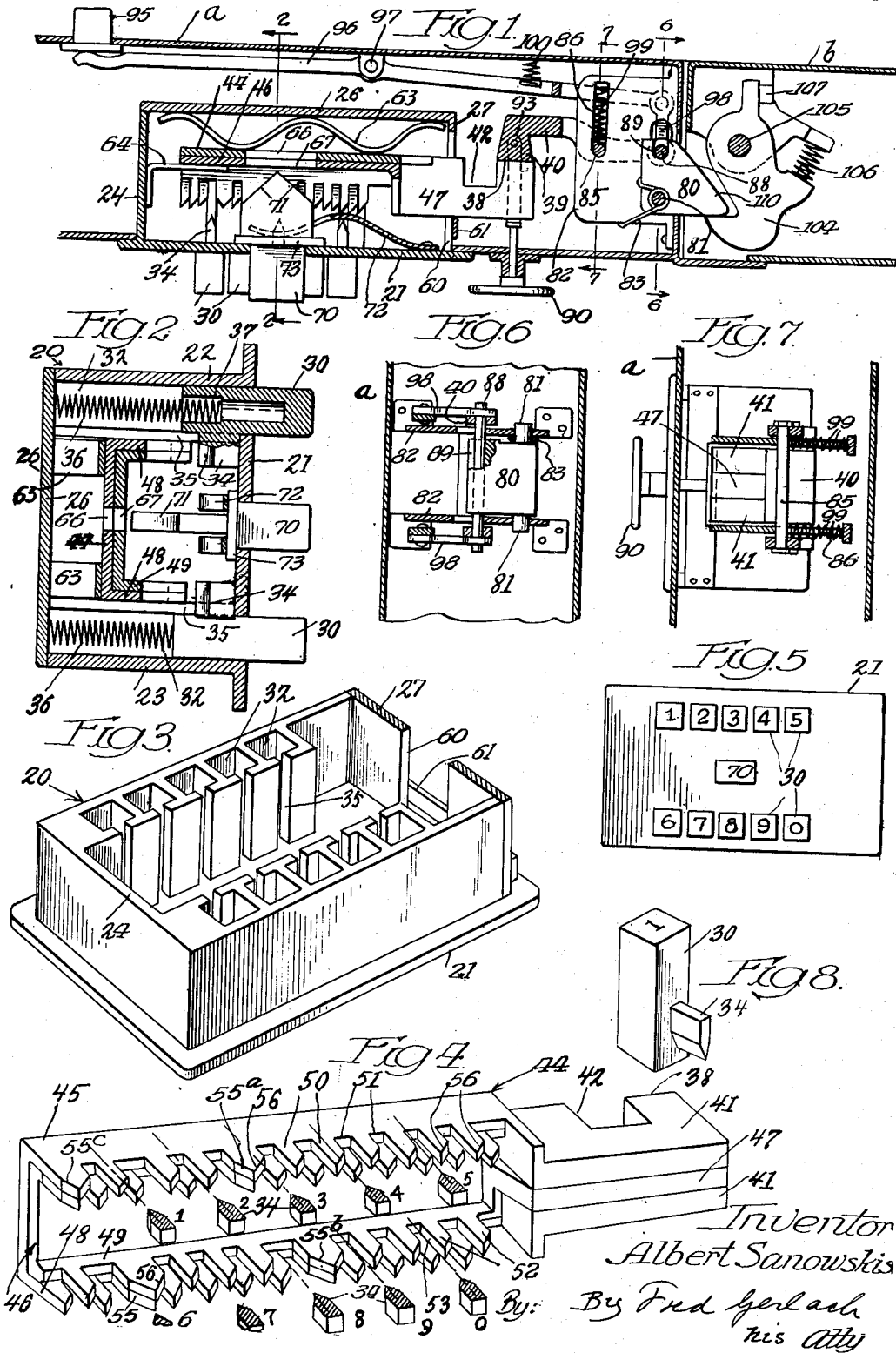
A. SANOWSKIS

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STEP-BY-STEP OPERATED COMBINATION LOCK

Filed March 26, 1948

2 Sheets-Sheet 1



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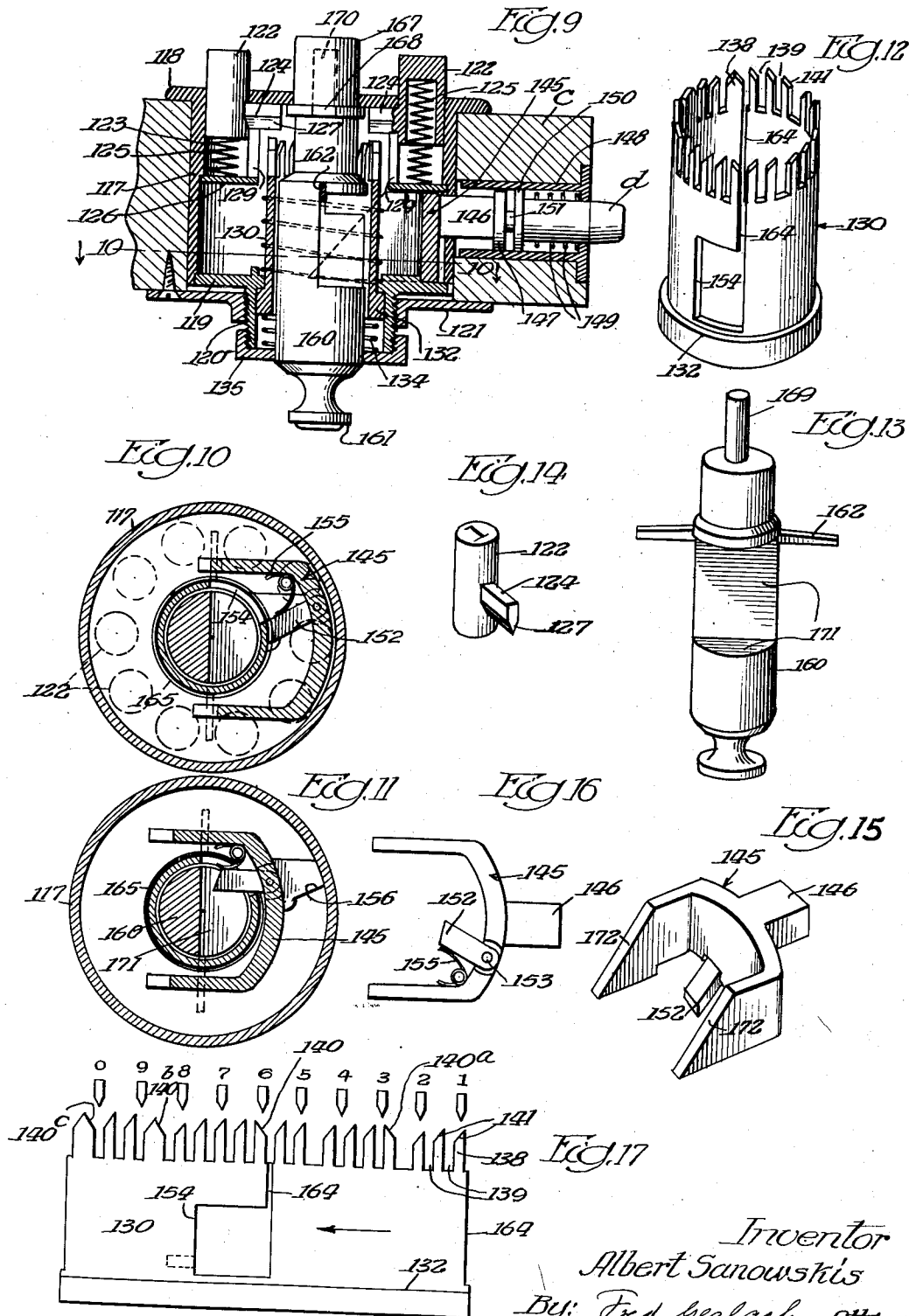
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UNITED STATES PATENT OFFICE

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STEP-BY-STEP OPERATED COMBINATION LOCK

Albert Sanowskis, Chicago, Ill.

Application March 26, 1948, Serial No. 17,230

5 Claims. (Cl. 70—133)

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The invention relates to combination locks.

One object of the invention is to provide an improved combination lock of the type which is controlled by a set of keys or buttons, and which is provided with a lock controlling device which is shiftable step-by-step in one direction by the operation of the keys in predetermined sequence and which, when the keys are not operated in said sequence, will effect a reverse movement of the lock controlling device.

Another object of the invention is to provide a combination lock in which the lock controlling device is movable step-by-step and is frictionally held in the positions into which it is shifted by the keys.

Another object of the invention is to provide a combination lock which is simple in construction and which can be economically produced.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawings—

Figure 1 is a horizontal section through a door provided with a combination lock embodying one form of the invention;

Figure 2 is a section of the combination lock taken on line 2—2 of Figure 1;

Figure 3 is a perspective of the case for the combination lock, the cover plate being shown in section;

Figure 4 is a perspective of the lock controlling racks and the wedge elements on the keys;

Figure 5 is a front elevation of the lock;

Figure 6 is a section taken on line 6—6 of Figure 1;

Figure 7 is a section taken on line 7—7 of Figure 1;

Figure 8 is a perspective of one of the keys;

Figure 9 is a horizontal section of a modified form of the invention and a door in which it is mounted, with the door-bolt in locking position;

Figure 10 is a section taken on line 10—10 of Figure 9, illustrating the control device positioned to lock the door-bolt;

Figure 11 is a similar section illustrating the lock controlling device in the position assumed when the door-bolt is retracted;

Figure 12 is a perspective of the cylindrical rack;

Figure 13 is a perspective of the resetting shaft;

Figure 14 is a perspective of one of the keys;

Figure 15 is a perspective of the lock controlling device;

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Figure 16 is an inverted plan of the lock controlling device; and

Figure 17 is a developed view illustrating the teeth on the cylindrical rack.

The form of the invention exemplified in Figures 1 to 8 is illustrated as applied to an automobile door *a* which fits into an opening in a surrounding frame *b* of the vehicle.

The combination lock includes a case which is adapted to be fixedly set into an opening cut into the outer side of the door *a*. This case includes a body-section 20 and a cover-section 26 which are suitably secured together to house the operating mechanism of the combination lock. The body-section 20 includes a top wall 22, a bottom wall 23, an end wall 24, and a front wall 21, all integrally formed. The cover section 26 closes the back of the body-section and is provided with an integral angular end 27. The cover section is suitably secured to the body section, usually by screws, to form therewith a housing or enclosing case for the operating mechanism of the combination lock.

A series of keys 30 of rectangular contour are individually mounted in upper and lower rows for axial sliding movement in rectangular guide-ways 32 formed along the top and bottom of the case. Each key 30 is provided with an integral V-shaped wedge element 34 which extends through a vertical slot 35 on the inner side of a guideway 32. Each element 34 is retractable by a spring 36 which urges one end of the element 34 against the inner face of the front wall 21 of the body section of the casing. Each spring 36 extends into a recess 37 in one of the keys 30. The outer faces of the keys 30 are provided with numerals 0 to 9, inclusive.

The combination lock includes a control bolt 41 for a lever 40 which is mounted inside of the door *a* and is adapted to control a spring-pressed door latch 38 for locking the latch against release from the outside of the door and releasing said latch to permit the door to be opened from the outer side of the door. Bolt 41 is provided with a notch 42 which, when in registry with the inner angular end 39 of lever 40, permits said lever to be shifted into position to release the latch 38 to permit the door to be opened. Lever 40 is fulcrumed at 35, as hereinafter more fully described, and carries a cross-pin 33 which is movable into a notch 39 to lock the latch 38, which is fulcrumed at 31, against pivotal movement. When the inner face 33 of the portion of bolt 41 between notch 42 and the outer end of the bolt is abutted by the angular end 39 of lever

40, cross-pin 38 on said lever will be held in notch 39 and lock latch 38 against pivotal movement. Bolt 41 is provided with a longitudinal slot, and a supplemental control bolt 47 fits in said slot, conforms in contour to the bolt 41, and is provided with a notch and a face which normally coincides with notch 42 and face 38, so that lever 40 will not be released when relative movement occurs between bolts 41 and 47 which misaligns the slots 42.

A rack 44 is integrally formed with bolt 41 and is longitudinally movable in the case for controlling the step-by-step movement of said bolt into position to release lever 40. A supplemental rack 46 is integrally formed with bolt 47, is longitudinally movable in and slidable relative to the rack 44, and controls the step-by-step movement of bolt 47 into position for releasing lever 40. Rack 44 is provided with flanges 48, and rack 46 is provided with flanges 49 which slidably fit and lap the inner faces of flanges 48. Racks 44, 46 are adapted to be moved step-by-step, by the wedge-elements 34, when the keys 30 are operated according to and in the sequence of the combination used, to shift the bolts 41, 47 into position to release lever 40.

Each of the flanges 48 is provided with a series of teeth or tongues 50 and slots 51 between said teeth, and the flanges 49 of rack 46 are provided with teeth or tongues 52 and intermediate slots 53. Said teeth have inner ends for engagement by the wedge-elements 34 on the keys 30, and the intermediate slots are adapted to receive said elements. These teeth on the racks which are successively shifted into confronting relation with the wedge-elements 34 on the keys corresponding to the predetermined combination if the keys are operated according to and in the sequence of the numbers of the combination, are provided with ends and which are inclined so that the racks will be operated step-by-step to the right and in the direction which will cause the racks to move bolts 41, 47 into position for releasing lever 40. Other teeth on the racks are provided with oppositely inclined ends 56 for causing the wedge-elements 34 on keys 30, which are not in the predetermined combination or if the keys are not operated in the sequence of the combination to shift the racks in the opposite direction, to prevent the bolts 41 and 47 from releasing lever 40. In other words, the wedge elements 34 on the keys 30 which are operated according to and in the sequence of the combination, will shift racks 44 and 46 step-by-step in unison to move bolts 41, 47 into position to release lever 40, and when the keys are not operated according to and in the sequence of the combination, one or both of the racks will be moved in the opposite direction to misalign the notches 42 in bolts 41 and 47 and thereby prevent the release of lever 40.

The racks illustrated are designed for the combination 6-3-9-1. Normally, when they are reset for locking, the racks 44, 46 will be in the position illustrated in Fig. 1 and correlatively positioned as illustrated in Fig. 4. When the No. 6 key is depressed, its wedge element 34 will engage an inclined surface 55 on the lower teeth on each of the racks 44, 46 and shift both racks conjointly one step toward the latch-releasing position of bolts 41, 47; this will move both racks into position so that the wedge element 34 on the No. 3 key will be aligned with the inclined surfaces 55^a on one of the upper teeth on each of the racks, and depression of said key will conjointly shift both racks and bolts 41, 47 a

second step to the right or toward latch-releasing position; this second step will bring the inclined surfaces 55^b on one of the lower teeth of each of the racks into alignment with the wedge element 34 on the No. 9 key, and depression of said key will then conjointly shift both racks the third step toward lock-releasing position; the wedge element 34 on the No. 1 key will then be aligned with the inclined surfaces 55^c on one of each of the upper teeth on both racks, and when the No. 1 key is depressed, its wedge element 34 will engage said inclined surfaces and conjointly shift both racks the fourth step, so that the notches 42 in both racks will register with the angular terminal 39 of lever 40, and the latter will be released for pivotal movement from the outer side of the door.

If any key other than the No. 6 key is first depressed while the racks are in normal locking position, its wedge element 34 will be aligned with a tooth having an inclined surface 56 which will cause one or both of the racks to move to the left one step and misalign the notches 42 in bolts 41, 47. The racks will then be disarranged so that it will be impossible to shift the bolts 41, 47 into releasing position by the keys until the racks have been reset to their normal position. Similarly, if after one or more keys of the combination have been operated and shifted the racks conjointly one or more steps, and the key next in the sequence in the combination is not operated, it will engage the inclined surface 56 on a tooth of one or the other of the racks to produce relative movement between them which misalign the notches 42 in the bolts 47 so that they cannot be shifted into lever-releasing position until the racks are reset into normal position and the keys of the combination are operated in the correct sequence.

Bolt 41 extends through and is guided in a slot 60 in the end 27 of cover 26. The front faces of bolts 41 and 47 fit against a bar 61 which is fixed to said cover. A pair of leaf-springs 63 is interposed between rack 44 and the back wall 26 of the body section of the case to urge bolts 41 and 47 forwardly. A stop 64 fixed in the case is engageable by the front face of rack 46 to limit the forward movement of the racks by springs 63. Springs 63 permit the racks to yield backwardly in the event that the teeth thereon become arranged to obstruct the movement of the keys and excessive force is applied to the keys, and prevent breakage of the teeth. Springs 63 exert a pressure against rack 44 and friction between the rack 44 and the rack 46. This friction may be sufficient to cause the racks to move in unison when one of them is shifted by a wedge element 34, so that the inclined teeth 55, 55^a, 55^b, and 55^c may be omitted from the inner rack 46.

When bolts 41, 47 have been shifted to bring notches 42 therein in registry with the angular end 39 of lever 40, said lever will be free to swing on its fulcrum 85, so that its angular end 39 can be shifted into the notches 42 in bolts 41, 47 for withdrawing cross-pin 38 from the notch 39 to release the latch 38 and permit the door to be opened. A pull button 90 is slidably mounted in the outer wall of the door, and is provided with a fork which is connected at 93 to lever 40 so that, when the bolts are in unlocking position, a pull on the button 90 will shift lever 40 to release latch 38 and permit the door to be opened.

After each operation of the racks to shift the bolts 41, 47 into lever-releasing position, it is

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necessary to retract the racks to their normal locking position and to reset their teeth for operation by the keys of the combination. The racks 44 and 46 are provided with normally aligned slots 66 and 67. A resetting key 70 is slidably mounted in the front wall 21 of the case, and is provided with a V-shaped wedge 71 which, when the key 70 is pressed inwardly, will enter slots 66 and 67 and shift both racks into their normal position. A leaf spring 72 is applied to a shoulder 73 on button 70 for retracting button 70 after each inward stroke. When the reset button 70 is pressed while the racks are out of normal position, the V-shaped end 71 will enter and pass through slots 67 and 66 and shift the racks into their normal locking position. If there has been relative movement of the racks, the wedge 71 will engage the slots 66 and 67 in both racks and shift them into normal relative position.

The combination lock and latch 40 are exemplified for use in a vehicle door, with means for permitting the door to be opened from the inside of the vehicle while the bolts 41, 47 remain in their normal or locking position, and means for releasing the door so it can be opened from the outside of the vehicle when the bolts 41, 47 have been shifted to latch-releasing position by operating the keys 30 in proper combination and sequence.

The fulcrum pin 81 and latch 80 is supported in brackets 82 which are fixedly mounted in the door. A spring 83 is applied to urge latch 80 into the position shown in Fig. 1, the outer side of said latch engaging the edge of a slot in the edge of the door through which the latch projects. A catch 104 is pivotally mounted at 105 in the vehicle door frame, and a spring 106 is applied to normally hold said catch against an abutment 107 fixed in said body. Latch 80 is provided with an inclined end 110 for swinging the catch to clear the latch when closing the door, the latch 80 snapping into a recess in the catch 104 for locking the latch against outward movement.

Lever 40 is forked and its fulcrum pin 85 extends through and is seated in slots 86 in brackets 82 and is pressed to its seat by a pair of springs 99. Lever 40 is operable to withdraw cross-pin 88 from notch 89 in latch 80 for releasing the latch from the inner side of the door while lever 40 is restrained by bolts 41, 47. For this purpose a button 95, accessible from the inside of the vehicle, is mounted in the inner side of the door and is adapted to rock a lever 96 which is fulcrumed at 97 and provided with a fork end to which links 98 are pivoted. Links 98 connect the cross-pin 88 and the forked end of lever 96. A spring 100 urges lever 96 into position to cause its forked end to hold cross-pin 88 in the notch 89 of latch 80. When button 95 is pressed, lever 96 will shift links 98 to withdraw cross-pin 88 from notch 89 in latch 80 and release the latch to permit it to swing inwardly against the force of spring 83, and thereupon permit the latch to clear the catch 104 and the door to be opened. In this movement of cross-pin 88, lever 40 remains in engagement with bolts 41, 47, and springs 99 permit the fulcrum pin 85 to be shifted while said bolts remain in locking position. When the door is open and is swung into closing position, latch 80 will shift catch 104 against the force of spring 106 to permit latch 80 to be locked by catch 104 when the door is in its closed position.

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In the construction thus far described, the lever 40 exemplifies a locking element for the latch which controls the opening and closing of the door; the racks 45 and 46 exemplify separately movable devices which are shiftable for controlling the release of the locking element; the V-shaped wedge elements 34 on the keys exemplify means for shifting the racks when the keys are operated in a predetermined sequence to release the locking element; the springs 63 exemplify spring-means for permitting the racks to be shifted when the racks are obstructed against step-by-step movements.

In Figs. 9 to 17 the invention is exemplified in a combination lock for a door *c* which includes a cylindrical rack provided with teeth co-acting with wedge-teeth on the keys for controlling a locking bolt *d*. This construction comprises a cylindrical case which is set into a hole bored through the door, and the bolt for locking the door is spring-released. The case comprises a cylindrical body 117 provided with an integral head 118 on the outer side of the door, an inner head 119 secured in the inner end of the cylindrical body 117, and provided with an integral screw-threaded sleeve 120 and a clamping plate 121 threaded to sleeve 120 on the inner side of the door.

An annular series of ten keys 122 numbered 0 to 9 are slidably mounted in cylindrical guideways 123 formed in the casing body 117 and provided with integral wedge-elements 124 having V-shaped ends 127. Springs 125 are confined between a ring 126, which is fixedly secured in the casing body at the inner end of guides 123, and extend into sockets in the keys 122, and are adapted to retract the keys and hold elements 124 against the inner face of plate 118. Elements 124 extend through and are axially guided in slots 129.

A cylinder rack or device 130 is centrally journaled in the casing, and is provided with a shoulder 132 which is held seated on an annular shoulder on plate 119 by a spring 134 interposed between a screw cap 135 and the adjacent end of cylindrical rack 130. Cylindrical rack 130 is provided at its inner end with alternating teeth 138 and slots or notches 139 for co-acting with the wedge elements 124 to shift the cylinder 130 step-by-step. Those teeth 138 which are operable by the keys of the correct denomination, when operated in a predetermined sequence are provided with surfaces for rotating rack 130 in one direction to move the rack into bolt-releasing position, and the remaining teeth are provided with oppositely inclined surfaces 141 for reversely rotating the rack to prevent the cylinder from being shifted to release the bolt *d*. Assuming the combination to be composed of numbers 6-3-9-1, the teeth of the cylindrical rack are normally positioned relatively to the keys so that the No. 6 key will engage the inclined surface 140 and shift the cylindrical rack one step; the wedge element 124 on the No. 3 key will engage the inclined surface 140^a and shift the cylindrical rack the second step; the No. 9 key will engage an inclined surface 140^b to shift the rack the third step; and the No. 1 key will engage an inclined surface 140^c to shift the cylindrical rack the fourth step when the keys are shifted in this sequence. Rotation of the cylindrical rack four steps in one direction will release the bolt-controlling mechanism as hereinafter described. If other keys are shifted or the keys are not shifted in the same sequence,

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they will engage one of the inclined surfaces 141 and reversely shift the cylindrical rack to prevent release of the bolt-locking device, or in exceptional instances pass into a slot 139 between the teeth 138 and fail to rotate the rack.

A bolt-controlling device, which is controlled by the step-by-step movement of the cylindrical rack 130, comprises a bifurcated element 145 which is slidable between head 119 and plate 126, and provided with a stem 146 which is engaged by a head 147 on bolt *d* and is slidably mounted in a sleeve 148 which is set into the edge of the door and pressed into door-releasing position by a spring 149 which is confined in a sleeve 148 and engages an annular shoulder 150 on bolt *d*. Head 147 is connected by a screw-threaded stem 151 to bolt *d* for adjustment of the projecting end of the bolt which is adapted to enter a socket in the door frame. Inward movement of control-element 145 by spring 149 is controlled by a dog 152 which is pivoted at 153 to said element, and has its distal end adapted to abut against the outer periphery of the cylinder rack 130 until said rack is rotated, to register the inner end of dog 152 with a slot 154 in rack 130 to permit dog 152 to move inwardly and release the element 145 for movement by the spring-pressed bolt *d*. A spring 155 is carried by element 145 and applied to dog 152 to normally press the distal end of the dog against an abutment 156 formed on the head 119. Shaft 160 is cut away as at 171 to provide clearance for dog 152 when it passes through slot 154 into the rack.

The mechanism for resetting the cylindrical rack to its normal rotative position in the case comprises shaft 160, which is axially slidable in the case and disposed within the cylindrical rack 130, and is provided with a pull-handle 161 at the inner side of the door for manual operation, and a cross-bar 162 which extends diametrically through and is fixedly secured to shaft 160 and extends through longitudinal slots 164 in the cylindrical rack 130. This bar 162 rotates shaft 160 step-by-step with the rack 130. A coil spring 165 around cylindrical rack 130 is disposed between the portions of bar 162 which project from said rack, for retracting the shaft 160 and holding it in normal position. A button 167 is slidably mounted in the outer wall 118 of the case and abuts against the inner end of shaft 160, and is provided with a shoulder 168 engaging the inner face of plate 118. Shaft 160 is provided with a stem 169 which is slidable and rotatable in a socket 170 in button 167.

The bifurcated element 145 is provided with inclined cams 172 at the sides of the rack 130. These cams are engageable with the bar 162 for shifting said element outwardly and for rotatively retracting shaft 160 and rack 130. When dog 152 is released by cylindrical rack 130 and spring 149 shifts the element 145 inwardly, cams 172 will engage the outer ends of bar 162, and rotate cylindrical rack 130 to its normal position, and bolt *d* will be held retracted by spring 149. This rotation of rack 130 by cams 172 will swing dog 152 against the force of spring 155 into the position illustrated in Fig. 11. The bolt *d* will remain retracted until the control element 145 is shifted outwardly and latched in its outward position by the dog 152, and the bolt is reset into its locking position.

When it is desired to reset the bolt *d* in its locking position, from the inner side of the door,

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the user will pull handle 161 which will cause the ends of cross-bar 162 to engage cams 172. This will cause the element 145 to be shifted outwardly until dog 152 passes out of slot 154 and is pressed by its spring 155 into position to engage the periphery of cylindrical rack 130 and prevent inward movement of said device and bolt *d*. The outward movement of handle 161 will cause cross-bar 162 to engage cams 172 on control device 145 and, when the handle is released, spring 165 will retract shaft 160 to its normal position.

When it is desired to reset bolt *d* from the outer side of the door, the user will push button 167 which will impart axial movement to shaft 160 and shift control element 145 and bolt *d* into locking position in the same manner, and to withdraw dog 152 from slot 154, so it will snap into position to arrest the element 145.

When the bolt *d* is in its locked position, the bolt-controlling device 145 and dog 152 will be positioned as illustrated in Fig. 10. Spring 149 will exert an inward pressure on bolt *d* which is transmitted to element 145. This inward pressure will hold the inner end of dog 152 against the cylindrical rack 130, while abutment 156 limits the pivotal movement of the dog in one direction by spring 155.

When the combination is composed of numerals 6-3-9-1, the slot 154 in cylindrical rack 130 will be positioned to release the dog when the rack is moved four steps in clockwise direction. Depression of key No. 6 will cause its wedge 127 to engage the inclined edge 140 of one of the teeth 138 and rotate the rack one step; this will position the inclined surface 140^a on the rack into alignment with the wedge on key No. 3; depression of Key No. 3 will rotate the cylindrical rack the second step, which will position the inclined surface 140^b on one of the teeth 138 on said rack for engagement by the wedge on key No. 9; depression of key No. 9 will shift the cylindrical rack the third step, and position the inclined surface 140^c on the rack for engagement by the No. 1 key; and the depression of key No. 1 will shift the cylindrical rack the fourth step, whereupon dog 152 will be released and the pressure of spring 149 on the bolt *d* and stem 146 will shift control device 145 and dog 152 inwardly through slot 154; the bolt *d* will then be released to permit the door to be opened.

When it is desired to change the combination of the form of invention illustrated in Figs. 1 to 8, it is only necessary to substitute racks 44, 46 provided with teeth having inclined ends for imparting step-by-step movement to the racks, by the keys of the combination. In the form of invention illustrated in Figs. 9 to 17, it is only necessary to substitute a cylindrical rack with inclined teeth for imparting step-by-step movement to the rack, by the keys of the combination.

In the construction last described the wedge devices 124, 127 on keys 122 exemplify shifting elements on the keys; the annular element 130 exemplifies a cylindrical rack; the teeth on the rack exemplify means shiftable by the keys for shifting the rack; the element 145 exemplifies a control device for the bolt *d* which is released by the rack when the keys are operated in a predetermined sequence.

A characteristic of the invention is that the rack provided with wedge-teeth is frictionally held in the positions into which they are shifted

step-by-step by the keys, and the racks are free to move in one direction by the keys of and in the sequence of the combination and are shifted in the opposite direction when the keys are otherwise shifted.

The invention exemplifies a combination lock which includes a device which is operable step-by-step in one direction to lock-releasing position when the keys are operated in a predetermined sequence and which, when the keys are operated out of said sequence, the device will be shifted in the opposite direction to prevent the release of the lock until the device has been reset to its normal position. The invention also exemplifies a combination lock which is efficient in preventing its unlocking operation and is simple in construction and adapted to be applied to doors of different types.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A combination lock comprising: a series of selectively operable keys, wedge elements on the keys, a releasable locking element, a cylindrical rotatable rack provided with teeth having inclined surfaces and slots engageable by the wedge elements on the keys for shifting the rack step-by-step in one direction to release the locking element by the operation of the keys in a predetermined sequence and a slidable control device for the locking element including a pivoted dog movable with said device and engaging the rack, the rack being provided with a slot into which the dog is movable for controlling said device to release the locking element.

2. A combination lock comprising: a series of selectively operable keys, wedge elements on the keys, a releasable locking element, a cylindrical rotatable rack provided with teeth having inclined surfaces and slots engageable by the wedge elements on the keys for shifting the rack step-by-step in one direction to release the locking element by the operation of the keys in a predetermined sequence, a control device for the locking element including a pivoted dog movable with said device and engaging the rack, the rack being provided with a slot into which the dog is movable for controlling said device to release the locking element, a cam on the control device, a rotatable shaft longitudinally slidable in the rack, and means on the shaft for engaging the cam for rotatably retracting the rack to its normal position, and a case in which the rack, control device, shaft and keys are operatively mounted.

3. A combination lock comprising: an enclosing case, a series of selectively operable keys, each including a stem axially slidable in the case and a wedge element projecting transversely from the stem, the case being provided with slots through which the wedge elements extend with ends projecting from the slots in the case, a releasable locking element, and a rack for controlling the release of the locking element, means for shifting the rack step-by-step and releasing the locking element by the operation of the keys in a predetermined sequence and provided with slots and teeth between the slots engageable by the transversely projecting ends of the wedge elements on the stems.

4. A combination lock comprising: an enclosing case, a series of selectively operable keys, each including a stem axially slidable in the case and a wedge element projecting transversely from the stem, the case being provided with slots through which the wedge elements extend with ends projecting from the slots in the case, a releasable locking element, and a rack for controlling the release of the locking element by the operation of the keys in a predetermined sequence, and provided with teeth engageable by the projecting ends of the wedge elements on the keys and slots between the teeth extended to form continuations of greater depth than the teeth, the wedge elements on the stems being slidable into the continuations of the slots between the teeth.

5. A combination lock comprising: an enclosing case, a series of selectively operable keys, each including a stem axially slidable in the case and an element projecting transversely from the stem having a V-shaped lower end and parallel sides above said lower end, the case being provided with slots through which the elements extend with ends projecting from the slots in the case, a releasable locking element, and a rack for controlling the release of the locking element by the operation of the keys in a predetermined sequence provided with wedge teeth and slots therebetween extended below the wedge teeth to form parallel sided continuations of greater depth below the teeth, the parallel sides of the elements on the stem being movable into and fitting in the parallel sided continuations of the slots in the rack.

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