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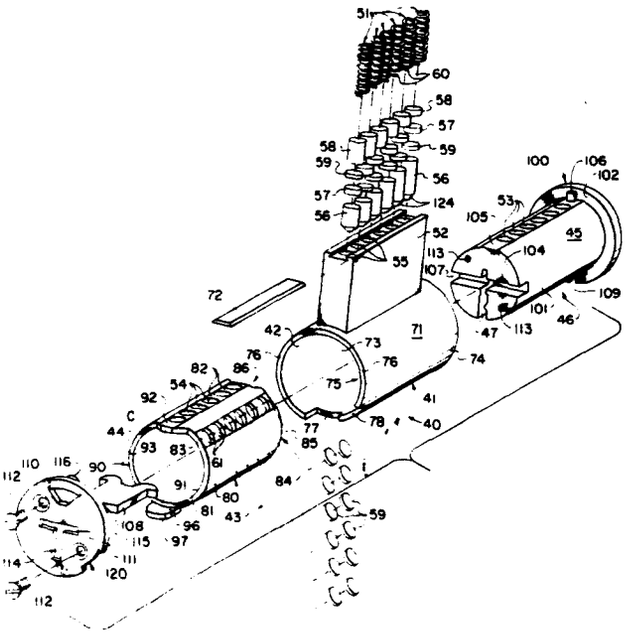
(54) Pin tumbler locks.

(57) A pin tumbler lock comprises a housing member (41), a sleeve member (43) axially and rotationally positioned within the housing member (41) and a plug member (46) rotatably received within the sleeve member (43). Operation of the lock requires release of the two shear surfaces defined by the contact surfaces of the sleeve, housing, and plug members. Transversely parallel extending bores (53, 54, 55) formed through the three members receive elements of a locking stack assembly (51). The locking stack assembly includes tumbler pins (56), driver pins (58), change wafers (59) and locking pins (57). Upon insertion of a proper key, the interfaces between the locking stack elements are positioned at the two shear surfaces thereby allowing operation of the lock. The sleeve member (43) additionally includes chambers (61) containing change wafers (59), and the relative position of the locking pins (57) can be selectively changed in the locking stack assembly upon positioning the sleeve member (43) in combination changing position.



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PIN TUMBLER LOCKS

The present invention relates to pin tumbler locks, and more particularly to pin tumbler locks in which the key combination can be changed.

Previously proposed locks having provision for changing the key combination have not proved entirely satisfactory as they employ a large number of intricate parts and are extremely complex in construction and operation. Certain of these locks have relatively large physical dimensions and are therefore limited to specific applications. Also the number of permutations to which the combination may be changed is limited. In addition, certain of these previously proposed locks require special keys which are significantly different from conventional keys.

According to the invention, there is provided a pin tumbler lock comprising a housing member, a sleeve member movably received within the interior of the housing member, a plug member rotatably received within the interior of the sleeve member, said plug member having a keyway formed therein for receiving a key, a locking stack assembly comprising elements including a driver pin, a locking pin, a tumbler pin and means for biasing said locking stack elements in contacting relation, said housing and sleeve and plug members each having a bore formed therein in radially aligned relation to receive the elements of the locking stack assembly, whereby a correct combination key positions the interfaces of said locking stack elements at points coincident with shear surfaces defined between said housing and sleeve and plug members and actuating means for operatively connecting said sleeve and plug members for moving said sleeve member axially within said lock, said actuating means being operative upon

positioning a correct combination key in the keyway and upon rotating said plug member substantially out of a position in which the bores through said housing and sleeve and plug members are in radially aligned relation.

Preferably, to allow changing of the lock operating combination, change wafer bores are formed radially through the sleeve member at positions axially and circumferentially displaced from corresponding bores in the sleeve which receive elements of the locking stack assembly. The sleeve member is operatively connected for selective positioning in a combination changing position. In the combination changing position, the change wafer chambers are positioned in radial alignement with the bores extending through the plug member and the housing member. At least one, but preferably two, change wafers are positioned within and carried by the change wafer chamber. Upon rotational and axial movement of the sleeve member to the combination changing position, at least one change wafer in the change wafer chamber is transferred into the locking stack assembly and a corresponding number of change wafers previously in the locking stack assembly is transferred into the change wafer chamber. As a result, the interfaces between at least some of the elements of the locking stack assembly are positioned at different radial depths, thereby resulting in change of the lock combination when the sleeve member is rotated out of the combination changing position into its normal lock operating position. To effectively change the lock combination, the length relationship of the change wafers and locking pins is such that the overall combined length of the maximum number of change wafers transosable into the locking stack assembly is at least one standard bitting depth interval less than the

length of the locking pin.

One of the elements of the locking stack assembly may comprise magnetic material to which the other elements of the locking stack assembly are attracted. The magnetic attraction tends to hold the elements of the locking stack together in contacting relation as the key is inserted into the keyway. By holding the elements together, the locking stack elements do not become separated but return to their proper contacting relationship at the shear surfaces for proper lock operation.

Although slightly modified conventional keys can be utilized to change the combination of the lock, there is preferably provided a set key for changing the lock combination. The lock combination changing set key includes a projection member attached to the key and operable for reciprocative motion generally parallel to the blade portion of the key.

The invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a left side elevational view of a changeable key combination transverse pin tumbler lock in accordance with the present invention;

Figure 2 is a front elevational view of the lock shown in Figure 1;

Figure 3 is a rear perspective view of the lock shown in Figures 1 and 2 illustrating the elements of the lock in exploded relation;

Figures 4 to 12 are vertical transverse sectional views taken substantially in the plane of line A-A of Figure 1. Plane A-A in Figure 1 falls substantially in the centre of a rearwardmost locking stack assembly present in the lock illustrated in Figure 1. More specifically, various conditions of the lock are illustrated in Figures 4 through 12.

Figure 4 illustrates the lock condition with a key removed. Figure 5 illustrates the lock condition with an improper combination key inserted. Figures 6 to 11 illustrate sequential conditions of the lock as the key is unlocked, the combination is changed, and the lock is locked. Figure 12 illustrates the lock condition after the combination has been changed and the key removed. Reference dots have been added to Figures 4 to 12 to illustrate the conditions of relative rotation of the housing sleeve and plug members of the lock. Certain chambers formed within the sleeve member of the lock are not visible in Figures 4 to 12 because of axial movement of the sleeve member relative to the viewing plane during different conditions of lock operation;

Figures 13 to 18 are developed partial sectional views of the lock taken from the view line B-B of Figure 2. In Figures 13 to 18, the housing member of the lock is broken away except in the lower left hand corner of each figure, and a tail piece retainer member and a flange portion of the plug member are cut away to a radial position at the outer cylindrical surface of the sleeve member. Figures 13 to 18 reveal relative positions of the housing member, sleeve member, and plug member as the lock is unlocked, the combination is changed and the lock is locked. More specifically, Figure 13 illustrates the condition of elements shown in Figures 4 and 12. Figure 14 illustrates the condition of elements shown in Figure 6. Figures 15 and 16 illustrate the condition of elements shown in Figure 7. Figure 17 illustrates the condition of elements shown in Figures 8 and 9. And Figure 18 illustrates the condition of elements shown in Figure 10. A short centre line added to each of

Figures 13 to 18 indicates the centre line of the bores or pinways formed in the housing member of the lock;

Figures 19 to 21 are vertical longitudinal section views of the lock taken substantially in the plane of line C-C of Figure 2, Figure 19 being enlarged. More specifically, Figures 19 and 20 illustrate two different arrangements of elements within locking stack assemblies in the lock. Figure 21 illustrates a key inserted into the lock to position the locking stack elements in a condition for normal operation of the lock;

Figure 22 is a partially sectioned view similar to Figure 21 with the plug and tail piece retainer members shown in elevation. Figure 22 illustrates the release of the inner and outer shear surfaces with proper operation of the lock;

Figure 23 is a front view similar to that of Figure 2 illustrating the rotational position of the key and plug member corresponding to the situation illustrated in Figure 22;

Figures 24 to 27 are considerably enlarged fragmentary partial transverse vertical sectional views similar to those of Figures 4 to 12. Figure 24 illustrates the position of the elements of the locking stack assembly to release the inner shear or release surface. Figure 25 illustrates the position of the locking stack elements to release the outer shear or release surface. Figure 26 illustrates alignment of a change wafer chamber in the sleeve member with the bore in the plug member. Figure 27 illustrates alignment of the change wafer chamber with the bores in the housing member and plug member in the combination changing position of the sleeve member. Certain chambers formed within the sleeve member are

not visible in Figures 25 to 27 because of axial movement of the sleeve member relative to the viewing plane during different conditions of lock operation;

Figures 28 to 30 are rear perspective view of the lock with the key inserted and with the tail piece and tail piece retainer removed to illustrate the position of the sleeve and plug members relative to the housing member at different points of lock operation. Figure 28 illustrates a condition also shown in Figures 5, 11, 21 and 24. Figure 29 illustrates a condition also shown in Figures 7, 15 and 26. Figure 30 illustrates the combination changing condition also shown in Figures 8, 9, 17 and 27;

Figure 31 is a perspective view of a set key which is advantageous for use with a lock disclosed herein; and

Figure 32 is a side elevational view of Figure 31 with a finger knob element sectioned in a plane coincident with the elevational vertical surface of the key as shown.

By way of general introduction, the elements of an integrally changeable key combination transverse pin tumbler lock 40 in accordance with the present invention are best seen in Figure 3, and the assembled relationship of these elements in the lock is shown best in Figures 1, 2, 19 and 21. The lock 40 includes a housing member 41 having a hollow interior opening 42 for receiving a sleeve member 43. The sleeve member 43 is generally of hollow tubular construction and includes a hollow interior 44 for receiving a barrel portion 45 of a plug member 46. As will be described more completely, the plug member 46 is mounted in the lock 40 for rotational movement relative to the housing 41, and the sleeve member 43 is mounted for both rotational and axial movement relative to the housing and plug members. The shear abutting contact surfaces between the housing member

at the interior opening 42 define an outer shear surface of the lock. The abutting contact surfaces between the barrel portion 45 of the plug member and the sleeve member 43 at the interior opening 44 define an inner shear surface of the lock. A keyway 47 is formed axially through the plug member 46 and receives the blade portion 48 of a conventional key 49 having the conventional bitting depths 50 cut in the blade portion 48, as is shown in Figure 21.

Elements of a locking stack assembly 51 are received within bores radially extending from the keyway 47 into an encasement portion 52 of the housing member 41. The bores into which the elements of the locking stack assemblies 51 are received are defined by tumbler pinways 53 extending radially through the barrel portion 45 of the plug member, by locking pin chambers 54 extending radially through the sleeve member, and by driver pinways 55 extending radially through the encasement portion 52 of the housing member. The tumbler pinways 53, locking pin chambers 54 and driver pinways 55 are positioned in the members 41, 43 and 46 in radially aligned relationship when the lock is in the locking position. The elements of each locking stack assembly include a tumbler pin 56, a locking pin 57, a driver pin 58, a change wafer 59 and a spring 60 or other means for biasing the elements of the locking stack assembly in radially inward and contacting relationship.

Upon insertion of a proper combination key 49 into the keyway, as is shown in Figure 21, the bitting depths 50 of the blade portion 48 contact the tumbler pins 56 of each locking stack assembly. The elements of the locking stack assembly are forced radially inward by the bias force of the springs 60. The elements of each locking stack assembly are radially positioned in accordance with the depths of

the bittings 50 cut in the key. A proper combination key positions the contacting interfaces of the locking stack elements in a coincidental relation with the inner and outer shear surfaces as the key is rotated. Positioned in this manner, the elements of the locking stack assembly allow the plug member to rotate with respect to the sleeve and housing members by operatively releasing or not blocking the inner shear surface. Similarly, the outer shear surface is released or not blocked by the elements of the locking stack assembly. After release of the inner shear surface by slight rotation of the plug member, means interconnecting the plug, housing and sleeve members move the sleeve member axially with respect to the housing member, and this axial movement releases the outer shear surface as is generally illustrated in Figure 22, to obtain normal lock operation.

The sleeve member 43 also includes a plurality of change wafer chambers 61 extending radially therethrough. Each change wafer chamber 61 is displaced circumferentially and axially with respect to a corresponding locking pin chamber 54. Each of the change wafer chambers contains and carries at least one, but preferably two or more, change wafer elements 59. In general, the lock 40 includes means for allowing movement of the sleeve member to a combination changing position which is axially and rotationally displaced from its normal lock operating position. In the combination changing position, the change wafer chambers 61 are positioned in radial alignement with the driver pinways 55. As will be described more completely, at least one of the change wafers 59 previously contained within one change wafer chamber 61 is transferred into the locking stack

assembly 51 and at least one change wafer previously within the locking stack assembly is transferred into the change wafer chamber 61. The change wafer is transferred into the locking stack assembly at a different position relative to the locking stack elements than the position occupied by the previous change wafer which has been removed from the locking stack assembly. As a result, the relative position of the locking pin in the locking stack assembly is shifted and the key combination of the lock has been changed.

A more complete description of the details of the lock elements, the assembly of these elements and operation of the lock 40, as well as a set key for use with the lock are next described.

Lock Structure

The majority of details of the lock elements are perceptable by reference to Figures 3 and 19. In describing the details of the lock 40, the term "axial" or a formative thereof refers to a reference axis around which the plug member and sleeve member rotate. The term "radial" refers to a reference perpendicular with respect to the axial reference. The term "longitudinal" refers to a direction generally parallel to the axial reference. The term "transverse" refers to a reference crosswise to a longitudinal reference. The terms "front" or "forward" or other similar terms refer to a portion of the lock towards the end in which the key is inserted, as is shown in Figure 2. The term "rear" or another similar term refers to the axial and longitudinal portion of the lock opposite to a forward position. The terms "up" and "down" or other similar terms are relative terms and are used in relation to the lock as shown in the drawing.

The housing member 41 includes a main cylindrical portion 71 from which the encasement portion 52 extends. The encasement portion 52 is generally of solid rectangular box-like configuration and extends radially outward and up from the cylindrical portion 71. The driver pinways 55 extend radially in parallel relation through the encasement portion and into the interior opening 42. The driver pinways are axially spaced from one another at equal intervals. The radially outward terminal ends of the driver pinways are terminated by a cap member 72 attached to the encasement portion 52. The elements of the locking stack assemblies 51 are inserted into the lock through the open outer ends of the driver pinways before the cap 72 is attached. The driver pinways, the locking pin chambers, change wafer chambers and tumbler pinways are preferably cylindrical in cross section, of uniform diameter, and slightly greater in diameter than the diameter of the locking stack elements received therein.

The interior opening 42 of the housing member is generally defined by an inner cylindrical surface 73 which extends axially through the cylindrical portion 71 of the housing member. The inner cylindrical surface 73 defines in part the outer shear surface of the lock. A forward edge 74 of the cylindrical portion 71 extends outward from the inner cylindrical surface 73 and lies in a plane essentially perpendicular with respect to the axial reference. A rear edge generally referenced 75 of the cylindrical portion 71 includes a planar portion 76, a portion defining a locking recess 77 and another portion defining a change recess 78, as is also shown in Figures 28 to 30. The planar portion 76 extends outward from the inner surface 73 and lies in a

plane essentially perpendicular to the axial reference. The locking recess portion 77 extends longitudinally forward from the planar portion 76 by a predetermined amount. The locking recess 77 is generally of a rectangular notch form (Figures 17 - 18) and extends radially through the cylindrical portion 71 of the housing member. The change recess 78 (Figures 13 - 18) extends longitudinally forward of the planar portion 76 by a distance less than the forwardmost longitudinal extension of the locking recess 77. The change recess 78 is circumferentially displaced in next adjoining relationship to the locking recess 77. The change recess is also generally of rectangular notch configuration and extends radially through the cylindrical portion 71.

The sleeve member 43 includes an outer surface 80 of essentially cylindrical and axially extending shape. The diameter of the outer surface 80 is slightly less than the diameter of the inner surface 73 of the housing member, thereby allowing the sleeve member to be received in a concentric and closely fitting relationship within the interior opening of the housing member. The fitting relationship is such that both axial and rotational movement of the sleeve member relative to the housing member can be smoothly effected without unnecessary clearance space. The interface between the outer surface 80 of the sleeve member and

the inner surface 73 of the housing member defines the outer shear surface of the lock 40.

The inner opening 44 of the sleeve member is defined by an inner cylindrical surface 81 extending radially through the sleeve and in coaxial relationship with the outer surface 80. The radial distance between the surfaces 80 and 81 defines the thickness of the sleeve member. The radial thickness of the sleeve member is preferably slightly in excess of the length of a locking pin 57 (see Figures 26 and 27). The actual thickness of the sleeve is determined by the diameter of locking pin and change wafer chambers and the radius of the outer cylindrical surface of the sleeve member.

The locking pin chambers 54 and change wafer chambers 61 extend radially completely through the sleeve member and intersect the inner and outer surfaces 81 and 80. The locking pin chambers 54 extend radially parallel to one another and longitudinally in axial alignment. The locking pin chambers are spaced at equal axial intervals equal to the intervals at which the driver pinways 55 are positioned. The change wafer chambers also extend radially parallel to one another and longitudinally in axial alignment at intervals equal to the axial intervals of the driver pinways. Each change wafer chamber 61 is circumferentially and axially spaced with respect to a corresponding locking pin chamber

(Figures 13 - 8). Flattened surfaces 82 and 83 (Figures 24 and 27) extend longitudinally through the intersections of the chambers 54 and 61 with the outer surface 80 of the sleeve member. The flattened surfaces 82 and 83 are of essentially the same transverse width as the diameter of the change wafer and locking pin chambers.

A front edge generally referenced 84 of the sleeve member is defined by a planar portion 85 and a sleeve actuating notch portion 86, also shown in Figures 13 - 18. The planar portion 85 extends between surfaces 80 and 81 and lies in a plane essentially perpendicular with respect to the axial reference. The sleeve actuating notch portion 86 includes a flat rearwardmost portion 87 and two oppositely spaced transverse camming surface portions 88 and 89, referenced only in Figure 15. The camming surface portions 88 and 89 extend convergently from the planar portion 85 toward the rearward portion 87. The sleeve actuating notch 86 is essentially circumferentially centered with respect to an axial reference through the centers of the locking pin chambers 54.

A rear edge generally referenced 90 of the sleeve member is defined by a planar portion 91 and a sleeve restoring projection 92, also shown in Figures 13 - 18. The planar portion 91 extends between surfaces 80 and 81 in a plane perpendicular to the axial reference. The sleeve restoring projection 92 extends rearward of the planar portion 91 and includes a rearwardmost flat surface 92 and two transversely opposite spaced camming surfaces 94 and 95 referenced only in Figure 15. The camming surfaces 94 and 95 angle

convergently from the planar surface 91 to the projection surface 93. The sleeve restoring projection 92 is essentially circumferentially centered with respect to an axial reference through the locking pin chambers 54.

The sleeve member 43 also includes an offset tab portion 96 positioned essentially diametrically opposite the sleeve restoring projection 92, as shown best in Figure 3. The tab portion 96 has a thickness which extends radially outward from the outer surface 80 (Figure 19). The radial inner surface of the tab portion 96 is approximately coincidental with the outer surface 80 of the sleeve member. The tab portion 96 also extends rearward of the planar portion 91 of the rear edge of the sleeve (Figures 13 - 18). The tab 96 includes a rearwardmost flat surface 97 and two transversely opposite camming surfaces 98 and 99 angling divergently outward from the flat surface 97 toward the edge portion 91, referenced only in Figure 14.

The plug member 46 is formed by the barrel portion 45 and a flange portion 100 positioned forward of the barrel portion 45. The exterior surface 101 of the barrel portion 45 is essentially of axially extending cylindrical shape. The diameter of the exterior surface is slightly less than the diameter of the inner surface 81 of the sleeve member, such that a close fitting relationship is achieved to allow smooth movement of the barrel portion within the interior opening of the sleeve without unnecessary clearance space. The interface between the outer surface 101 of the barrel portion and the inner surface 81 of the sleeve member defines the inner shear surface of the lock.

The flange portion 100 extends radially outward from the barrel portion 45 at the front end of the plug member. The flange portion defines a planar shoulder surface 102 facing rearwardly of the flange and extending in a plane essentially perpendicular with respect to an axial reference. The shoulder surface 102 is adapted to contact the forward edge 74 of the housing member 41 (Figure 19) and to maintain the plug member in a stationary axial position with respect to the housing member as the plug member is rotated relative to the housing member. The keyway 47 extends axially through the plug member from a forward face 103 of the flange 100 to a rear end 104 of the barrel portion 45. The rear end 104 is defined by a flat surface which extends in a plane perpendicular with respect to an axial reference. As shown in Figures 2, 3, 13 and 19 to 21, a change opening 109 is formed radially outward through the flange 100 from the bottom of the keyway 47. The change opening 109 is important in the combination changing operation, as will be described.

The tumbler pinways 53 extend radially in parallel relation with the keyway 47 (Figure 4) through the barrel portion and intersect the upper outer surface 101. The tumbler pinways 53 are positioned in axial alignment along the plug member and are positioned at axial intervals along the plug member equal to the intervals between corresponding driver pinways 55 and locking pin chambers 54. The driver and tumbler pinways are positioned in circumferential alignment when the shoulder portion 102 contacts the forward edge 74 of the housing member. Therefore, each of the driver pinways 55 is positioned essentially at an equal axial distance from the forward edge 74 of the housing member as a corresponding tumbler pinway 53 is axially positioned from

the shoulder surface 102 of the flange 100. The outer surface 101 of the plug member includes a longitudinally extending flat portion 105 (Figures 28 to 30). The flat portion 105 has transverse width equal to the diameter of the cylindrical tumbler pinways 53 and extends in intersecting relation with the aligned pinways 53. The longitudinal positions of the tumbler pinways are such that each pinway 53 is in parallel alignment with a bitting depth 50 formed on the upper blade portion 48 of a fully inserted key.

A sleeve actuating pin member 106 extends radially outward from the flattened surface 105 at a position longitudinally adjacent to the shoulder surface 102. The pin member 106 is centered with the axially aligned centers of the tumbler pinways 53. The pin member 106 is preferably made of hardened steel to deflect drilling through the flange portion of the plug member and along the shear surface of the lock in an attempt to force open the lock. A slot 107 extends transversely of the barrel portion 45 at the rear end 104 of the plug member. The slot 107 is adapted to receive a forward end portion of a tail piece member 108.

A tail piece retainer 110 is attached to the rear end 104 of the plug member 46. The tail piece retainer 110 holds the plug member, tail piece, sleeve member and housing member in assembled relationship. The tail piece member operates a conventional bolt or latch, not shown. A slot 111 in the tail piece retainer 110 receives the tail piece member 108 and holds the tail piece member in the slot 107. The tail piece retainer 110 is attached to the end 104 of the plug by screws 112 threaded into threaded bores 113. A lower portion 114 of the slot 111 is in alignment with the

keyway 47.

The tail piece retainer 110 includes a forward facing shoulder surface 115 extending essentially radially outward from the barrel portion of the plug member in a plane perpendicular with respect to the axial reference. The shoulder surface 115 contacts the rear edge portion 76 of the housing member 41 to hold the plug, sleeve and housing members in assembled relationship. The tail piece retainer 110 rotates with the plug member and the surface 115 prevents axial movement of the plug member with respect to the housing member while allowing rotational movement. The axial distance between the shoulder surface 102 of the flange and the shoulder surface 115 of the tail piece retainer is slightly greater than the axial distance between the front and rear edges 74 and 75 of the housing member, thereby allowing smooth rotational movement while preventing relative axial movement of the plug member relative to the housing member.

A sleeve restoring tab 116 projects longitudinally forward from the shoulder surface 115 of the tail piece retainer 110, as is also shown in Figures 13 - 19. The tail piece retainer 110 is attached to the plug member such that the sleeve restoring tab 116 is in axial alignment with a center line through the tumbler pinways 53 and sleeve actuating pin 106. The sleeve restoring tab 116 is positioned at a radial distance equal to the radial distance of the sleeve member from the center axial reference through the plug member. The thickness of the sleeve restoring tab is no greater than the thickness of the sleeve member. The sleeve restoring tab 116 includes a forward flat surface 117 and two oppositely spaced camming surfaces 118 and 119 converging from the shoulder surface 115 to the forward

surface 117, as referenced only in Figure 14.

A sleeve rotating notch 120 is formed radially inward of the outer circumferential edge of the tail piece retainer 110 and rearward of the shoulder surface 115. The radial inward depth of the notch 120 extends inward to the outer surface 80 of the sleeve member. The notch 120 includes two circumferentially oppositely spaced camming surfaces 121 and 122, referenced only in Figure 13, which converge rearwardly from the shoulder surface 115 of the tail piece retainer. The notch 120 is located in a predetermined circumferential position on the tail piece retainer to receive a portion of the offset tab portion 96 of the sleeve member when the sleeve member is in or is being rotated to and from the combination changing position (Figures 16 - 18).

Details of some of the elements of the locking stack assembly 51 are best seen in Figures 24 - 27. Each of the locking stack assembly elements 56 to 59 is preferably cylindrical in cross-section. The diameter of the each element is slightly less than the diameter of the bores formed radially through the plug, sleeve and housing members, thereby allowing radial movement of the locking stack elements without binding or the like. The axial reference and length dimensions of the locking stack assembly elements extend radially with respect to the lock. The flat interfacing end surfaces of the locking stack elements which abut and contact the flat interfacing end surfaces of the next radially adjacent, locking stack elements are all essentially perpendicular with respect to an axis through each cylindrically shaped element. Chamfered edges 123 are provided

between the outer cylindrical surfaces and the interfaces. The purpose of the chamfered edges 123 is to compensate for wear, slight variations in the correct key bitting depths and accumulated manufacturing tolerances in lengths of locking stack elements during lock operation.

The length of the driver pins 58 and the tumbler pins 56 may vary in a desired manner. The length of each of the change wafers 59, both within the locking stack assembly 51 and within the change wafer chambers 61 is uniform. The length of the change wafers is equal to an integral multiple of the standard depth interval to which bitting depths are formed in the key. The length of each locking pin 57 is the same and is no greater than radial thickness of the sleeve member 53. Further, the length of each locking pin 57 is an integral number of lengths of a change wafer 59. Depending on the diameter of the locking pins and the outside diameter of the sleeve member 43, the length of the locking pins 57 may be somewhat less than the radial thickness of the sleeve member 43. As is shown in Figure 25, as the plug member 46 rotates, the point where the outside cylindrical surface 101 of the barrel member 45 intersects the flat surface 105 acts as a cam to move the locking pins slightly upward. The slight upward movement, shown in Figure 25, positions the interface or abutting surface between the locking pin 57 and change wafer 59 coincidently with the outer shear surface thereby allowing release of the outer shear surface.

The maximum number of change wafers positioned continually in each change wafer chamber is such that the combined length of the change wafers in the change wafer chamber is equal to the length of a locking pin. As will

be more apparent from the subsequent description of key combination changing operation, the maximum number of change wafers transposable from the change wafer chamber into the locking stack assembly is less than the total number continually received in the change wafer chamber. Consequently, the total combined length of the transposed change wafers is less than the total length of the locking pin, by at least one bitting depth interval.

As shown best in Figure 21, the innermost radial ends 124 of the tumbler pins 56 are rounded or otherwise formed in a suitable manner to contact and seat against the bitting depths 50 formed in the blade portion 48 of a key 49 when fully inserted in the keyway. Shoulder portions 133 and 134 of the key extend transversely outward from the blade portion 48 on opposite sides and shoulder 133 contacts the outer surface 103 of the flange portion 100 of the plug, thereby limiting the maximum depth to which the key 49 can be longitudinally inserted into the keyway. A bow portion 135 of the key extends from the blade portion to allow the key to be grasped by the fingers of the user.

Preferably, the overall radial length of each locking stack assembly is essentially the same as shown in Figures 20 and 21. Uniform locking stack lengths make the lock more difficult to pick since release depths of each locking stack assembly are more difficult to perceive by probing or the like.

At least one of the elements of each locking stack assembly comprises permanent magnetic material or material capable of being magnetized as permanent magnetic material. The other elements of the locking stack assembly are formed of material attracted to the permanent magnetic material.

Preferably, the driver pins are formed of the permanent magnetic material or a permalloy such as Alnico because such magnetic material cannot be machined to maintain close length tolerances, as is necessary for the other elements of the locking stack assembly. Preferably, the remaining elements of the locking stack except the springs, are made of a free machining magnetic stainless steel alloy which is attracted by the magnetic flux of the magnetic locking stack element.

The purpose of the permanent magnetic element and other elements is to prevent the locking stack elements from separating at the abutting end interface surfaces from one another, except during proper operation of the lock. Slight separation can occur because the locking stack elements bounce up and down over the serrations between bitting depths as the key is inserted and withdrawn. When the user imparts a slight rotating torque to the key and plug member before the key is fully inserted into the keyway, the locking stack elements may hang up and not fully seat on the abutting end surfaces of one another or the tumbler pins may not fully seat on the bitting depths of the key bit. Magnetic attraction insures that the elements of the locking stack assembly are maintained in abutting relationship until the shear surfaces are released by proper lock operation. The magnetic element also enhances the resistance to picking because it is more difficult to separate the elements of the locking stack assembly when they are attracted to one another. In some circumstances, picking a lock can be achieved by probing each locking stack assembly individually while applying rotating torque to the plug to release the locking stack

assemblies one at a time. The magnetic element reduces the susceptability of the lock to this type of picking.

All of the locking stack elements of the lock 40 are made of suitable metallic materials, as is apparent to one skilled in the art. When magnetic locking stack elements are employed, it is preferable to form the housing, plug and sleeve members from non-magnetic material to avoid undesirable magnetic interaction with the magnetic locking stack elements.

Lock Assembly

Assembly of the lock can best be understood by reference to Figures 3 and 13 to 19. The sleeve member 83 is inserted coaxially intermediate the barrel portion 45 of the plug member and the inner cylindrical surface 73 of the housing member. The plug member 46 is inserted from the front edge 74 of the housing member into the interior opening 42. The rearward facing shoulder 102 of the flange portion 100 abuts and contacts the forward edge 74 of the cylindrical portion 71 of the housing member. The forward end of the tail piece member 108 is inserted into the slot 107. The tail piece retainer 108 extends through the slot 111 in the tail piece retainer member 110, and the tail piece retainer is attached to the rear end 104 of the barrel portion of the plug by the screws 112. A proper combination key is inserted in the keyway 47 and the tumbler pins are inserted from the driver pinways 55 into the tumbler pinways 53 of the plug member. The sleeve member is next positioned in the combination changing position, wherein the change wafer chambers are aligned with the driver pinways, and two change wafers 59 are inserted into each of the change wafer chambers 61. The sleeve member is moved to a position wherein the locking pin chambers are aligned with the driver pinways and the

remainder of the locking stack elements are inserted. The locking stack assemblies are maintained in position by attaching the cap member 72 over the outer end of the encasement portion 52 of the housing member.

With the sleeve member fully inserted to the front in the housing member, the offset tab 96 is received within the locking recess 77 and the forward edge portion 85 is in abutting contact with the shoulder 102 of the flange portion of the plug. The sleeve actuating notch 86 surrounds and receives therein the sleeve actuating pin 106. With the forward edge portion 85 of the sleeve abutting the shoulder surface 102, the center points of the locking pin chambers 54 are positioned at the same axial positions as the center points of the driver pinways 55 and tumbler pinways 53 (Figures 19 - 21).

In assembled relation, certain relationships should be noted, as can also be seen from Figures 13 to 18. With the forward edge portion 85 of the sleeve member 43 abutting the shoulder surface 102 of the flange 100 as shown in Figure 13, the forward flat surface 117 (Figure 14) of the sleeve restoring tab 116 of the tail piece retainer contacts the rearward flat surface 93 (Figure 15) of the sleeve restoring projection 92. Thus, it should be recognized that the rotation of the plug member to its home position during normal lock operation operatively causes the sleeve actuating tab 116 to contact the sleeve restoring projection 92 and force the sleeve member to its axially forward position. It should also be noted that the locking recess 77 in the housing member extends longitudinally forward a sufficient distance so that the tab portion received therein does not

inhibit full forward axial movement of the sleeve.

The maximum longitudinally forward extension of the change recess 78 is insufficient to allow the offset tab 96 to move longitudinally completely out of the locking recess during normal lock operation, because the rearward flat surface 97 (Figure 14) of the tab 96 contacts the forward surface 115 of the tail piece retainer. An exception occurs during the combination changing operation when the sleeve rotating notch 120 is positioned in axial alignment with the offset tab 96 (Figures 15 to 18). Under this circumstance, the sleeve member can be moved axially rearward a sufficient distance to move the tab out of the locking recess 77. The rearward flat surface 93 of the sleeve restoring projection contacts the shoulder surface 115 of the tail piece retainer in this condition (Figures 16 - 18). Further, the radial outward extent of the opening 109 formed radially outward through the flange 100 from the keyway 47 is sufficient to expose an amount of the planar edge portion 85 of the front edge 84 of the sleeve member (Figures 2 and 19). Other relationships are implicit from the description of structure and operation.

Normal Lock Operation

Normal operation of the lock begins with the lock in the condition illustrated in Figures 2, 4, 19 or 20. The plug member is in a home or beginning position, typically with the keyway 47 in a vertically extending manner. The elements of the locking stack assembly are biased radially inward to the maximum point allowable by the inner termination of the tumbler pinways in the plug member. In Figure 4, the lock is in the locked condition due to the driver

pin 58 extending through both release or shear surfaces. Therefore, it is impossible to move any of the plug, sleeve or housing members with respect to one another. In Figures 19 and 20, it is also apparent that both shear surfaces are blocked by locking stack elements, since none of the abutting interface surfaces of the locking stack elements coincide with either of the shear surfaces.

Figure 5 illustrates the condition of a lock with an improper key inserted. The locking stack elements have been biased upward or radially outward by the bitting depth 50 of the key. The abutting surface between the locking pin 57 and the change wafer 59 coincides with the inner shear surface. Therefore, the inner shear surface is released and slight rotation of the plug is possible as is shown in Figure 6. However, the outer shear surface is not released since the driver pin 58 extends through the outer shear surface. As is shown in Figure 14, the plug member is rotated slightly until the sleeve actuating pin 106 contacts the transverse camming surface 88 (Figure 15) of the sleeve actuating notch 86. At this point, no further rotation is possible because the outer shear surface is blocked. The blocked outer shear surface prevents the rearward axial movement of the sleeve member, and therefore the lock remains in the locked condition.

With a proper key inserted, both shear surfaces are released. Release of the inner and outer shear surfaces is illustrated in Figures 7, 15, 21, 22 and 25. Rotation of the plug member from the Figure 14 position causes the sleeve actuating pin 106 to follow the camming surface 88 (Figure 15) of the sleeve actuating notch 86 to axially

push the sleeve member rearward to the position shown in Figure 15. Rotation of the plug in either the clockwise or the counterclockwise directions results in the same type of normal lock action, with the sleeve actuating pin contacting one or the other of the opposite camming surfaces 88 or 89 (Figure 15) of the sleeve actuating notch 86 to push the sleeve rearward. It should be noted that as the plug is rotated, the sleeve restoring tab 116 moves out of rotational alignment with the sleeve restoring projection 92 to thereby allow axial movement of the sleeve member. It should be further noted that the forward edge of the offset tab portion 96 of the sleeve does not move rearward to a position in which the tab 96 moves completely out of the locking recess 77. Each time the plug is returned to its home position, the sleeve restoring tab 116 contacts the sleeve restoring projection 92 and moves the sleeve member to its axially forward position.

Normal lock operation can thus be summarised. With the elements of the locking stack assemblies positioned to release both shear surfaces, rotation of the plug member first releases the inner shear and thereafter, the sleeve actuating pin operatively moves the sleeve member axially rearward. The rearward movement of the sleeve shifts the locking pin chambers axially with respect to the driver pinways. Returning the plug member to home position causes the sleeve restoring tab 116 to contact the sleeve restoring projection 92 and force the sleeve member to its forwardmost position. Thus, the plug member rotates with respect to the housing and the sleeve member moves only axially with respect to the housing during normal lock operation. During normal lock operation, the sleeve member has

not been shifted sufficiently rearward so that the change wafer chambers 61 align with the tumbler pinways 53 regardless of the rotational position of the plug, as is illustrated by Figure 15.

It is apparent from this manner of operation that the locking recess 77 and tab 96 form one means for preventing rotational movement of the sleeve member relative to the housing member while allowing axial movement of the sleeve member relative to both the housing and plug members. The flange shoulder surface 102 and the surface 115 of the tail piece retainer 110 form means for allowing rotational movement of the plug member relative to the housing member while preventing axial movement of the plug member relative to the housing member. The sleeve member is shifted from its first or forwardmost axial position to a second or intermediate axial position by means of the sleeve actuating pin 106 and the sleeve actuating notch 86. The intermediate axial position defines a normal lock operating position of the sleeve member. The home position of the plug member defines its first rotational position, and the position at which the sleeve member is shifted to the second axial position is a second rotational position of the plug member. The second rotational position is illustrated in Figures 22 and 23. The sleeve restoring projection 92 and the sleeve restoring tab 116 form one example of means for shifting the sleeve member axially from its second axial position to its first axial position.

Key Combination Changing Operation

Changing the combination of the lock proceeds by inserting a proper combination set key, releasing both interfaces

and rotating the plug member to a predetermined position shown in Figures 7, 15 and 26, which defines a third rotational position of the plug member. In the predetermined rotational position shown in Figure 15, the offset tab 96 is aligned with the sleeve rotating notch 120 in the tail piece retainer 110. Under these conditions, a projection member 145 is manually inserted into the change opening 109 to contact the forward edge portion 85 of the sleeve member 43 and move the sleeve member to a rearwardmost axial or third axial position (Figure 16). At the third axial position the rearward surface 93 (Figure 15) of the sleeve restoring projection 92 contacts the surface 115 of the tail piece retainer. Also, the offset tab 96 projects into the notch 120. Camming surface 98 (Figure 14) of the tab 96 contacts one camming surface 121 (Figure 13) of the notch 120 to slightly rotate the sleeve member with respect to the housing member and shift the tab 96 slightly out of the locking recess 77 into the change recess 78.

Thereafter, the plug member is rotated back from its third rotational position to its first rotational position shown in Figure 8, and the sleeve rotating notch 120 carries the offset tab 96 circumferentially in the change recess 78 (Figure 17). Rotation of the sleeve thereby occurs, placing the change wafer chambers 61 in radially aligned condition with the tumbler and driver pinways as is shown in Figure 17. The two change wafers in the change wafer chamber are inserted into the locking stack elements between the tumbler pin and the change wafer in the locking stack assembly, as is shown in Figures 8, 9 and 27. The locking pin positioned in the locking pin chamber has been temporarily rotated out of

alignment with the driver and tumbler pinways. Thereupon, the set key is removed and a new combination key is inserted. The new combination key has bitting depths cut to a new combination, the new combination being defined by at least one of the bitting depths on the new key being a depth different from the corresponding bitting depth of the first key by an amount equal to the length of at least one change wafer. Insertion of the new or second key is illustrated in Figure 9.

By comparing Figures 8 and 9, it can be seen that the new key is cut to a deeper bitting depth. As a result, the upper change wafer which was positioned in the driver pinway 55 is transferred into the change wafer chamber, and the lower change wafer previously positioned in the change wafer chamber is transferred into the tumbler pinway 53. It should be noted that in the preferred embodiment two change wafers remain in the change wafer chamber at all times. Therefore, it is possible to once again release both shear interfaces because abutting end surfaces of the change wafers between the driver pin and the tumbler pin are coincidental with the shear surfaces (Figures 24 and 27). The combination change position of the sleeve is illustrated in Figure 17.

In accordance with the general principle involved in the key combination changing operation, the maximum total combined length of the maximum number of change wafers transposable at a new relative position in the locking stack assembly is the length of one bitting depth interval less than the total length of a locking pin. As a result, it can readily be recognized that the length in the locking

stack from the rounded end of the tumbler pin to the interface surfaces on the ends of the locking pin is changed. In the preferred embodiment only one change wafer is transposed and its length is one bitting depth interval less than the locking pin length. It is possible in accordance with this change principle concept that more than two change wafers can be positioned in the change wafer chamber and that more than one change wafer can be transposed into the locking stack. Of course, the length of the locking pin and the radial thickness of the sleeve would be adjusted accordingly.

The new combination or second key is thereafter rotated counterclockwise past the combination changing position as is shown in Figure 10. Rotating the plug counterclockwise causes the sleeve rotating notch 120 to carry the tab 96 back to an aligned position with the locking recess 77 (Figure 18). The camming surfaces 122 (Figure 12) and 99 (Figure 14) longitudinally force the tab 96 into the locking recess 77. The key and plug are rotated back to the home position as is shown in Figure 11 and the sleeve restoring tab 116 and sleeve restoring projection 92 force the sleeve member to its axial forward or first position. Thereafter, normal lock operation occurs with the new key in the same manner as has previously occurred with the old key. Removal of the new key from the lock results in a condition illustrated in Figure 12.

By comparing Figures 4 and 12, it can be seen that the combination change operation, in effect, transferred a change wafer 59 from a position radially outward with respect to the locking pin 57 to a position radially inward with respect to the locking pin. In this manner, a wide variety

of lock permutation combinations are available, particularly since such changes are available in each of the locking stack assemblies.

During the lock combination changing operation, it is apparent that the sleeve member is moved to a rearwardmost or third axial position, as well as rotated. Rotation occurs from the first or normal locking condition position as is defined when the tab 96 is within the locking recess 77, to a second rotational position where the tab is maximally circumferentially displaced in the change recess 78 (Figure 17 and Figures 15 and 18). Thus, the change recess 78 and the tab 96 comprise one form of means allowing rotation of the sleeve member to a combination changing position. The sleeve rotating notch 120 and the tab 96 form one means for operatively rotating the sleeve member from its first rotational position to its second rotational position, and also for rotating the sleeve member back from the second to the first rotational position.

It is apparent to those skilled in the art that the conventional techniques of master keying and grand master keying can be employed by appropriately arranging the elements of the locking stack assembly. Figure 20 is one illustration of such a technique wherein more than one change wafer 59 and locking pin 57 have been employed in some of the locking stack assemblies. It should be noted that combination changes for master keys can be effected without affecting pass key depths, and vice versa, in the same manner as combination changes for pass keys.

Set Key

A conventional pass key 49 illustrated in Figure 21 has previously been described in normal operation of the lock 40. It is noted that the pass key 49 includes two transversely spaced shoulder portions 133 and 134 which extend outwardly from the blade portion 48 of the key. The shoulder portion 133 limits the maximum amount of insertion of the key into the keyway 47 upon contacting the front surface 103 of the flange 100. The lower shoulder portion 134 covers the opening 109 in the bottom portion of the keyway. Thus, the lower shoulder portion of a conventional pass key prevents exposure of the forward edge of the sleeve 43 through the opening 109 and thus prevents unauthorized change.

One form of a set key for changing the combination of the lock 40, not specifically shown, requires removal of the lower shoulder portion 134 of a conventional pass key. Thus the lower longitudinal edge of the blade portion 48 extends into the bow portion 135 of the key. With this arrangement a projection member such as a stiff wire or the like can be manually inserted below the blade portion 48 to contact the forward planar edge portion 85 of the sleeve to shift it axially to the rearwardmost axial position preparatory to rotating the sleeve to the combination changing position.

A preferred form of another type of set key 140 is illustraged in Figures 31 and 32. The key 140, of course, includes an elongated blade portion 141 attached to a bow portion 142. An upper shoulder 143 extends transversely of the blade portion to limit axial insertion of the key in the

lock. A projection member 145 is positioned permanently within a slot 144 formed in the bow portion 142. The slot 144 extends in next adjacent and offset parallel relation with the lower straight edge of the blade portion. The projection member 145 is attached to a finger knob member 146 on each transverse side of the bow portion. A rounded boss portion 147 formed on the end of the projection member positioned toward the bow portion extends transversely out of an enlarged slot 148, and the finger knob members 146 are connected to the outer transverse ends of the boss portion, preferably by rivets 150 extending transversely through an opening 151 in the boss portion 147. The finger knob members 146, the boss portion 147 and the enlarged slot 148 define one form of means for permanently affixing the projection member 145 to the key 140. The maximum forward and rearward projection of the projection member is limited by contact of the boss portion with the ends of the enlarged slot 148.

Upon insertion of the set key 140 into the keyway and rotation of the key to the position in which combination changing precedure can begin (Figure 15), the finger knob members are grasped and the projection member 145 is moved toward the rear of the lock. The leading edge 149 of the projection member 145 contacts the forward edge portion 85 of the sleeve member, and further movement of the projection member forces the sleeve member rearwardly (Figure 16). Thereafter, the sleeve can be rotated to the combination changing position and the combination changing process can proceed as previously described. The projection member 145 can be withdrawn from the opening 109 by moving the

finger knob members 146 away from the flange of the lock. It is apparent that the projection member 145 is therefore permanently connected to the key in a manner whereby it may be moved in longitudinally reciprocating motion parallel to and in next adjoining relation with the bit portion of the key, to be inserted into and removed from the opening 109.

In the foregoing description of various keys, only six different bitting depths have been illustrated for purposes of clarity. It should be understood that the more common nine or ten bitting depths can be employed with the lock 40 in the same manner as the six illustrated.

The foregoing description makes ia apparent that the lock 40 of the present invention allows relatively rapid and selective change of the key combination without removing the lock from its installed position or replacing parts. Furthermore, more pick-resistant lock action has been secured because of the release of the inner shear surface prior to release of the outer shear surface. Release of the inner shear surface prevents further probing or the like in an attempt to pick or release the outer shear surface. The construction and arrangement of elements within the lock is such that the overall dimensions of the lock can be used in a wide variety of applications. The number of key combinations to which the lock may be changed allow rapid key combination change for operation by different pass keys as well as a number of acceptable key combination changes for master key operation. Ideally, master key bitting depths are cut to lesser depths than pass key bitting depths.

The unique use of magnetic elements within the locking stack assemblies enhances the reliability of operation and the pick-resistance of the lock.

The configuration and arrangement of the present lock makes is applicable for use in cylindrical locks, tubular deadlocks, padlocks, mortise and rim cylinders and a variety of other situations.

The pin tumbler lock described herein allows rapid and selective change of the lock operating key combination without removing the lock from its installed position and without disassembling or replacing any of the parts of the lock. The lock can be used with conventional keys having bitting depths cut therein in a conventional manner, for use as pass keys and as master keys. The locking combination can be selectively changed for operation by different pass keys while maintaining the lock in condition for operation by at least one master key or a grand master key. The overall outside dimensions of the lock are such as to permit the lock in a wide variety of different applications. Finally, the lock has increased resistance to picking or other forms of unauthorised use, and significantly reduces the potential for separation of the locking stack elements upon insertion of a key into the lock.

CLAIMS

1. A pin tumbler lock comprising a housing member, a sleeve member movably received within the interior of the housing member, a plug member rotatably received within the interior of the sleeve member, said plug member having a keyway formed therein for receiving a key, a locking stack assembly comprising elements including a driver pin, a locking pin, a tumbler pin and means for biasing said locking stack elements in contacting relation, said housing and sleeve and plug members each having a bore formed therein in radially aligned relation to receive the elements of the locking stack assembly, whereby a correct combination key positions the interfaces of said locking stack elements at points coicident with shear surfaces defined between said housing and sleeve and plug members, and actuating means for operatively connecting said sleeve and plug members for moving said sleeve member axially within said lock, said actuating means being operative upon positioning a correct combination key in the keyway and upon rotating said plug member substantially out of a position in which the bores through said housing and sleeve and plug members are in radially aligned relation.

2. A lock as claimed in claim 1, further comprising restoring means operatively connecting said sleeve and plug members for moving said sleeve member in an axial direction opposite to that axial movement effected by said actuating means, said restoring means being operative upon rotation of said plug member into a position wherein the bores through said housing and sleeve and plug members are in radially aligned relation.

3. A lock as claimed in claim 1 or claim 2, further comprising means for allowing predetermined axial and rotational movement of the sleeve member relative to said plug and housing members into a combination changing position of said sleeve in which an auxiliary bore formed through said sleeve member and positioned axially and circumferentially spaced from the first-mentioned bore formed in said sleeve member, is positioned in radial alignement with the bore in said housing member, and change means operatively connecting said sleeve and plug members for positioning said sleeve member in the combination changing position.

4. A lock as claimed in claim 3, wherein said change means comprises a change opening extending from said sleeve member through said plug member to an exterior surface of said plug member at an exterior surface of said lock, whereby an instrument can be inserted through the change opening to contact said sleeve member, at least one change wafer element preferably being positioned continually within the auxiliary bore of said sleeve member.

5. A pin tumbler lock comprising a housing member, a sleeve member movably received within the interior of the housing member, a plug member rotatably received within the interior of the sleeve member, said plug member having a keyway formed therein for receiving a key, a locking stack assembly comprising elements including a driver pin, a locking pin, a change wafer, a tumbler pin and means for biasing said locking stack elements in contacting relation,

said housing and sleeve and plug members each having a bore formed therein in radially aligned relation to receive the elements of the locking stack assembly, whereby a correct combination key positions the interfaces of said locking stack elements at points coincident with shear surfaces between said housing and sleeve and plug members, the sleeve member being mounted for predetermined axial and rotational movement relative to said plug and housing members into a combination changing position of said sleeve member, an auxiliary bore formed through said sleeve member and axially and circumferentially spaced from the first-mentioned bore formed in said sleeve member so that the auxiliary bore is positioned in radial alignement with the bore in said housing member upon said sleeve member being positioned in the combination changing position, at least one change wafer positioned within the auxiliary bore in said sleeve, and change means for positioning said sleeve member in the combination changing position.

6. A lock as claimed in claim 5, further comprising actuating means operatively connecting said sleeve and plug members for moving said sleeve member axially upon rotation of said plug member substantially from a position wherein the bores first aforementioned through said housing and sleeve and plug members are aligned, said sleeve member being of substantially uniform radial thickness, the locking pin of said locking stack assembly being substantially of length equal to the radial thickness of said sleeve member, and a plurality of change wafers being positioned in the change wafer chamber, each change wafer being of the same

thickness, and the total length of the plurality of change wafers in the change wafer chamber being substantially equal to the radial thickness of said sleeve member.

7. A lock as claimed in claim 5 or claim 6, wherein one of the elements of said locking stack assembly includes permanent magnetic material to attract the other elements of said locking stack assembly, preferably one of the driver pin or the locking pin or the tumbler pin of said locking stack assembly including the permanent magnetic material, and the other elements of said locking stack assembly and the change wafers positioned in the auxiliary bore including material attracted to the permanent magnetic element, and the portions of said housing member and said sleeve member and said plug member generally adjacent to the bores of said members being formed of material not attracted to the magnetic material.

8. A lock as claimed in any one of claims 5 to 7, wherein said change means further comprises a change opening extending from said sleeve member through said plug member to an exterior surface of said plug member at an exterior surface of said lock, whereby an instrument can be inserted through the change opening to contact said sleeve member, said instrument preferably being in the form of a projection member carried by a key so as to be aligned with the change opening when the key is inserted into the keyway of the plug member, said projection member being mounted on the key for longitudinal reciprocating movement relative

to the key to contact with the sleeve member.

9. A key adapted for insertion in a keyway formed in a rotatable plug member of a tumbler lock, said key comprising a generally elongated blade portion receivable within the keyway of said plug member, a bow portion extending from the blade portion and adapted to be grasped to operate said lock, a stop shoulder arranged to contact the plug member and limit insertion of said key into the keyway, a projection member permanently connected to said key, the projection member extending longitudinally of the blade portion of said key, the projection member being operatively connected to said key for longitudinally reciprocation motion parallel to the bit portion, and means operatively connected to said projection member for moving said projection member in longitudinally reciprocating motion, said moving means extending from said projection member to be grasped.

10. A tumbler lock comprising a housing member, a rotatable pin movably positioned relative to said housing member, a plurality of bores extending in radial alignment in said plug and housing members, and a plurality of key-operated movable locking stack elements received in the bores, at least one of said locking stack elements comprising a permanent magnetic material, and at least one of the other of said locking stack elements comprising material attracted to the permanent magnetic material element of the locking stack.

11. A tumbler lock comprising a housing member, a cylindrical sleeve member movably positioned within the interior of said housing member, said sleeve member contacting said housing member at an interface defining an outer shear surface, a plug member having a cylindrically shaped and axially extending barrel portion, movably positioned within the interior of said sleeve member, the barrel portion contacting the sleeve member at an interface defining an inner shear surface, an axially extending keyway opening in the housing member for receiving a blade portion of a key, first connection means operatively connecting said plug and housing members for allowing rotational movement of said plug member relative to said housing member and for preventing substantial axial movement of said plug member relative to said housing member, said first connection means allowing said plug member to assume a first rotational position and a second rotational position relative to said housing member, the second rotational position being rotationally displaced from the first rotational position, second connection means operatively connecting said sleeve and housing members for allowing axial movement of said sleeve member from a first axial position to a second axial position relative to said housing member, the second axial position being axially displaced from the first axial position, said second connection means also operatively preventing rotation of said sleeve member in the first and second axial positions relative to said housing member, at least one driver pinway formed in said housing member and extending radially outward from the interior opening of said

housing member, at least one locking pin chamber formed in and extending radially through said sleeve member, the locking pin chamber being located in said sleeve member in radial alignement with the driver pinway opening upon said sleeve member assuming the first axial position, a tumbler pinway formed in said plug member and extending radially from the barrel portion into the keyway, the tumbler pinway being located on said plug member in radial alignement with the driver pinway and the locking pin chamber upon said plug member assuming the first rotational position and upon said sleeve member assuming the first axial position, the aligned tumbler pinway and locking pin chamber and driver pinway defining a locking stack bore, a locking stack assembly comprising elements including a driver pin and a locking pin and a tumbler pin, said locking stack assembly being received within the locking stack bore, the driver pin and the locking pin and the tumbler pin being received respectively within the driver pinway and the locking pin chamber and the tumbler pinway in contacting relationship with the ends of said pin elements positioned essentially at the inner and outer shear surfaces upon insertion of a proper combination key into the keyway and upon said plug and sleeve members being positioned respectively in the first rotational and first axial positions, thereby allowing operation of said lock by said rotation of said key from its first rotational position to its second rotational position, actuating means operatively connected for moving said sleeve member from its first axial position to its second axial position upon rotation of said plug member

from its first rotational position to its second rotational position, and restoring means operatively connected for moving said sleeve member from the second axial position to its first axial position upon said plug member being rotated from its second rotational position into its first rotational position.

12. A pin tumbler lock as claimed in claim 11, having provision for changing the key combination without removing said lock from its installed position and without disassembly or replacement of parts, wherein said plug member is rotatable to a third rotational position, the third rotational position being rotationally displaced from either the first or second rotational positions of said plug member, said second connection means operatively connects said housing member to said plug member for allowing axial movement of said sleeve member to a third axial position, the third axial position being axially displaced from either of the first or second axial positions of said sleeve member, said locking stack assembly further includes a change wafer as an element of said assembly, and the rotational position of the sleeve member in the first and second axial positions defines a first rotational position of said sleeve member, said lock further comprising third connection means operatively associated with said second connection means and operatively connected to said plug and sleeve members for allowing rotation of said sleeve member to a second rotational position when said sleeve

member is positioned in the third axial position, the second rotational position being rotationally displaced from the first rotational position of said sleeve member, the condition of said sleeve member when simultaneously positioned in the second rotational and third axial positions defining a combination changing position, a change wafer chamber formed in and extending radially through said sleeve member, said change wafer being positioned in radial alignement with the driver pinway when said sleeve member is positioned in the combination changing position, means operatively extending to the exterior of said lock from said sleeve member for allowing movement of said sleeve member to its third axial position when said plug member is positioned in its third rotational position, and sleeve rotating means operatively connected for rotating said sleeve member from its first rotational position to its second rotational position, said sleeve rotating means being operative with rotation of said plug member from its third rotational position to its first rotational position.

13. A pin tumbler lock as claimed in claim 11 or claim 12, wherein said first connection means comprises a flange member extending radially outward from said plug member and defining a shoulder surface contacting one axial end of said housing member, and a retainer member attached to said plug member and extending radially outward from said plug member, said retainer member defining a shoulder contacting the other axial end of said housing member, and said second connecting means comprises a locking recess

formed in said housing member, and an offset tab member attached to said sleeve member and extending into said locking recess when said sleeve member is positioned in the first and second axial positions.

14. A pin tumbler lock as claimed in any one of claims 11 to 13, wherein said actuating means comprises an actuating member connected rigidly to said plug and extending radially outward of said plug member, and an actuating notch formed in said sleeve member in predetermined position to receive the actuating member therein when said plug and housing members are positioned respectively in their first rotational and first axial positions, said actuating notch further including at least one cam surface for operatively moving the sleeve member to its second axial position upon contact with the actuating member when said plug member is rotated from its first rotational position to its second rotational position, and said restoring means comprises a restoring tab member operatively attached to said plug member and connected to rotate with said plug member, said restoring tab member further comprising at least one cam surface, and a restoring projection member connected to said sleeve member at a predetermined position, the predetermined position being one which locates said restoring projection member in axially aligned and contacting relation with said restoring tab member when said plug member and said housing member are respectively positioned in their first rotational and first axial positions, said

restoring projection member further comprising at least one cam surface adapted to contact the cam surface of said restoring tab member upon said sleeve member being positioned in the second axial position and said plug member being rotated to its first rotational position.

15. A pin tumbler lock as claimed in claim 12, wherein a plurality of change wafers are positioned continually in said change wafer chamber, and said locking stack assembly includes at least one group of change wafers, each group being defined by a predetermined number being one less than the number of change wafers continually in the change wafer chamber, the length relationship of said locking pins and change wafers transposable from one change wafer chamber into lone locking stack assembly is at least one bitting depth interval less than the length of the locking pin of the locking stack assembly.

16. A pin tumbler lock substantially as hereinbefore described with reference to the accompanying drawings.

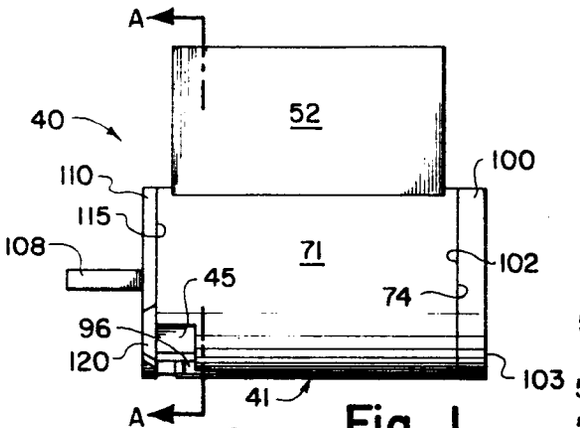


Fig. 1

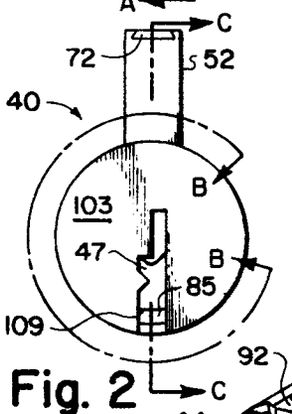


Fig. 2

Fig. 3

Fig. 4

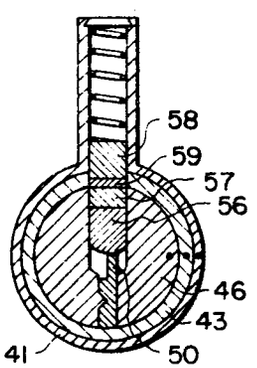


Fig. 5

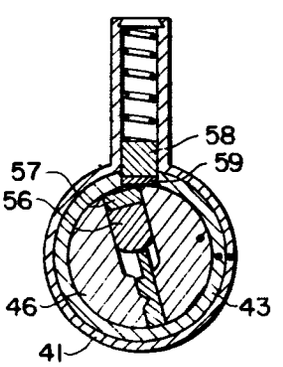


Fig. 6

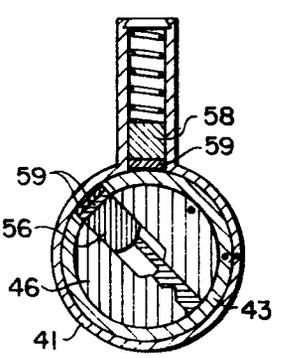


Fig. 7

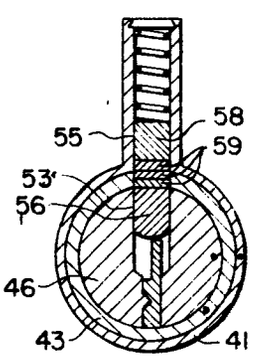


Fig. 8

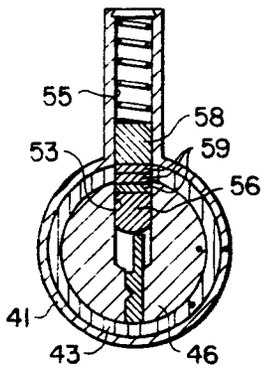


Fig. 9

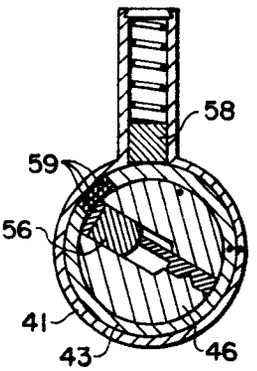


Fig. 10

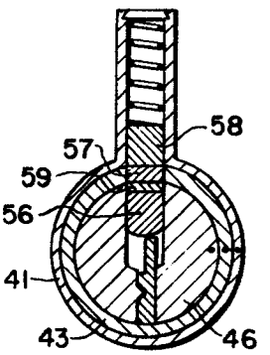
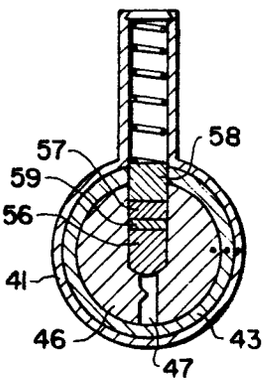


Fig. 11



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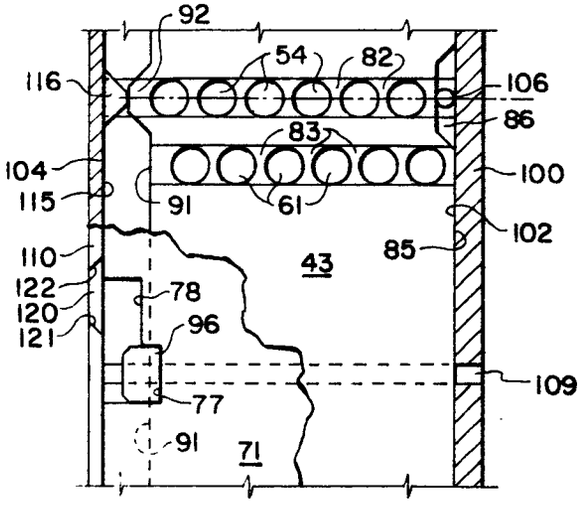
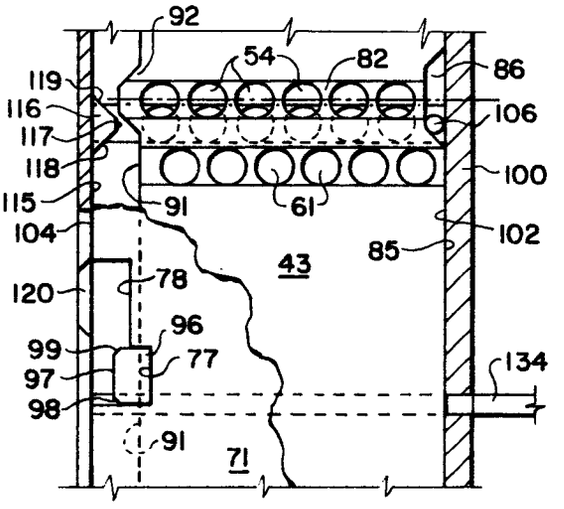


Fig. 13



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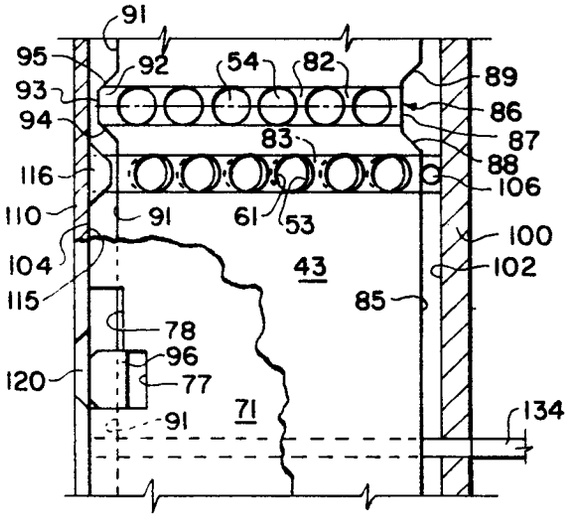

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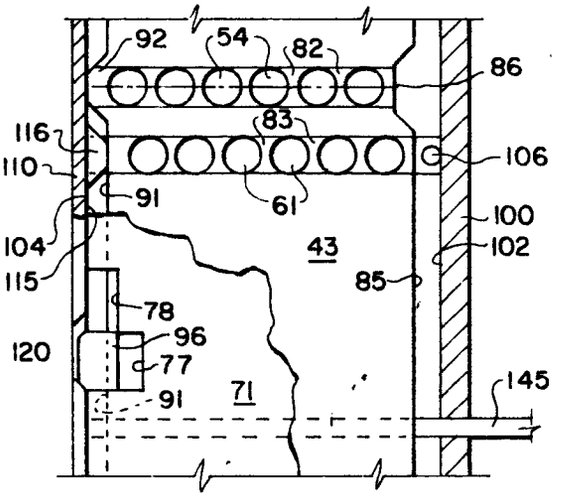

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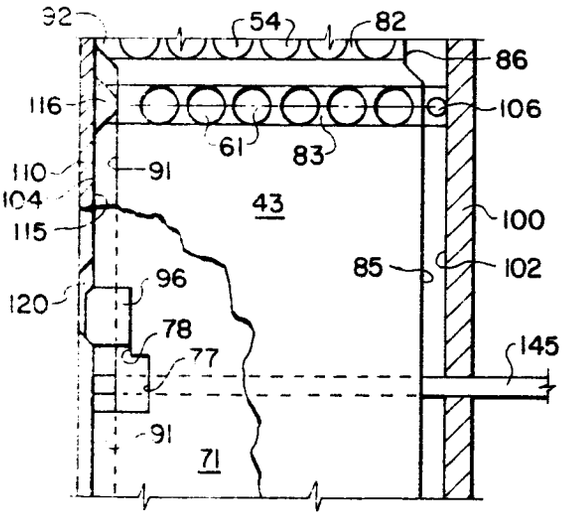

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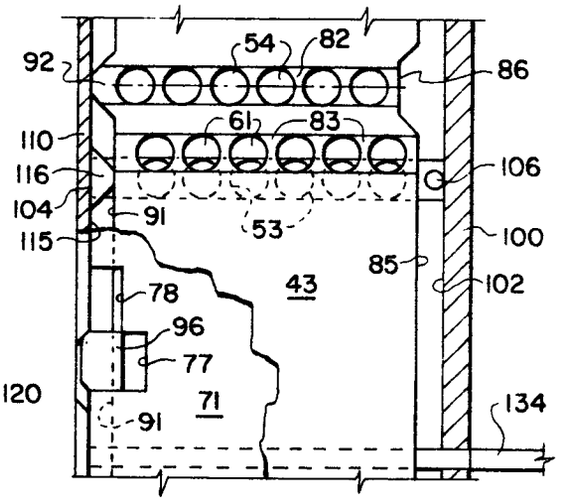

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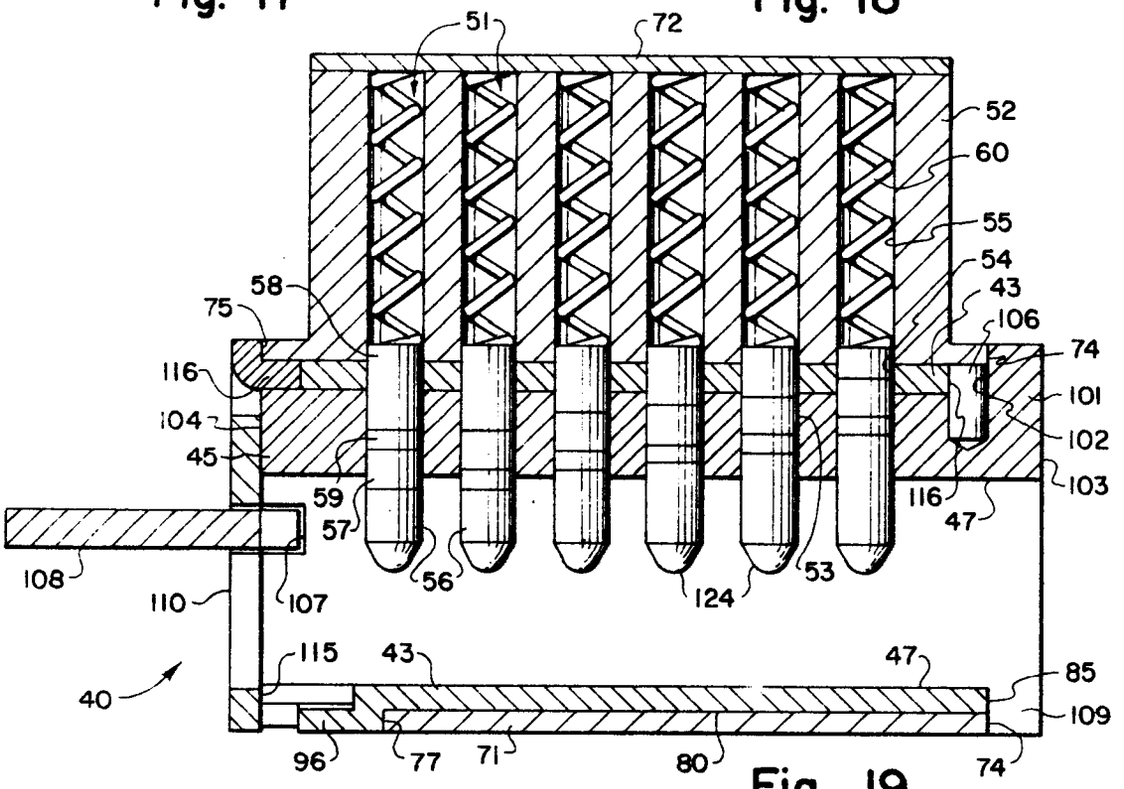

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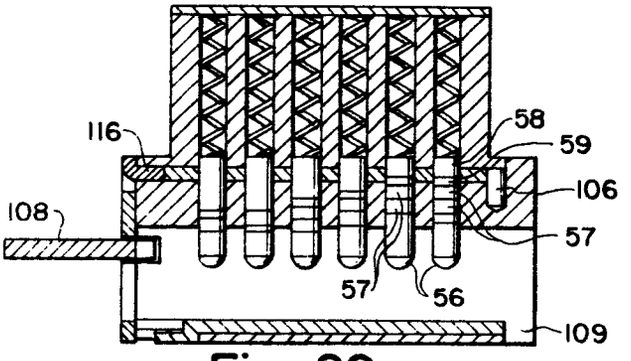

Fig. 20

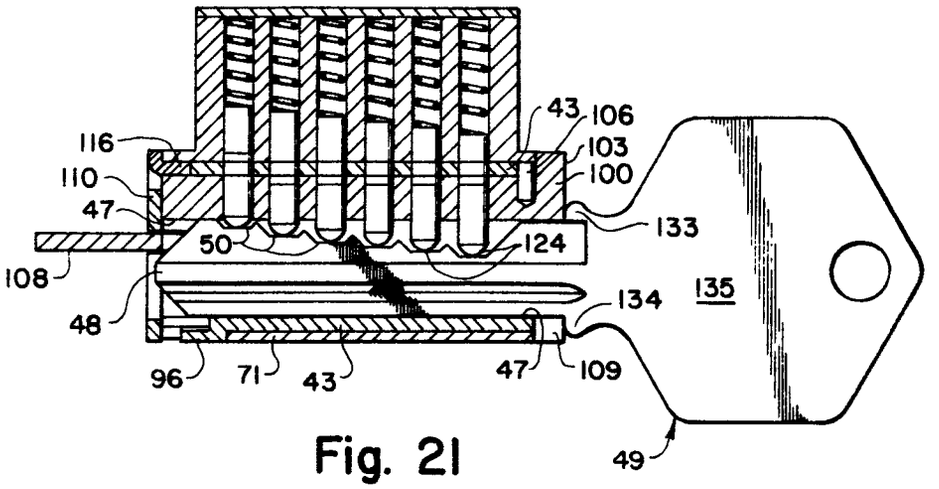

Fig. 21

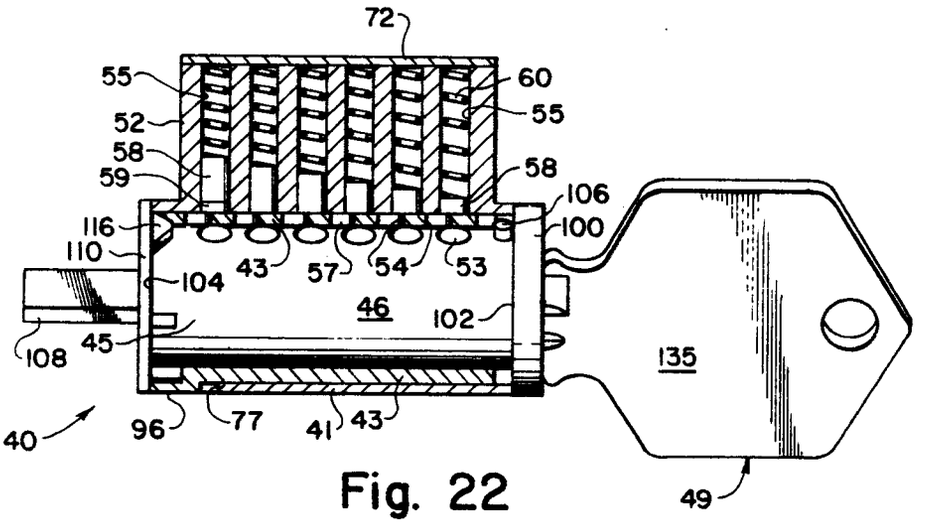

Fig. 22

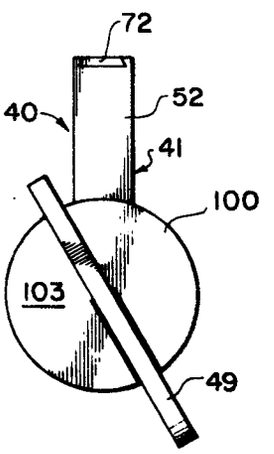

Fig. 23

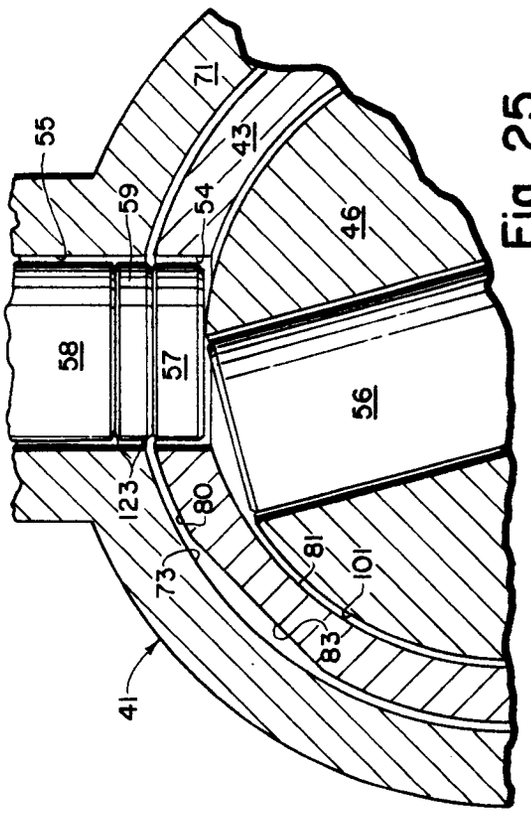

Fig. 25

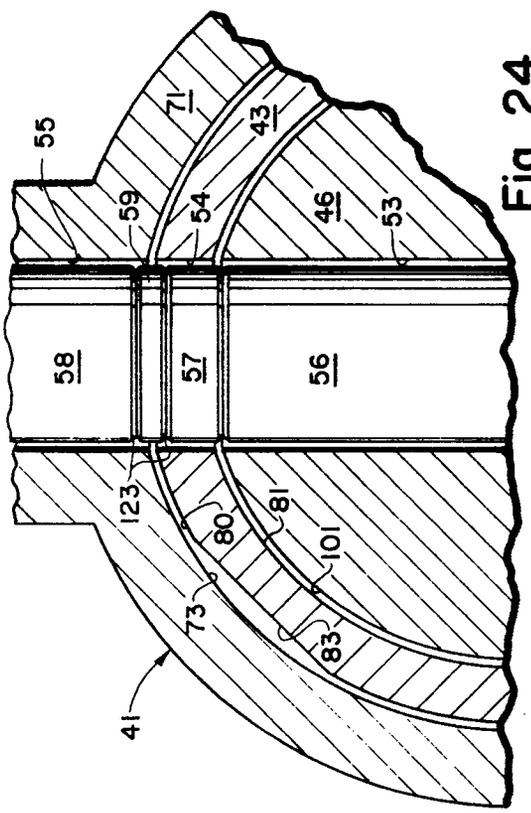

Fig. 24

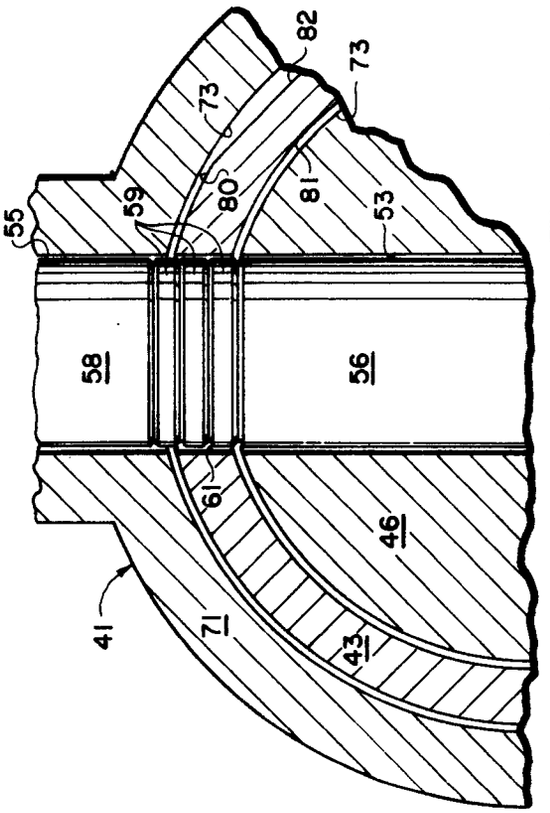

Fig. 27

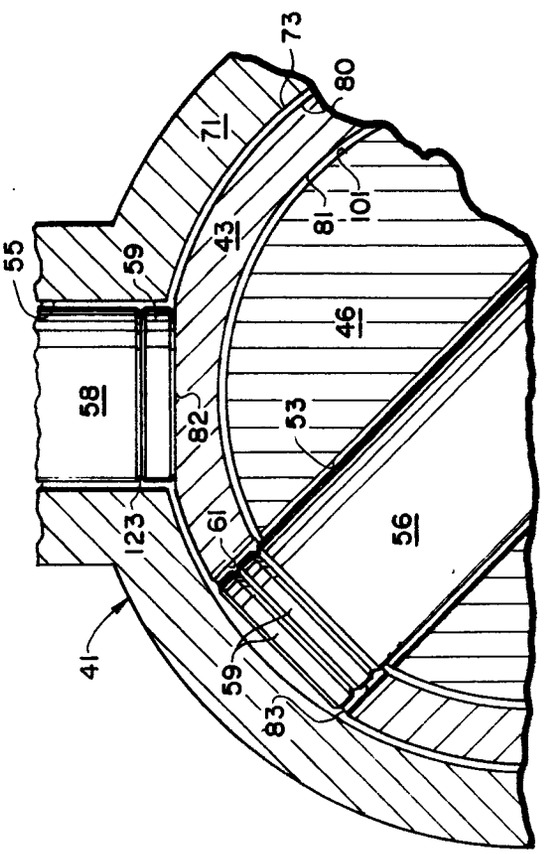

Fig. 26

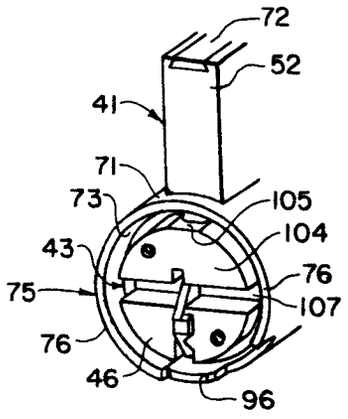

Fig. 28

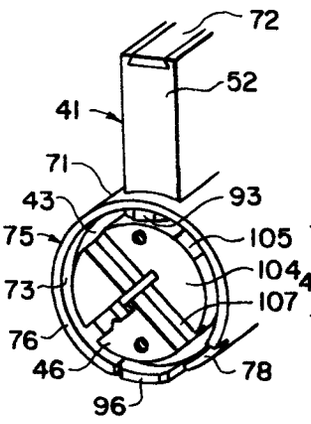

Fig. 29

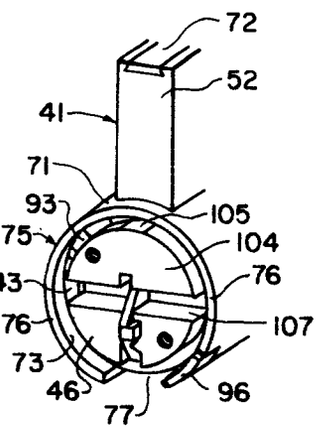

Fig. 30

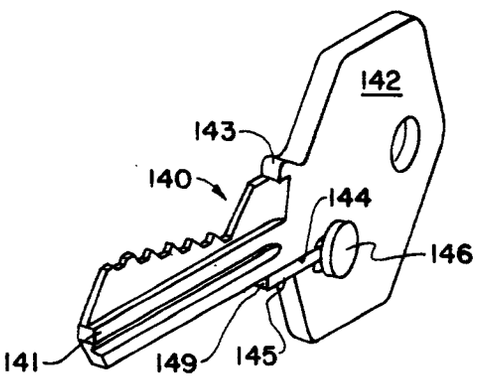

Fig. 31

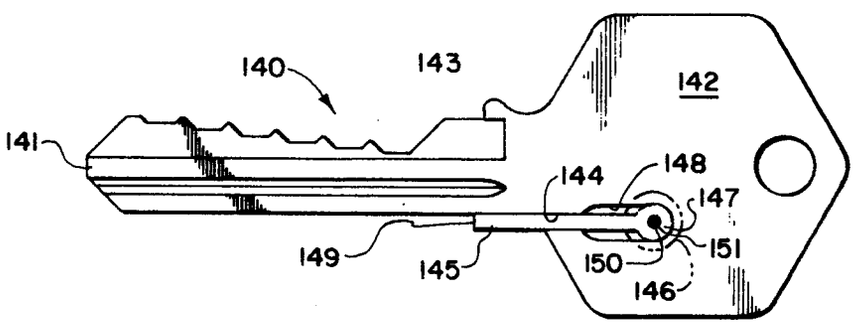

Fig. 32

European Patent Office

EUROPEAN SEARCH REPORT

0006765
Application number

EP 79 301 277.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	GB - A - 955 828 (THE AMERICAN HARDWARE CORPORATION) * page 3, column 2, line 99 to page 4; fig. 1 to 15 * --	1,3, 5
	US - A - 2 113 007 (G.E. SWANSON) * pages 3 and 4; fig. 1 to 13 * --	1,3, 5,11
A	US - A - 2 427 814 (E.A. SCHACHINGER) * complete document * --	1,3, 5
A	US - A - 2 326 358 (H.L. HULL) * complete document * ----	1,5, 6

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

E 05 B 27/04

TECHNICAL FIELDS SEARCHED (Int.Cl.³)

E 05 B 27/00
E 05 B 37/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	02-10-1979	WUNDERLICH

EPO Form 1503.1 06.78