

Jan. 21, 1969

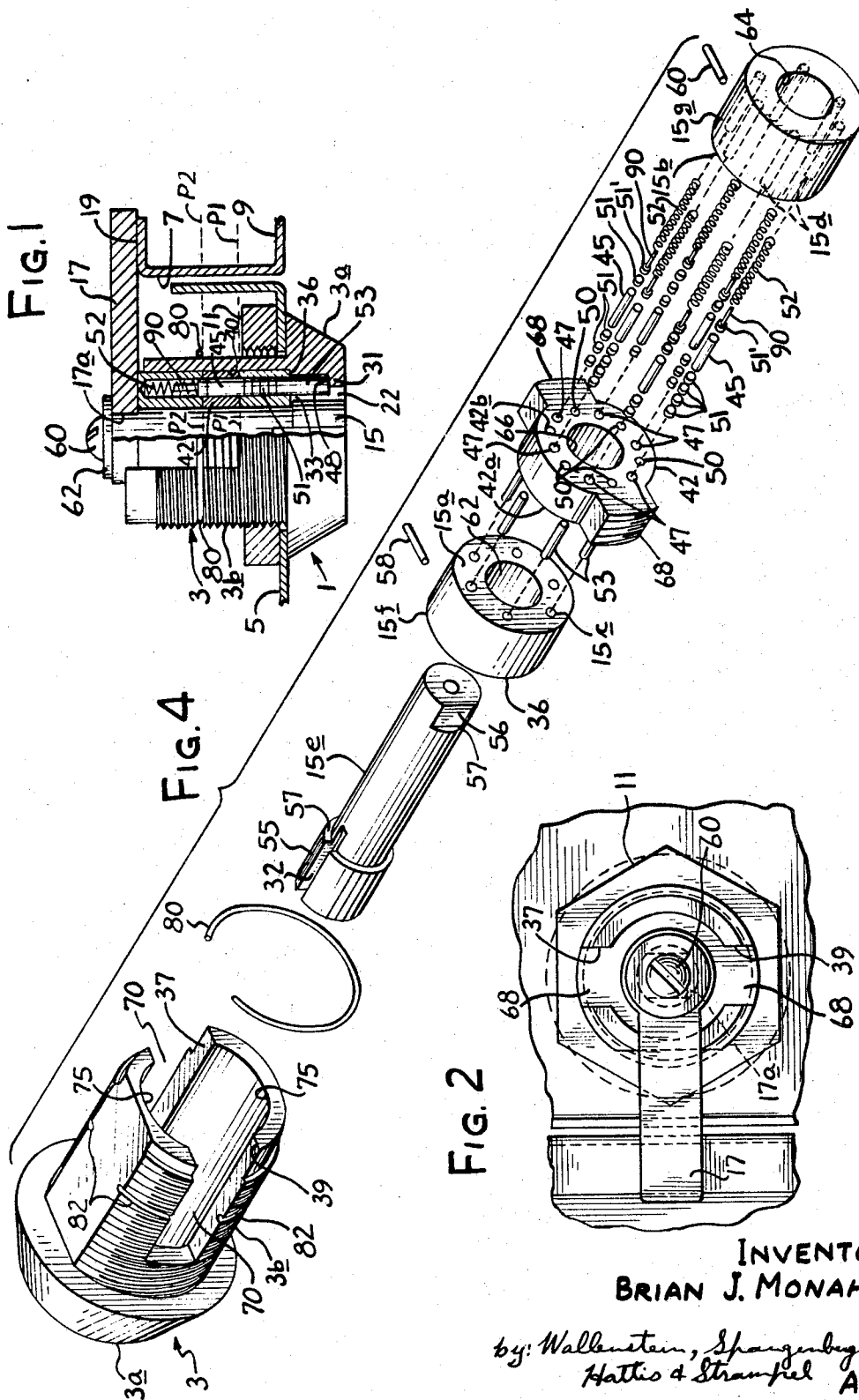
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3,422,646

INSTANTANEOUS TUMBLER CHANGE LOCK

Filed March 15, 1967

Sheet 1 of 4



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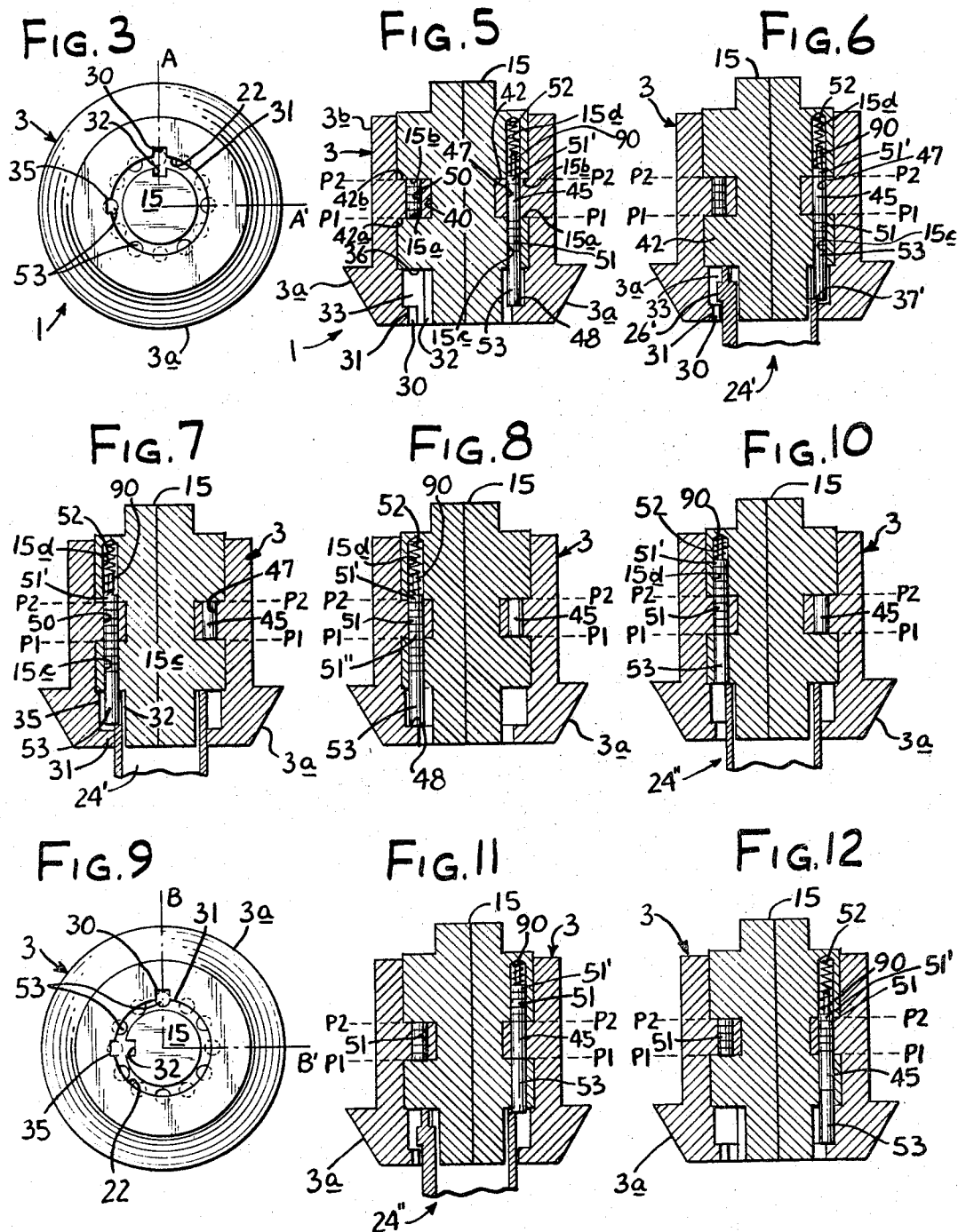
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Sheet 2 of 4



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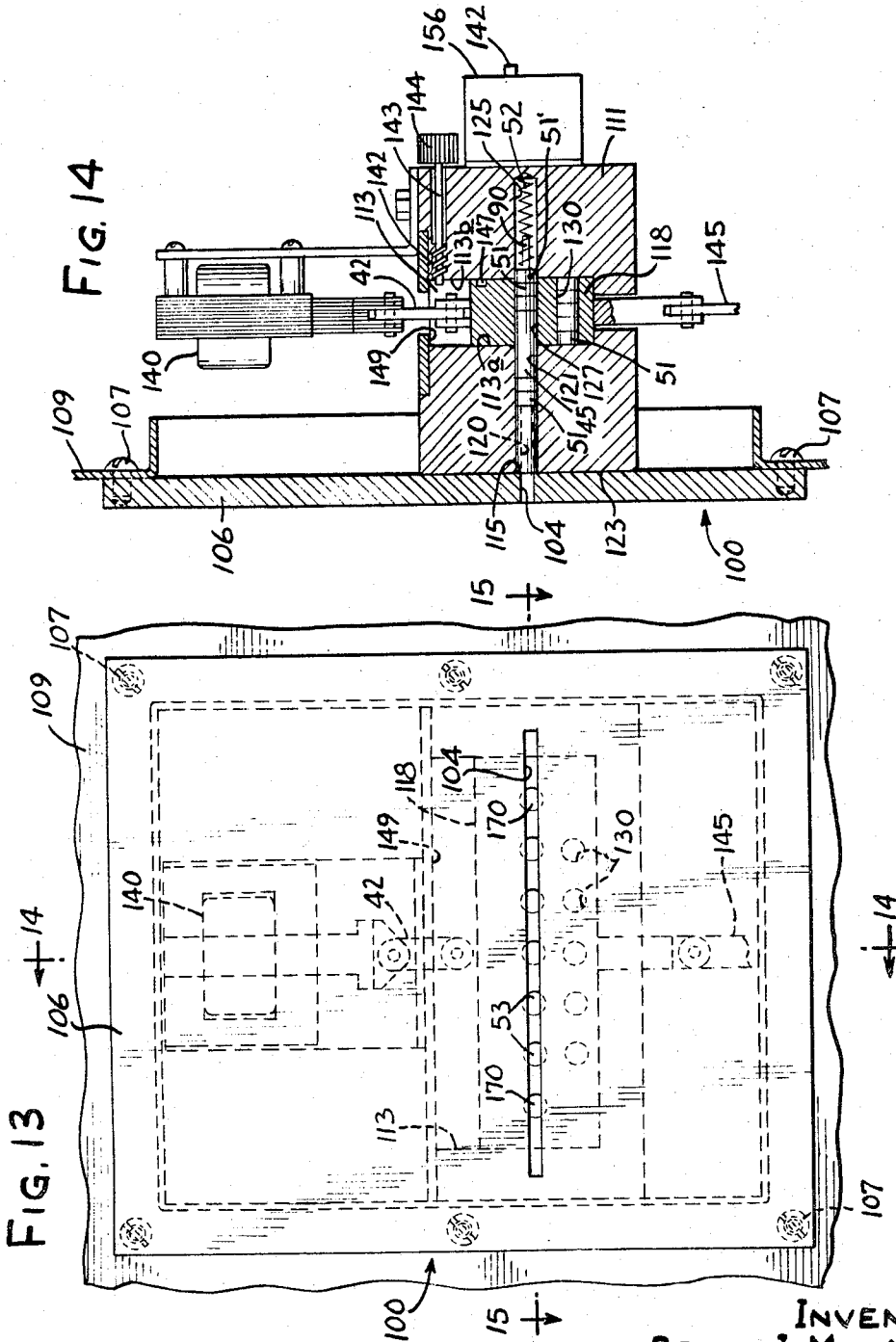
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Sheet 3 of 4



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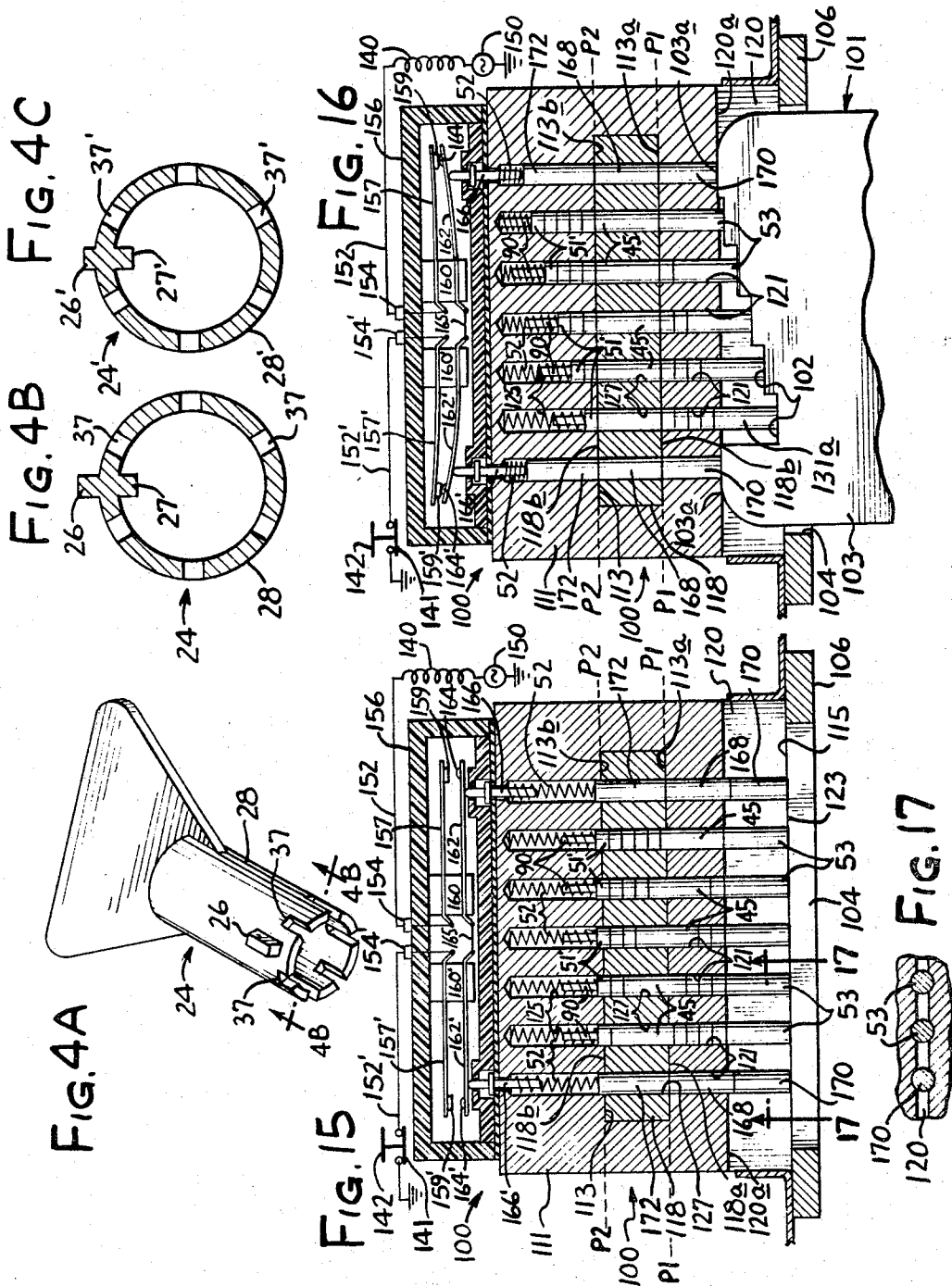
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Sheet 4 of 4



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INSTANTANEOUS TUMBLER CHANGE LOCK

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16 Claims

ABSTRACT OF THE DISCLOSURE

This lock comprises two main body members, one of which is slidably disposed with respect to the other for rotational or reciprocating motion with respect to the other. One of the members provides a socket or recess into which the other member fits and there are provided at the interfaces of the members two spaced pairs of confronting abutting surfaces which established two spaced shear planes. The other member, which is positioned between the shear planes, has parallel locking pin-receiving slideways and wafer storage slideways extending between the shear planes. The recessed member has aligned front and rear pairs of parallel tumbler-receiving slideways which, in the locking position of its movable member, are respectively aligned with the corresponding locking pin-receiving slideways of the other member, and, in a tumbler changing position of the movable member, are respectively aligned with the corresponding wafer storage slideways in the other member. In the locking position of the movable member, each aligned set of slideways carries a movable tumbler assembly comprising a spacer pin, a locking pin, which has a length identical to the distance between the shear planes and preferably remains at least partially at all times within its locking pin slideway, and a fixed total number of wafers each of the same thickness. The number of wafers located in front of the locking pin is variable by the shifting of wafers between the front and rear of the locking pin.

The present invention relates to locks wherein the tumblers can be changed for operation by a new key without removal or replacement of any parts of the lock by the simple expedient of moving the bolt of the lock to a tumbler changing position with a key fitting the lock, replacing the old key by a new key and returning the bolt to the locking position of the bolt. Such a tumbler lock, for example, is disclosed in U.S. Patent No. 2,326,358. Tumbler type locks of the type described and as heretofore available suffer from a number of disadvantages. The most serious drawbacks to those locks was that a large number of different key unlocking shoulder combinations can open a given lock, and the locks can be easily picked because each tumbler assembly consists of a locking pin and tumbler changing wafers such that each tumbler assembly has a varying number of release points where the interfaces of the wafers and of the locking pin and a wafer lineup with the single shear plane of the lock.

The present invention avoids the aforementioned problems by using a unique locking principle in which only one combination of key unlocking shoulders can open a given lock of this type, where the tumblers can be changed by the mere insertion of a new key into the lock in its tumbler changing position, and where the depth at which a locking pin of a tumbler assembly is set to be released is not discernible by probing to detect the presence of aligned interfaces between the parts of the tumbler assembly and the adjacent parts of the lock.

The basic feature of the invention is the provision of a recess or a socket in one of the two relatively movable members of the lock for receiving the other member of

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the lock so that two shear planes or interfaces are provided at the opposite ends of the latter member. The latter member has a set of parallel locking pin-receiving slideways which extend between the two shear planes or interfaces for holding locking pins and a corresponding set of parallel wafer storage slideways extending between the shear planes or interfaces for holding a supply of tumbler changing wafers. The recessed member is provided with a set of tumbler-receiving slideways which extend outwardly from each plane or interface and are aligned with the locking pin-receiving slideways in the other member when the movable member is in a locking position and are aligned with the wafer storage slideways when the movable member is in a tumbler changing position. The locking pins have a length corresponding to the length between the shear planes or interfaces so there is only one position of each locking pin where the movable member or bolt of the lock can be moved, namely the position where the end faces of the locking pin line up with both shear planes or interfaces. For every other position of each locking pin where end faces of wafers line up with a shear plane or interface, the other shear plane or interface is crossed by the locking pin. Thus, because an interface between parts of the tumbler assembly passes one or the other of the two shear planes or interfaces at every wafer depth besides the depth at which the locking pin is set to release, there is a false indication of release at every wafer depth, and the lock is thereby made highly pick resistant.

The lock is preferably (although not necessarily) constructed so the locking pins can never be completely moved out of the locking pin-receiving slideways. To this end, the length of the locking pins and the locking pin-receiving slideways are greater than the maximum number of wafers transposable from in front of the locking pins to behind the locking pins and vice versa by an amount equal to an integral number of wafer thicknesses. Tumbler urging springs are placed in the rear tumbler-receiving slideways of the recessed members for urging the tumbler assemblies to the front key-receiving end of the lock. Means are provided to prevent the springs from crossing the rear shear plane or interface of the lock.

As will appear from the description to follow, the present invention can be constructed in a variety of forms and configurations. For example, in one form of the invention, the movable member is a cylindrical member with an annular recess into which the other stationary locking pin containing member projects. The various slideways described above are spaced around concentric circles and open onto the shear planes located at the opposite margins of the annular recess. The slideways of the stationary member extend between the shear planes and carry the locking pins and the supply of wafers which are used to effect a tumbler changing operation. The key preferably comprises a hollow cylindrical member which fits into an annular opening in the front end of the lock.

In another form of the invention, the recessed member is stationary and forms part of the lock housing, and the movable member is a reciprocable rectangular bolt slidably mounted in a rectangular recess or slide channel in the stationary member. The movable member here carries the locking pins and tumbler changing wafers. In this form of the invention, the key most advantageously comprises a plate-like member having stepped tumbler engaging shoulders cut into one edge of the plate.

The above and other features and advantages of the present invention will become apparent upon making reference to the specification to follow, the claims and the drawings wherein:

FIG. 1 is a partial vertical sectional view of a rotatable tumbler lock constructed in accordance with the present invention;

FIG. 2 is a rear view of the lock shown in FIG. 1;
FIG. 3 is a front view of the lock shown in FIG. 1;
FIG. 4 is an exploded view of most of the parts making up the lock shown in FIG. 1;

FIG. 4A is a perspective view of a key used to open the lock of FIGS. 1-4;

FIG. 4B is a transverse sectional view of the key of FIG. 4A, taken along section line 4B-4B thereof;

FIG. 4C is a transverse sectional view of a key similar to that shown in FIG. 4A, but used as a tumbler changing key;

FIG. 5 is a somewhat diagrammatic longitudinal sectional view of the lock taken along the sectional planes A-A' in FIG. 3 when the bolt of the lock is in its normal locking position;

FIG. 6 is a view corresponding to FIG. 5 where a tumbler changing key has been inserted into the lock;

FIG. 7 is a somewhat diagrammatic longitudinal sectional view of the lock taken along section planes B-B' in FIG. 9 where the bolt of the lock has been turned by the key shown in FIG. 6 to a tumbler changing position;

FIG. 8 is a view corresponding to FIG. 7 when the key has been removed from the lock;

FIG. 9 is a front view of the lock when the bolt has been turned into the tumbler changing position;

FIG. 10 is a view corresponding to FIG. 8 after a new tumbler changing key has been inserted into the lock;

FIG. 11 is a partially diagrammatic longitudinal sectional view of the lock when the bolt and key shown in FIG. 10 is rotated into the normal locking position thereof;

FIG. 12 is a view corresponding to FIG. 11 with the new tumbler changing key removed therefrom;

FIG. 13 is a front view of the reciprocating type tumbler lock constructed in accordance with the present invention;

FIG. 14 is a longitudinal sectional view through the lock shown in FIG. 13, substantially taken along the lines 14-14 therein;

FIG. 15 is a longitudinal sectional view through the lock of FIG. 13, taken substantially along the line 15-15 therein;

FIG. 16 is a view corresponding to FIG. 15 after a plate or card-shaped key is inserted into the lock of FIG. 15; and

FIG. 17 is a fragmentary sectional view through the lock shown in FIG. 16, taken substantially along the lines 17-17 therein.

Referring now more particularly to FIG. 1, a rotatable tumbler lock 1 is shown having a stationary cylindrical housing with a flanged head portion 3a and a threaded shank portion 3b. The flanged head portion of the housing 3 abuts against the outer surface of a sheet metal door 5 shown in a closed position covering an opening 7 in a housing or framework 9. The lock is held in place on the door 5 in any suitable way, such as by a nut 11 threaded around the shank portion 3b. The lock has a bolt or barrel assembly 15 which carries a locking tongue 17 which is shown in FIG. 1 in a locking position where it extends behind a locking shoulder 19 provided on the framework 9.

The front face of the flanged head portion 3a of the housing 3 has an annular key-receiving opening 22 (FIG. 3) defined between the housing 3 and the barrel assembly 15 to receive a hollow cylindrically shaped key 24 or 24' (FIGS. 4A-4C). The keys 24 and 24' are identical except for the lengths of outer radially extending lugs or ears 26-26' provided on the ends of the cylindrical key bodies 28-28', the lug 26' being much shorter in a radial direction than the lug 26 on the key 24. The lug 26 is sized just to fit within a notch 30 formed on the flanged head portion 3a of the lock along the outer margin of the annular recess 22 (FIG. 3). The keys 24 and 24' have identical inner radially extending lugs 27-27' adapted just to fit within a notch 32 formed in the barrel assembly 15 along the inner margin of the annular recess. The notch

30 is formed in a radially inwardly extending lip 31 of the flanged head portion 3a of the lock housing which lip overlies a cylindrical space or opening 33 therein (FIG. 5).

The forward end of the barrel assembly 15 has a forwardly facing annular key abutment shoulder 36 confronting the inner side of the recesses 33 within the flanged head portion 3a of the lock housing. The abutment shoulder 36 receives the outermost edge of the cylindrical body 28 or 28' of the key 24 or 24' inserted into the lock. The keys 24 and 24' have axial recesses or grooves 37-37' cut in the outer end edges of the cylindrical walls 28-28' thereof, the particular combination of the depths thereof varying with each different key.

The lock 1 can be changed to operate with a different key by the simple expedient of inserting a tumbler changing key 24' into the lock, rotating the barrel assembly 15 to a tumbler changing position and then inserting a new tumbler changing key into the lock. To this end, the barrel assembly 15 is rotatable in a counterclockwise direction into the position shown in FIG. 9 where the key lug-receiving notch 32 is opposite a notch 35 formed in the lip 31 of the flanged head portion 3a of the lock housing. The barrel assembly is thus rotatable when the proper key 24 or 24' is inserted into the annular recess 22. Then, the lugs 26-27 or 26'-27' thereof pass through the notches 30 and 32 into the opening 33 behind the lip 31. The notch 35 has a depth equal to the radial height of the short lug 26' on the tumbler changing key 24', so the higher lug 26 on the key 24 could not be removed from the lock when the barrel assembly is rotated into a tumbler changing position. Thus, only the tumbler changing key 24' can be withdrawn from the lock when the barrel assembly 15 is in its tumbler changing position. Then, the insertion of a new tumbler changing key 24' (FIGS. 10-11) will, in a manner to be explained, change the tumblers to be described to accommodate a key with the new combination of tumbler engaging recesses or grooves.

The movement of the barrel assembly 15 may be limited by the engagement of the locking tongue 17 with shoulders 37 and 39 respectively (FIG. 2) formed at the rear end of the shank portion 3b of the lock housing 3. The shoulders 37 and 39 are formed by cutting a step in the shank portion of the lock housing 3 as best shown in FIG. 4. When the tongue 17 abuts the housing shoulder 37, the aforementioned notch 32 in the barrel assembly 15 will be in alignment with the shallow notch 35 in the lock housing 3. The clockwise rotation of the barrel assembly is limited by the abutment of the tongue 17 with the shoulder 39. The locking tongue 17 will clear the shoulder 19 to permit the door to be opened in both extreme positions of the barrel assembly 15.

As previously indicated, the basic feature of the invention is in the unique relationship between the barrel assembly 15 and the lock housing 3. To this end, the barrel assembly 15 is provided with an annular recess 40 intermediate its ends (FIG. 5) which receives a stationary non-rotatable body of material 42 which may form radially inward extension of the shank portion 3b of the lock housing 3 or to be a separate member immovably anchored to the housing. The stationary annular body of material 42 has parallel outwardly axially facing surfaces 42a and 42b which confront and are in abutment with adjacent parallel axially facing surfaces 15a and 15b of the barrel assembly 15. The confronting abutting surfaces of the stationary body of material 42 and the barrel assembly 15 define spaced parallel front and rear shear planes P1-P1 and P2-P2. In a manner to be described, locking pins 45 are slidably mounted in correspondingly shaped locking pin slideways 47 formed within the stationary body of material 42. The pins 45 normally extend across the front shear plane P1-P1 in the locking position of the barrel assembly 15, and are of a length equal to the length of the slideways 47, so that they can extend to the opposite faces 42a and 42b of the body of

stationary material 42. Different portions of the locking pins extend across the front shear plane P1—P1 and the insertion of a proper key into the lock will move the locking pins into a position where they are completely within the slideways 47 so the end faces thereof are flush with the shear planes P1—P1 and P2—P2, permitting the rotation of the barrel assembly 15. The body of stationary material 42 also has axial wafer storage slideways 50, there being one such wafer storage slideway for each locking pin slideway 47 therein.

In the locking position of the barrel assembly 15, the various locking pin slideways 47 in the body of stationary material 42 are brought into alignment with corresponding axial tumbler-receiving slideways 15c and 15d respectively extending forwardly and rearwardly from the axially facing surfaces 15a and 15b of the barrel assembly 15. The particular position which a locking pin 45 has in the locked position of the barrel assembly depends upon the number of wafers 51 positioned between each locking pin 45 and a spacer pin 53. Each spacer pin 53 forms part of a tumbler assembly including a stack of wafers 51 and a locking pin 45. Each tumbler assembly is urged by a spring 52 in the associated rear slideway 15d toward the front of a lock where the spacer pin 53 abuts a reference abutment shoulder 48 defined by the inner margin of the annular lip 31 of the flanged head portion 3a of the housing 3 when the key is not inserted in the lock. When a key which fits the lock is inserted into the lock (FIG. 6), the shoulders provided at the bottoms of the various recesses 37 or 37' on the cylindrical wall of the key 24 or 24' involved engage the spacer pins 53 and push the tumbler assemblies involved rearwardly into a release position where the locking pins are completely within the confines of the locking pin slideways 47.

When the barrel assembly 15 is rotated by a tumbler changing key 24' into its tumbler changing position, the locking pins 45 are left in the locking pin slideways 47 and each of the tumbler-receiving slideways 15c and 15d of the barrel assembly 15 are brought opposite the ends of a wafer storage slideway 50 (FIG. 7) in the body of stationary material 42 where, by insertion of a new tumbler changing key into the lock (FIG. 10), different combination of wafers 51 are moved into or out of the slideways 15c and 15d in a manner to be more fully explained.

To provide an easy to manufacture and assemble lock construction, the rotatable barrel assembly 15 is preferably made in the manner best illustrated by the exploded view of FIG. 4. The barrel assembly 15 there illustrated includes a cylindrical shaft 15e having an enlarged head 55 providing a shoulder 57, a forward cylindrical barrel 15f which is secured as by a pin 58 to the forward portion of the shaft 15e where it bears against the shoulder 57, and a rear cylindrical barrel 15g which is secured as by a pin 60 to the rear end portion of the shaft 15e. The barrels 15f and 15g have circular central openings 62 and 64 which received the shaft 15e. The front and rear barrels 15f and 15g are spaced from one another a distance equal to the spacing between the shear planes P1—P1 and P2—P2 (FIG. 1) and define therebetween the aforementioned annular recess 40 in which the body of stationary material 42 is located.

The body of stationary material 42 in FIG. 4 is a separate member 42 having a cylindrical central portion with a circular opening 66 extending therethrough for receiving the shaft 15e, and diametrically opposed radial projections 68—68 adapted to extend into axially extending recesses 70 and 70 cut in the shank portion 3b of the lock housing 3.

The locking tongue 17 (FIG. 2) has a non-circular opening 17a conforming to the non-circular cross section of the rear end of the shaft 15e as provided by a flat 56 formed on the end thereof. The tongue 17 abuts

a shoulder 57 on the shaft and is held in place thereon in any suitable way, such as by a screw 60 having a head bearing against a lock washer 62 and a shank threaded into the body of the shaft 15e (FIG. 1).

The barrel assembly 15 including the shaft 15e and the barrels 15f and 15g and the stationary member 42 are initially assembled upon the shaft 15e, the springs 52, pins 45 and 53 and wafers 51 are inserted, and then the resultant assembly is positioned within the cylindrical recess defined between confronting surfaces 75 and 75 in the housing shank portion 3b, the cylindrical exterior surfaces of the barrels 15f and 15g and the stationary member 42 being in engagement with the confronting cylindrical surfaces 75—75. The radial projections 68—68 of the stationary member 42 must, of course, slide within the longitudinal slots 70—70 in the housing shank portion 3b. The assembly just described is fixed in place within the hollow interior of the shank portion 3b by a split locking ring 80 which snaps within circular recesses 82 formed in the exterior housing of the shank portion 3b and extends behind the radial projections 68—68 of the stationary member 42 to retain the entire barrel assembly 15 and the stationary member 42 in place within the lock housing.

The aforementioned tumbler-receiving slideways 15c at the front of the barrel assembly 15 are cylindrical bores extending axially completely through the front barrel 15f to open onto the opposite face thereof. There are six such tumbler-receiving slideways 15c in the barrel 15f which are spaced 60 degrees apart along a common circle which is coaxial of the axis of the cylindrical outer surface of the front barrel 15f. The aforementioned tumbler-receiving slideways 15d at the rear of the barrel assembly comprise six cylindrical bores of the same diameter as the slideways 15c extending partway through the rear barrel 15g from the front face thereof. The slideways 15d are spaced 60 degrees apart and are respectively aligned with the corresponding slideways 15c in the front barrel 15f.

The aforementioned locking pin slideways 47 are six cylindrical bores of the same diameter as the slideways 15c and 15d and extending axially completely through the cylindrical portion of the stationary member 42. The slideways 47 are spaced 60 degrees apart about a circle of the same radius as the circle about which slideways 15c and 15d are located. When the barrel assembly 15 is in its normal locking position, the six locking pin slideways 47 on the stationary member 42 are in alignment with the six tumbler-receiving slideways 15c and 15d.

The aforementioned wafer storage slideways 50 are positioned midway between the various locking pin slideways 47 in the stationary member 42 and comprise six cylindrical bores of the same diameter as the other slideways and extend axially completely through the stationary member 42, where they open onto and are in respective alignment with the six tumbler-receiving slideways 15c and 15d in the barrels 15f and 15g when the barrel assembly is in a tumbler changing position. FIGS. 5 and 6 show four wafers 51 between a locking pin 45 and a spacer pin 53. In the lock being described, this is the maximum number of wafers which can be positioned between a locking pin 45 and its spacer pin 53. (The minimum number is zero.) Each locking pin 45 and its slideway 47 are preferably one wafer thickness greater in length than the maximum number of wafers which can be transposed from in front of the locking pin 45 to behind the locking pin 45 and vice versa. Accordingly, the slideways 47 (and 50) in the stationary member 42 have a length equal to five wafer thicknesses. Thus, in the preferred form of the invention, each locking pin 45 can never be in a position where it is completely within its front tumbler-receiving slideway 15c.

Each locking pin 45 must also be prevented from being moved completely within its rear tumbler-receiving slideway 15d. As shown in FIG. 5, each tumbler assembly

includes, in addition to a locking pin 45, spacer pin 53 and wafers 51 between the locking pin 45 and the spacer pin 53, one or more wafers on the rear side of each locking pin 45, the number of which varies from one wafer as shown in FIG. 5, where there are four wafers in front of the locking pin 45 involved, to five wafers when there are no wafers in front of the locking pin (FIG. 12). The aforementioned springs 52 in the rear tumbler-receiving slideways 15d are compressed between the rear closed ends of the slideways 15d and the rearwardmost wafer 51' therein. Each rearwardmost wafer 51' is preferably provided with a rearwardly extending projection 90 which bottoms against the closed end of the slideway 15d when the tumbler assembly is moved to its rearwardmost position, but the compressed length of the springs may be designed to achieve the same bottoming effect. The lock is designed so that the latter wafers 51' will always remain partly within the rear slideway 15d. This keeps the springs 52 from being jammed in the rear shear plane P2—P2 and, since the locking pins 45 are five wafer thicknesses long, the locking pins 45 cannot be pushed into position where they are completely within the rear slideways 15d.

The wafer storage slideways 50 are always filled with five wafers. When the barrel assembly 15 is rotated into a tumbler changing position as shown in FIG. 7 with a tumbler changing key 24', there will be a total of ten wafers between each spacer pin 53 and the spring 52 in the associated rear slideway 15d. When the tumbler changing key 24' is removed from the lock (FIG. 8), the various spacer pins 53 will engage the abutment shoulder 48 at the front of the housing 3. The spacer pins 53 are dimensioned so that the rear shear plane P2—P2 will then bisect the rearwardmost wafers 51' and the front shear plane P1—P1 will bisect the wafers 51' spaced five wafers from the rearwardmost wafers 51'. In such case, it is manifest that the tumbler assemblies cannot be rotated from this position. When a new tumbler changing key 24'' (FIG. 10) is inserted within the lock, there will be from zero to four wafers between each spacer pin 53 and the forwardmost shear plane P1—P1, five wafers within each wafer storage slideway 50 and from one to five wafers within each rear slideway 15d. The exact number of wafers which are located together between each spacer pin 53 and the front shear plane P1—P1 and within the associated rear slideways 15d depends upon the depth of key recesses 37' in which the spacer pin is bottomed. The shear planes P1—P1 and P2—P2 will then cut across the interfaces of adjacent wafers, thereby permitting the return of the barrel assembly 15 to its normal locking position shown in FIG. 11.

As previously indicated, the present invention also is adaptable to reciprocating tumbler type locks, and reference should now be made to FIGS. 13 through 17 which illustrate this form of the invention. The lock 100 differs from the rotatable tumbler locks of FIGS. 1 through 12 in a number of respects including the fact that some of the parts of the lock 100 are stationary and the movable parts of lock 100 are reciprocated along straight lines instead of being rotated.

It should be understood that the locks 1 and 100 could be used to lock and unlock any mechanism, door or other operable instrumentality. For example, in the case of the lock 100, the key 101 can be a credit card with the customer's name, address, etc. thereon which is used to operate an article dispensing device and which automatically transfers the customer's identification to a suitable recording medium in the device.

In the lock 100, the key 101 comprises a plate like key body 103 having cut in one longitudinal edge 103a a series of steps or shoulders 102, the depths of which depend upon the particular combination of tumbler assemblies which the key is designed to operate with. The key

101 is insertable within a longitudinal slot 104 formed in a front stationary wall 106 of the lock 100.

The front wall 106 of the lock 100 is welded or otherwise secured to a lock body 111 which has a rectangular slide channel 113 cut in the center portion thereof extending parallel to the wall 106. The front wall 106 of the lock is anchored to a sheet metal wall of the housing or door 109 of the article or piece of equipment involved by screws 107 threading partway into the same from the inside of the housing 109. The slide channel 113 has spaced front and rear parallel surfaces 113a and 113b (FIG. 15) extending parallel to a reference abutment shoulder 115 formed by the rear face of the front wall 106. The front surface 113a locates a front shear plane P1—P1 and the rear surface 113b locates a rear shear plane P2—P2. Slidably disposed within the slide channel 113 is a rectangular bolt 118 which has opposite parallel surfaces 118a and 118b which are in sliding engagement with the housing surfaces 113a and 113b. The lock body 111 has a longitudinally extending rectangular slot 120 running parallel to the length of the lock body at the front thereof. The slot 120 has the same width and is in alignment with the key-receiving slot 104 in the front wall 106.

In the illustrated embodiment of the invention, there are provided in the lock body 111 seven cylindrical slideways 121 transversely extending between the front face 123 of the lock body 111 and the front surface 113a of the slide channel 113 which slideways intersect and are centered on the rectangular slot 120. Similar cylindrical slideways 125 are provided in the lock body extending transversely from the rear surface 113b of the slide channel 113 and part way through the lock body, the slideways 125 being of the same size and in alignment with the slideways 121 formed in the front of the lock body 111. The rectangular bolt 118 has seven locking pin slideways 127 extending transversely between the opposite parallel surfaces 118a and 118b thereof, the slideways 127 being of the same size and being similarly positioned to the aforementioned aligned slideways 121 and 125 when the bolt 118 is in a locking position, as shown in FIGS. 14—16.

The bolt 118 is provided with a series of five cylindrical wafer storage slideways 130 (FIG. 14) of the same diameter as and extending parallel to the locking pin slideways 127 therein, there being one such wafer storage slideway 130 opposite each of the five centermost locking pin slideways 127. The axis of each wafer storage slideway 130 is in a vertical plane with the axis of the associated locking pin slideway 127 and associated aligned slideways 121 and 125 which plane extend transversely of the front wall 106. Also, the axes of all the locking pin slideways 127 and the axes of all the wafer storage slideways 130 are respectively in parallel horizontal planes extending transversely to the direction of movement of the bolt 118 within the slide channel 113. When the bolt 118 is in the locking position shown in FIGS. 14 through 16, each locking pin slideway 127 in the bolt 118 is in alignment with and opens onto the confronting ends of a pair of aligned slideways 121 and 125 intersecting the slide channel 113.

Each of the five centermost aligned sets of slideways 121—125—127 will normally contain a different arrangement of tumbler assemblies each comprising a locking pin 45 cutting across the front shear plane P1—P1, a spacer pin 53 at the forwardmost end of the tumbler assembly, from zero to four wafers 51 between the locking pin 45 and spacer pins 53, and from one to five wafers behind the locking pin 45. The rearwardmost wafer 51' of each tumbler assembly also has a rearwardly extending projection 90 which performs the same function as the similarly numbered projections 90 on the rearwardmost wafers 51' of the lock 1 in FIGS. 1 through 12, so that each rear tumbler-receiving slideway 125 can accommodate only five wafers. Each tumbler assembly is urged forwardly by a compressed coil spring 52 located between

the rear end of each associated rear housing slideway 125 and the rearwardmost wafer 51' so the spacer pins normally abut the abutment shoulder 115 on the rear of the front wall 106 of the lock.

As in the case of the various locking pins 45 in the lock 1 of FIGS. 1 through 12, the locking pins 45 are of the same length as the associated locking pins slideways 127 and are most advantageously one wafer thickness longer than the maximum number of wafers which can be transposed from in front of each locking pin 45 to behind each locking pin 45 and vice versa, namely four wafer thicknesses in the exemplary lock being described.

Each wafer storage slideway 130 contains five wafers 51 at all times, and, when each wafer storage slideway 130 in the bolt 118 is moved opposite a pair of tumbler-receiving slideways 121 and 125, the wafers can be passed along the aligned slideways 121-130-125 to vary the tumbler combination involved in a manner analogous to that described in connection with the change of the tumbler assemblies in the lock 1 of FIGS. 1-12. Of course, the bolt is movable into such a tumbler changing position only when a proper key 101 is inserted into the lock to push all of the locking pins fully into the locking pin slideways 127 so the shear planes P1-P1 and P2-P2 pass between the interfaces of the separable parts of the tumbler assemblies. The insertion of the key 101 into the lock 100 will, in a manner to be described, energize a solenoid or similar device 140 (FIG. 14) which pulls an arm 42 attached to the upper end of the bolt 118, as viewed in FIG. 14, upwardly against an abutment shoulder, such as one formed by the shank of a screw member 143 preferably accessible only on the inside of the housing 109 so the key owners cannot effect a tumbler changing operation. Where the housing 109 is part of a vending machine or the like, the owner of the vending machine would have access to the inside of the housing through a key operated door located elsewhere in the housing. The bolt 118 is normally resiliently urged into a normal bottom locking position by a solenoid spring (not shown) which urges the armature of the solenoid 140 downwardly. Movement of the bolt into the position where it abuts the shank of the screw will operate a mechanism (or move a door locking member to a position permitting the door involved to be opened). The bolt 118 has suitable operating arms 145 attached to the bottom end thereof as viewed in FIG. 14, which arm is connected to the mechanism or door locking member involved. It should be noted that, in the latter operating position of the bolt, the wafer storage slideways 127 have not been moved into alignment with the tumbler-receiving slideways 121 and 125.

The screw member 143 has a head or knob 144 on the end thereof accessible from within the housing and which can be turned to withdraw the end thereof from the slide channel 113 to permit the bolt 118 to be moved completely upwardly to the end of the slide channel 113 by the energized solenoid where the bolt abuts a shoulder 149. In this position of the bolt 118, the various wafer storage slideways 130 in the bolt are aligned with the housing slideways pairs 121 and 125 which permits variation of the placement of the wafers in the tumbler assemblies. The bolt 118 can be held in the latter position independently of the energized state of the solenoid by providing a bore 147 in the bolt 118 into which the screw member can be inserted by turning the head or knob 144. Also, for reasons to be explained, a normally closed manually operable pushbutton switch 141 with an operating button 142 accessible on the inside of the housing is provided to de-energize the solenoid 140 while a key is fully inserted in the lock.

In the form of the invention being described, during a tumbler changing operation the operator should have access to both the inside and the outside of the housing 109, so he can insert a key into and withdraw a key from the outside of the lock 100 and can turn the screw

knob 144 and operate the normally closed switch 141 accessible on the inside of the housing. Thus, to change the key which can operate the lock 100, the operator turns the screw member 143 in one direction to withdraw the same from the slide channel 113, inserts the key which operates the lock fully into the slot 104 of the lock which pushes the locking pins fully into the locking pin-receiving slideways and energizes the solenoid 140, then turns the screw member 143 in the opposite direction to extend the shank of the screw member into the bolt bore 147 of the raised bolt 118, and then inserts a new key having a different combination of tumbler operating shoulders into the slot 104 of the lock to place the appropriate number of wafers in the various front and rear tumbler-receiving slideways 121 and 125. The operator then turns normally-closed switch 141 off by momentarily depressing the button 142 which de-energizes the solenoid 140 and turns the screw member to remove it from the bolt bore 147 which results in the dropping of the bolt 118 into its lowered locking position while the new key is held in the lock to maintain the changed tumbler condition until the wafer storage slideways are moved out of alignment with the slideways 121 and 125. The new key is withdrawn from the lock, and normally-closed switch 141 is released to the circuit closing position. The screw member 143 is then turned to extend the end thereof into the slide channel 113.

Refer to FIGS. 15 and 16, which, among other things, illustrates the manner in which the solenoid 140 is energized and de-energized. As there shown, the solenoid 140 has one terminal which is connected to the terminal of a source of energizing voltage, such as a source of 60 cycle 110 volt A.C. voltage identified by reference numeral 150. The other terminal of the voltage source 150 is assumed to be grounded. The other terminal of the solenoid 140 is connected by a conductor 152 to a terminal 154 at the rear of a micro-switch housing 156. The terminal 154 is connected to a stationary contact arm 157 having a contact 159 on the end thereof. The arm 157 and the contact 159 form part of a micro-switch unit 160 which has a movable switch arm 162 having a contact 164 on the end thereof which is normally spaced from the stationary contact 159. The movable arm 162 is movable toward the arm 157 to bring the contact 164 against the contact 159 by means including an operating pin 166 which projects within one of the endmost rear housing slideways 125.

The movable arm 162 is connected by a conductor 165 to the movable arm 162' of a micro-switch unit 160' similar to the micro-switch unit 160. Accordingly, the movable arm 160' has a contact 164' on the end thereof which is adapted to make engagement with a stationary contact 159' mounted on the end of a stationary arm 157'. The arm 157' is connected to a terminal 154' on the outside of the micro-switch housing 156, conductor 152' is connected between the terminal 154 and one terminal. The movable switch arm 162' is movable toward the switch arm 157' to bring the contact 164' against the contact 159' by an operating pin 166' projecting into the other endmost rear housing slideway 125.

Each of the aforementioned endmost rear housing slideways 125 are, in the locking position of the bolt 118, opposite and in alignment with the corresponding endmost locking pin slideways 127 in the bolt 118. The aligned endmost set of slideways 121-127-125 each have an assembly of pins therein including a locking pin 168 which is identical to the locking pins 45 in the other slideways 127, and a pair of spacer pins 170 and 172 positioned respectively on the front and rear sides of the locking pin 168. Each of the spacer pins 170 has a length equal to the spacing between the inner wall 120a of the housing slot 120 and the front surface 113a of the slide channel 113 which is less than the spacing between the reference abutment shoulder 115 on the back of the front wall 106 of the lock and the

inner slot wall 120a. Each assembly of pins 168-170-172 is urged to the forward end of the associated lock by a compressed spring 52 positioned between the end of the associated rear housing slideways 125 and the rearwardmost spacer pin 172. Normally, each spring 52 will urge the associated assembly of pins 168-170-172 forwardly so that the forwardmost spacer pins 170 abut the reference abutment shoulder 115. In such case, the spacer pin 172 will cut across the rear shear plane P2-P2.

When a proper key 101 is inserted within the lock, the outermost edge portions 103a thereof will abut the slot wall 120a and, in so doing, will push the forwardmost spacer pins 170 in the endmost housing slideways 121 and 121 into the position shown in FIG. 16 where the locking pins 168 will be completely within the associated bolt locking pin slideways 127-127 and the shear planes P1-P1 and P2-P2 will be in line with the interfaces between the pairs of pins 168-170 and 168-172 to permit the bolt 118 to be moved. When the key 101 is fully inserted into the lock, the rearwardmost spacer pins 172-172 will respectively engage the aforementioned operating pins 166-166' which will push the associated switch arms 162-162' rearwardly to bring the contact pairs 159-164 and 159'-164' into engagement. Upon closure of the micro-switches 160 and 160', it is apparent that the solenoid 140 will become energized to pull the bolt 118 into an upper position.

It should be apparent that the various forms of the present invention provide an extremely effective and reliable key lock construction where only one particular set of tumbler operating shoulders on a key can operate a lock which, in turn, provides for a ready change of the tumbler assemblies by the simple expedient of inserting a new key into the lock when the lock is in its tumbler changing position.

It should be understood that numerous modifications may be made in the most preferred forms of the invention described above without deviating from the broader aspects therein.

It should be understood that reference made in the claims to parallel surfaces are intended to include surfaces of parallel planes or curved surfaces having a constant spacing therebetween.

I claim:

1. A lock comprising a first member having a recess therein defined by spaced front and rear parallel surfaces, a number of pairs of aligned tumbler-receiving slideways in said first member on opposite sides of the recess, each pair of aligned tumbler-receiving slideways extending transversely forwardly and rearwardly from said parallel surfaces, a second member located between and abutting said parallel surfaces of said first member, one of said members being mounted for movement with respect to the other in a direction parallel to said parallel surfaces of said first member, the interfaces between said relatively movable members establishing spaced front and rear shear interfaces for the lock, said second member having locking pin-receiving slideways extending completely therethrough where they confront and are in respective alignment with the tumbler-receiving slideways of said first member in a locking position of said movable member, locking pins slidably disposed in said respective locking pin-receiving slideways of said second member and movable across said shear interfaces where they extend in varying distances into said tumbler-receiving slideways, the locking pins having a length equal to the length of the associated slideways, means forming a reference abutment shoulder at the forward end of the lock, spacer members in said tumbler-receiving slideways of said first member which spacer members include a varying number of wafers in front of the locking pins, resilient means in the tumbler-receiving slideways of said first member for urging the assembly of locking pins and spacer members toward said reference abutment shoulder when said movable member is in said locking position, the locking pins

then extending across said front shear interface to prevent movement of said movable member, said second member having wafer storage slideways therein associated with the respective locking pin-receiving slideways of said second member, wafers filling each of said wafer storage slideways, said wafer storage slideways being brought into alignment with the respective pairs of tumbler-receiving slideways of said first member when the movable member is in a tumbler changing position, said wafers being then transposable through said wafer storage slideways of said second member and between the tumbler-receiving slideways of said first member, said locking pins and said locking pin-receiving slideways and said wafer storage slideways having a length which is at least one wafer thickness greater than the overall length of the largest number of wafers transposable between the tumbler-receiving slideways of said first member, and key-receiving means at said reference abutment shoulder for receiving a key with tumbler engaging shoulders extending beyond said reference abutment shoulder for moving the various tumbler assembly members rearwardly in said slideways against the force of said resilient means.

2. The lock of claim 1 wherein there is provided means associated with each locking pin-receiving slideway for preventing the complete movement of at least one of the associated locking pin and wafers out of the associated locking pin-receiving slideway by said rearward movement thereof, the last mentioned means being slidable in the rearward-most tumbler-receiving slideways of said first member which means engage a portion of said first member to prevent further rearward movement thereof and of the locking pins.

3. The lock of claim 2 wherein there is provided means associated with each locking pin-receiving slideway for preventing the complete movement of at least one of the associated locking pin and wafers out of the associated locking pin-receiving slideways by said rearward movement thereof, the last mentioned means being wafers like the wafers in said wafer storage slideways and against which said resilient means bear, the latter wafers abutting a portion of said rear tumbler-receiving slideways when the number of wafers in each of said rear tumbler-receiving slideways behind said locking pins is one wafer greater than the largest number of wafers transposable between the tumbler-receiving slideways of said first member.

4. The lock of claim 1 wherein each rear tumbler-receiving slideway of said first member has means therein for preventing the resilient means from passing the rear shear interface of the lock.

5. The lock of claim 1 wherein said first member is the movable one of said first and second members and is rotatable with respect to the second member.

6. The lock of claim 1 wherein said second member is the movable one of said first and second members and is reciprocatable with respect to said first member.

7. In a lock of the type including a fixed member and a movable member having a surface slidable along a confronting surface of the fixed member, the interface between said surfaces forming a shear interface for the lock, and said movable member being movable from a normal locking position to a tumbler changing position and an unlocking position, one of said members having parallel tumbler-receiving slideways and the other having corresponding parallel locking pin slideways, said slideways of said members intersecting said shear interface forming respective pairs of aligned slideways when the movable member is in a normal locking position, tumbler assemblies in the aligned slideways, each assembly including a relatively long locking pin which extends across said shear interface to prevent movement of said movable member from said locking position and a number of spacer members including a varying number of wafers, the numbers of which vary with the positions which the associated locking pins have relative to said shear interface in the locking position of said movable member, and said other member having wafer storage slideways filled

with additional ones of said wafers and which wafer storage slideways are in alignment with the tumbler-receiving slideways of said one member when said movable member is in said tumbler changing position of said movable member for enabling the shifting of wafers between said tumbler-receiving and wafer storage slideways, key-receiving means at the end of said one member remote from said shear interface for receiving a key having tumbler engaging shoulders for respectively engaging the outer ends of the respective tumbler assemblies for moving the same in the aligned tumbler slideways of said members into positions where said shear interface is not crossed by any of the parts of the tumbler assemblies to permit movement of the movable member to either of the other aforesaid positions, and resilient means urging each tumbler assembly toward said key-receiving means, the improvement comprising: said one member having a portion extending to the side of said other member opposite the side at which said shear interface is located and having a surface which confronts the adjacent surface of said other member to form a second shear interface spaced from and parallel to the first mentioned shear interface, the locking pin and wafer storage slideways of said other member extending therethrough to intersect said second shear interface as well as said first shear interface, said other portions of said one member having tumbler-receiving slideways corresponding to the locking pin slideways of the other member and being in alignment therewith when the movable member is in said locking position and being in alignment with the wafer storage slideways of said other member when the movable member is in said tumbler changing position, where the wafers and the locking pins can be moved across both of said shear interfaces, the distance between said shear interfaces being at least one wafer thickness greater than the overall length of the maximum number of wafers transposable between the tumbler-receiving slideways of said one member, and said locking pins being of the same length as the distance between said shear interfaces so each locking pin intersects one of said shear interfaces in all but one position of the tumbler assembly of which it forms a part.

8. The lock of claim 5 wherein said rotatable movable member is a member having a circular cross section and an outer annular recess having spaced front and rear parallel shear planes extending transversely to the axis of rotation of the same, the other member extends into said annular recess, said locking pin-receiving and wafer storage slideways being in said movable member, all of said slideways of said members extending parallel to the axis of rotation of said movable member and being centered along circles of the same diameter and which are coaxial of said axis of rotation.

9. The lock of claim 8 wherein said movable member is an assembly of a shaft member and axially spaced front and rear slideway containing barrel portions fixedly secured to the shaft member.

10. The lock of claim 9 wherein the lock includes a stationary housing having a bore therein within which said movable member is rotatably mounted, the other of said members being a piece separate from said housing, the movable member and the latter member forming an assembly longitudinally insertable into said housing bore, and said latter member including means engaging with the housing for holding the same against rotation.

11. The lock of claim 10 wherein said key-receiving means is an annular slot adapted to receive a hollow cylindrical key body, said slot being coaxial of the axis of rotation of said movable member and defined between said shaft and said housing.

12. The lock of claim 6 wherein said movable member is reciprocally mounted in a slide channel formed in the other member, said movable member contains the locking pin-receiving and wafer storage slideways, the longitudinal axes of the locking pin-receiving slideways tumbler-receiving slideways and the wafer storage slideways being respectively in parallel planes perpendicular to the direction of movement of the movable member and said wafer storage slideways being located respectively opposite the locking pin-receiving slideways in said movable member and spaced therefrom in the direction of movement of the movable member in said slide channel.

13. The lock of claim 6 wherein the key insertable into said key-receiving means is a plate-like member having tumbler engaging shoulders at varying depths along one edge of the key, and there is provided operating means responsive to the full insertion of the key into said lock and the movement of said locking pins completely into the locking pin-receiving slideways for moving the movable member from a normal locking position, where the locking pin-receiving slideways of said movable member and the tumbler-receiving slideways of the other member are in alignment, to a second position where none of the slideways in said movable member are in alignment with the tumbler-receiving slideways in said other member, and means for effecting the movement of said movable member from said second position to a third position where the wafer storage slideways are in alignment with said tumbler-receiving slideways.

14. The lock of claim 13 wherein said operating means includes a solenoid and a control circuit therefor, the control circuit including switch means which energizes the solenoid when said key is fully inserted into the lock.

15. The lock of claim 1 wherein said spacer member wafers are of identical thickness and said wafer storage slideways have a length which is an integral number of wafer thicknesses greater than the overall length of the maximum number of wafers transposable between the tumbler-receiving slideways of said first member.

16. The lock of claim 7 wherein said spacer member wafers are relatively short identical wafers, and the distance between said shear interfaces is an integral number of wafer thicknesses greater than the overall length of the maximum number of wafers transposable between the tumbler-receiving slideways of said one member.

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