



- (51) International Patent Classification:
E05B 19/12 (2006.01)
- (21) International Application Number:
PCT/US2013/040216
- (22) International Filing Date:
8 May 2013 (08.05.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/644,383 8 May 2012 (08.05.2012) US
- (71) Applicant: **SCHLAGE LOCK COMPANY LLC**
[US/US]; 2720 Tobey Drive, Indianapolis, IN 46219 (US).
- (72) Inventor: **CLIFFORD, Jason, C.**; 3410 Honeyburl
Drive, Colorado Springs, CO 80918 (US).
- (74) Agents: **STEPHENSON, Mark, T.** et al.; Krieg Devault
LLP, One Indiana Square, Suite 2800, Indianapolis, IN
46204 (US).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: KEY HAVING MOVABLE MEMBERS AND LOCKING SYSTEM

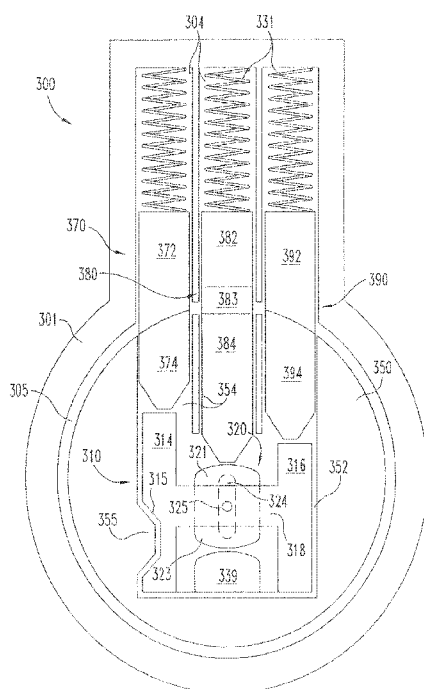


Fig. 3

(57) Abstract: An illustrative key includes first and second substantially vertical blades being connected by a substantially horizontal connecting member such that an axial channel is formed between the two blades. Members may be slidingly coupled to the connecting member such that the members are moveable into the channel. One embodiment of the present disclosure is a unique variable position key operable to be received in a keyway of a locking cylinder including a plurality of tumblers. Other embodiments include unique apparatuses, systems, devices, hardware, methods, and combinations for a multi-blade key and locking system. Further embodiments, forms, features, aspects, benefits, and advantages of the present application shall become apparent from the following description and drawings.



Published:

— with international search report (Art. 21(3))

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

KEY HAVING MOVABLE MEMBERS AND LOCKING SYSTEMCROSS REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of U.S. Provisional Patent Application No. 61/644,383 filed May 8, 2012, which is incorporated herein by reference.

5

BACKGROUND

The present invention relates to keys and locks operable by the same. Key-operable locks may face a number of challenges that can compromise the security of the lock such as unauthorized duplication of the keys. Many conventional keys are easily copied, for example by taking an impression of the key or tracing its profile. Accordingly, there remains a need for further contributions in this area of technology. The present application provides novel and non-obvious contributions to this area of technology.

10

SUMMARY

One embodiment of the present disclosure is a unique variable position key operable to be received in a keyway of a locking cylinder including a plurality of tumblers. Other embodiments include unique apparatuses, systems, devices, hardware, methods, and combinations for a multi-blade key and locking system. Further embodiments, forms, features, aspects, benefits, and advantages of the present application shall become apparent from the following description and drawings.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1a is a perspective view of an example key.

Fig. 1b is an elevational illustration of the key of Fig. 1a

Fig. 2 is a cutaway view of an illustrative key-plug interaction.

Fig. 3 is a cross-sectional view of an example locking system.

Fig. 4a is a perspective view of an example key.

Fig. 4b is a cutaway view of the key of Fig. 4a.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications in the described embodiments, and any further applications of the principles of the invention as described herein are contemplated as would normally occur to one skilled in the art to which the invention relates.

As used hereinafter, a reference to the length, height, or width of an element of a key is to be interpreted in light of the characterization of the dimensions and the following definitions unless specifically noted otherwise. The geometry of the key defines three mutually orthogonal axes; each dimension is measured along one of the axes. Width is measured along the first axis, defined as the direction in which the crossbar must extend to connect the blades. Width will be defined as the horizontal direction. Length is measured along a second axis defined as the axial direction of the shank. Height is measured along the third axis, the direction in which will be considered as vertical direction and the bittings are formed (or in the case of a key blank, the direction in which bittings will be formed). The present application contemplates that the dimensions and orientation may be substantially in the direction indicated or in the direction indicated.

With reference to Figs. 1a and 1b, there is illustrated an exemplary key 100 that includes a head portion 102 and a shank portion 110. Shank portion 110 includes vertical blades 114 and 116, and a horizontal cross-bar 118. Crossbar 118 extends between blades 114, 116. The inner surfaces 114a and 116a respectively of blades 114, 116 cooperate with an upper surface 118a of crossbar 118 to define an upper channel 111, and with a lower surface 118b of crossbar 118 to define a lower channel 112. One or more of blades 114, 116 may include one or more grooves 115. One or more grooves 115 may be configured to receive a counter-shaped/correspondingly-shaped ward in a corresponding keyway, and may include side-bitting (not shown) to provide an additional layer of security. In the illustrated embodiment, blades 114, 116 each extend parallel to one another in the vertical direction, and crossbar 118 is perpendicular to blades 114, 116. The present application contemplates in other forms that the blades are not parallel to one

another and that the crossbar may or may not be disposed perpendicular to one or both of the blades.

Crossbar 118 includes a plurality of through-bores 122 extending through and orthogonal to crossbar 118. Disposed within each through-bore 122 is a floating pin 120. Through-bores 122 are substantially aligned with biting positions (a subset of which is illustrated in Fig. 1b as biting positions B2-B4) such that, when shank portion 110 is inserted into a corresponding keyway, each floating pin 120 is aligned with a tumbling system. In the illustrated embodiment, blades 114, 116 include bittings 132 which are aligned with the same set of biting positions as floating pins 120. In certain embodiments, the height of a blade 114, 116 at each biting position (sometimes referred to as the root depth) may be selected from a finite set of root depths. For example, bittings 132 may be formed such that the root depth each biting position is provided by the formula $RD = 0.2 + 0.015 * n \pm TF$, where RD is the root depth in inches, n is an integer between zero and nine, inclusive, and TF is a tolerance factor having a value of 0.002. In other embodiments, the root depth at each biting position may be selected according to different increments, or may be selected from a continuum of root depths. In other embodiments, one or more of blades 114, 116 may be bitted according to different biting positions, or may not be bitted at all.

Cross-bar 118 further includes a plurality of radial bores 142 and/or a plurality of axial bores 144, each being connected to a through-bore 122. A rod/pin may be inserted through a bore 142, 144, and into a slot formed in a floating pin 120, such that floating pin 120 is slidably coupled to crossbar 118. Further details of the sliding pins will be provided with respect to Fig. 2.

Fig. 2 is an illustrative view of an example shank portion 210 which has been inserted into a corresponding locking mechanism 200. While floating pins 120 (as illustrated in Fig. 1) are of a uniform height, floating pins 220 are of varying heights. Further, while floating pins 120 are each disposed in a separate through-bore 122, floating pins 220 are disposed in a single through-hole 222 extending in the axial direction of shank portion 210.

Floating pins 220 include a tip portion 221 and a base portion 222, and have formed therein a cavity 224. Cavity 224 extends horizontally through floating pin 220, and extends vertically from a location proximate tip portion 221 to a location proximate base portion 222. Each cavity 224 is configured to receive a guide member 225. In the illustrated embodiment,

guide members 225 are positioned in radial bores similar to radial bores 142, such that floating pins 220 are slidingly coupled to shank portion 210. That is to say, floating pins 220 are free to travel a distance corresponding to the vertical dimension of cavity 224. A floating pin 220 may include a biasing member (not shown) configured to urge the floating pin into a predetermined position. Floating pins 220 may be mounted such that they are restrained from angular displacement. For example, while guide members 225 are illustrated as having a circular cross-section, a cross-section of an alternate embodiment guide member 225 may instead include straight portions configured to engage the inner walls of cavities 224, thus hindering rotation. Additionally or alternatively, portions of the outer side of each floating pin 220 may contact another floating pin 220 or a wall defining the axial through-hole.

In the illustrated embodiment, cavity 224 is a through-hole which extends the entire width of floating pin 220, and guide member 225 extends through cavity 224. In other embodiments, the cavity may be a channel formed in the side of floating pin 220 such that the channel does not extend through floating pin 220. An example of such an embodiment is described below with respect to Figs. 4a and 4b.

In Fig. 2, lock assembly 200 includes a shell 201, a plug 250, and a plurality of tumbling systems, here illustrated as pin tumbler sets 230. Shell 201 includes a plug cavity 205 in which plug 250 is positioned. Plug cavity 205 is generally cylindrical, but may include one or more grooves (not shown), for example if plug 220 includes sidebar locking features. Plug 250 includes a keyway 252 configured to receive shank portion 210, and may include a ward 255 configured to prevent insertion of a key which does not have a counter-shaped/correspondingly-shaped groove. Keyway 252 is defined in part by a radial slot configured to receive crossbar 218. The radial slot may include a protrusion 259 configured to urge floating pins 220 downward, such that a shank having a fixed inner blade cannot enter keyway 252. Plug 250 further includes a plurality of plug tumbler cavities 254 configured to align with corresponding shell tumbler cavities 204 formed in shell 210, thereby creating a tumbler chamber.

Disposed within each tumbler chamber is a spring 231 and a tumbler set 230. Each tumbler set 230 includes a driving pin 232 and a driven pin 234. Driven pins 234 are configured to travel along the surfaces of floating pin tip portions 221. One or more of the driven pin 234 and the floating member tip portion 221 may be rounded or tapered to facilitate such travel. One

or more tumbler set 230 may further include one or more master key pin 233 between driving pin 232 and driven pin 234, such that lock assembly 200 can be master-keyed.

Located within keyway 252 are a plurality of positioning members 239. Positioning members 239 are configured to interact with floating pins 220 such that, upon insertion of shank portion 210 into keyway 252, floating pins 220 are urged in the vertical direction, which in turn urges tumbler sets 230 in the vertical direction. One or more of the positioning member 239 and the floating pin base portion 223 may be rounded or tapered to facilitate travel of floating pin 220. In the illustrated embodiment, each positioning member 239 is positioned on a first side of keyway 252, and each tumbler set 230 is positioned on a second side of keyway 252. It is also contemplated that a positioning member 239 may be positioned on the same side of keyway 252 as a tumbler set 230.

In tumbler sets 230, each pin contacts another pin at an interface; when a floating pin 220 is of the proper configuration, an interface of the corresponding tumbler set is substantially aligned with a shear line 240. When the proper shank portion 210 is inserted into keyway 252, an interface in each tumbling system is substantially aligned with shear line 240. This defines an unlocked state of locking system 200, in which plug 250 is free to rotate with respect to shell 201.

In the illustrated embodiment, the tumbling systems are sets of pin tumblers. In other embodiments, the tumbling systems may include other types of tumblers, such as wafer tumblers, disc tumblers, and lever tumblers, and may further include a sidebar locking feature. Furthermore, while locking assembly 200 is illustrated as a six-tumbler, key-in-knob/lever interchangeable core, other tumbler counts and other formats – such as full-size interchangeable core and small format interchangeable core – may be used.

In the illustrated embodiment, each positioning member 239 is releasably coupled to plug, such that positioning members 239 are removable for rekeying operations, but do not move when shank portion 210 is inserted into keyway 252. In other embodiments, one or more positioning member 239 may be formed integrally with plug 250. In further embodiments, one or more positioning member 239 may be movable in the vertical direction upon insertion of shank portion 210.

Additionally, while in locking assembly 200 the tumbler sets 230 provide the interference which prevents plug 250 from rotating when in a locked state, the interference may additionally

or alternatively be provided by other means. For example, plug 250 may include a sidebar locking mechanism (not shown) operable between a locked state in which a portion of the sidebar protrudes into a groove formed in shell 201 and an unlocked state in which the sidebar is at least partially retracted into plug 250.

5 Returning now to Fig. 1, blades 114, 116 include bittings 132 and teeth 131. In certain embodiments, one or more blade may not be bitted. For example, a corresponding locking system may be configured such that the tumbling systems are activated only by floating pins 120. As an additional example, key 100 may be manufactured as a blank key, to which bittings may be added later. In the illustrated embodiment, bittings 132 are formed on the upper surface of
10 each blade. In other embodiments, bittings 132 may additionally or alternatively be formed on lower surface of one or more of the blades, as in key 400 (described below). In further embodiments, the vertical sides of the blades may be bitted, for example to engage additional tumbling systems.

 In embodiments which include bittings 132, blades 114, 116 may define an identical
15 configuration of bittings 132, or may define different configurations. For example, with respect to Fig. 3, locking system 300 includes three tumbler sets 370, 380, 390 at each biting position. Shank portion 310 includes blades 314, 316 and floating pin 324, the vertical position of which is adjusted by positioning member 339. In the illustrated embodiment, floating pin 320 is aligned with a central axial plane of plug 350, and blades 314, 316 are parallel to the central axial plane.
20 Other embodiments are also contemplated. For example, one or more of blades 314, 316 may be substantially parallel to the central axial plane or may be offset at another angle. Each of blades 314, 316, and floating pin 324 is configured to adjust the position of a different tumbler set. Blade 314 adjusts the position tumbler set 370, floating pin 320 adjusts the position of tumbler set 380, and blade 316 adjusts the position of tumbler set 390. Although tumbler sets 370, 380,
25 390 are each parallel to blades 314, 316 in other embodiments, one or more tumbler set may be offset with respect to a blade.

 In the illustrated embodiment, each tumbling system is a pin tumbler set. In other embodiments, the tumbling systems may include other types of tumblers, such as wafer tumblers, disc tumblers, and lever tumblers, and may further include a sidebar locking feature. While
30 tumbler sets 370, 380, 390 are aligned to the same biting positions, in other embodiments the tumbling systems may be aligned with different biting positions.

While the embodiments described hereinabove illustrate vertical keys, in other embodiments the key may be a horizontal, Euro-style key. Figs. 4a and 4b illustrate an example embodiment of a horizontal key 400, in which elements similar to those of the key 100 are labeled with similar reference characters. Key 400 includes a head portion 402 and a shank
5 portion 410, which includes blades 414, 416, and crossbar 418. Blades 414, 416 include bittings 432 on both the top and the bottom surfaces, which may be configured such that key 400 is reversible. It is also contemplated that bittings 432 may be formed on only the top surface or only the bottom surface of one or more of blades 414, 416.

Floating pins 420 have channels 424, and are slidably coupled to crossbar 418 such that
10 floating pins 420 are movable in the vertical direction. Each floating pin 420 is partially positioned in a seating cavity 426, and extends vertically through a through-hole 422. Through-holes 422 are configured such that floating pins 420 are located at a plurality of biting positions, at least some of which are different than the biting positions at which bittings 432 are located. In other embodiments, each floating pin 420 may be aligned with the biting positions of bittings
15 432.

Through-hole 422 is defined in part by protrusions 425, which are configured to be received in channels 424. The relative sizes of channels 424 and protrusions 425 are such that floating pins 420 are vertically movable between a lower terminal position in which base portion 423 is positioned in lower channel 412 and an upper terminal position in which tip portion 421 is
20 positioned in upper channel 411. In the illustrated embodiment, a first section of floating pin 420 defines tip portion 421 and the vertical surface of channel 424, and a second section defines base portion 422. In other embodiments, the first and second sections may be identical, each defining a segment of the vertical surface of channel 424. In the manufacturing process, the first section may be inserted in through-hole 422 such that protrusion 425 is positioned within channel 424,
25 and the second section is coupled to the first section. The first and second sections may be coupled by any method known in the art, such as an interference fit, epoxy or brazing.

In the embodiment of Fig. 4, channels 424 and protrusions 425 have substantially straight surfaces in the axial direction of shank portion 410, such that floating pins 420 can move vertically, but cannot rotate. In other embodiments, one or more floating pin 420 may be
30 slidably coupled to crossbar 418 such that the floating pin is both vertically movable and rotatable with respect to crossbar 418. For example, channel 424 may be formed on the entire

circumference (or an arcuate segment thereof) of floating pin 420. Furthermore, while protrusion 425 is formed integrally with crossbar 418, it is also contemplated that protrusion 425 may be a rod having a first end positioned in a corresponding cavity in crossbar 418 and a second end protruding into channel 424.

5 While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the spirit of the inventions are desired to be protected. It should be understood that while the use of words such as preferable, preferably,
10 preferred or more preferred utilized in the description above indicate that the feature so described may be more desirable, it nonetheless may not be necessary and embodiments lacking the same may be contemplated as within the scope of the invention, the scope being defined by the claims that follow. In reading the claims, it is intended that when words such as “a,” “an,” “at least one,” or “at least one portion” are used there is no intention to limit the claim to only one item
15 unless specifically stated to the contrary in the claim. When the language “at least a portion” and/or “a portion” is used the item can include a portion and/or the entire item unless specifically stated to the contrary.

CLAIMS

WHAT IS CLAIMED IS:

1. A key comprising:

a shank including two key blades with a crossbar extending therebetween, an upper
5 channel is defined by an upper surface of the crossbar and an inner surface of each key blade,
and a lower channel is defined by a lower surface of the crossbar and the inner surface of each
key blade;

a plurality of floating pins independently slidingly coupled to the crossbar such that each
of the plurality of floating pins is vertically movable between a lower terminal position in which
10 a lower portion of the floating pin is positioned in the lower channel and an upper terminal
position in which an upper portion of the floating pin is positioned in the upper channel; and

wherein the plurality of floating pins are slidingly coupled to the crossbar at a plurality of
floating pin biting positions.

2. The key of claim 1, wherein the crossbar and the key blades are oriented perpendicular to
one another.

3. The key of claim 2, wherein each of the plurality of floating pins is configured to be
operable to engage and adjust a position of a tumbling system of a corresponding lock to an
20 unlocked position.

4. The key of claim 1, wherein each of the plurality of floating pins has a height dimension
that is not equal to the height dimension of an adjacent floating pin.

5. The key of claim 1, wherein one of the blades defines a first plurality of bittings at a first
plurality of blade biting positions.

6. The key of claim 5, wherein the plurality of floating pin biting positions is aligned with
the first plurality of blade biting positions.

7. The key of claim 5, wherein a root depth of the first blade at each of the first plurality of blade biting positions is selected from the group consisting of 0.2 inches, 0.215 inches, 0.23 inches, 0.245 inches, 0.26 inches, 0.275 inches, 0.29 inches, 0.305 inches, 0.32 inches, and 0.335 inches, each within a tolerance of 0.002 inches.

5

8. The key of claim 5, wherein the second of the blades defines a second plurality of bittings at a second plurality of blade biting positions.

9. An apparatus comprising:

10 a cylindrical plug extending along an axial direction and including a keyway and a cavity on the circumferential outer surface of the plug;

the keyway including two blade slots, a floating pin slot, and a crossbar slot, each extending into the plug along the axial direction, the floating pin slot is connected to the cavity and is aligned with a central axial plane of the plug, and the blade slots are positioned on

15 opposite sides of the central axial plane, and the crossbar slot connects the blade slots and the floating pin slot; and

a tumbling system having a first portion positioned in the floating pin slot and a second portion positioned in the cavity, the tumbling system being operable between a locked position in which a contiguous section of the tumbling system is disposed on opposite sides of a shear line of the plug, and an unlocked position in which no contiguous section of the tumbling system is

20 disposed on opposing sides of a shear line of the plug; and
a positioning member protruding into the keyway, and configured to adjust the position of a floating pin on a key shank to a position in which the floating pin adjusts the tumbling system from a locked position to an unlocked position.

25

10. The apparatus of claim 9, wherein the plug further includes a second cavity connected to a first of the blade slots;

the apparatus further comprising a second tumbling system having a first portion positioned in the first blade slot and a second portion positioned in the second cavity;

30 the second tumbling system being operable between a locked position in which a contiguous section of the second tumbling system is disposed on opposing sides of a shear line of

the plug, and an unlocked position in which no contiguous section of the second tumbling system is disposed on opposing sides of a shear line of the plug; and

wherein the second tumbling system is configured to be in the unlocked position when in contact with a portion of a key blade having a first root depth, and is configured to be in the
5 locked position when in contact with a portion of a key blade having a second root depth.

11. The apparatus of claim 9, wherein each of the blade slots is parallel to the floating pin slot, and to one another, and wherein the crossbar slot is perpendicular to the floating pin slot.

10 12. A locking system comprising:

a key comprising:

a first blade, a second blade, and a connecting portion coupling the first and second blades in a spaced relationship defining a gap ; and

a plurality of rigid members slidingly coupled to the key and each of the plurality
15 of rigid members is movable in a direction perpendicular to a plane defined by the connecting portion, and at least a portion of each of the plurality of rigid members is positioned in the gap; and

a lock comprising:

a housing defining a substantially cylindrical cavity;

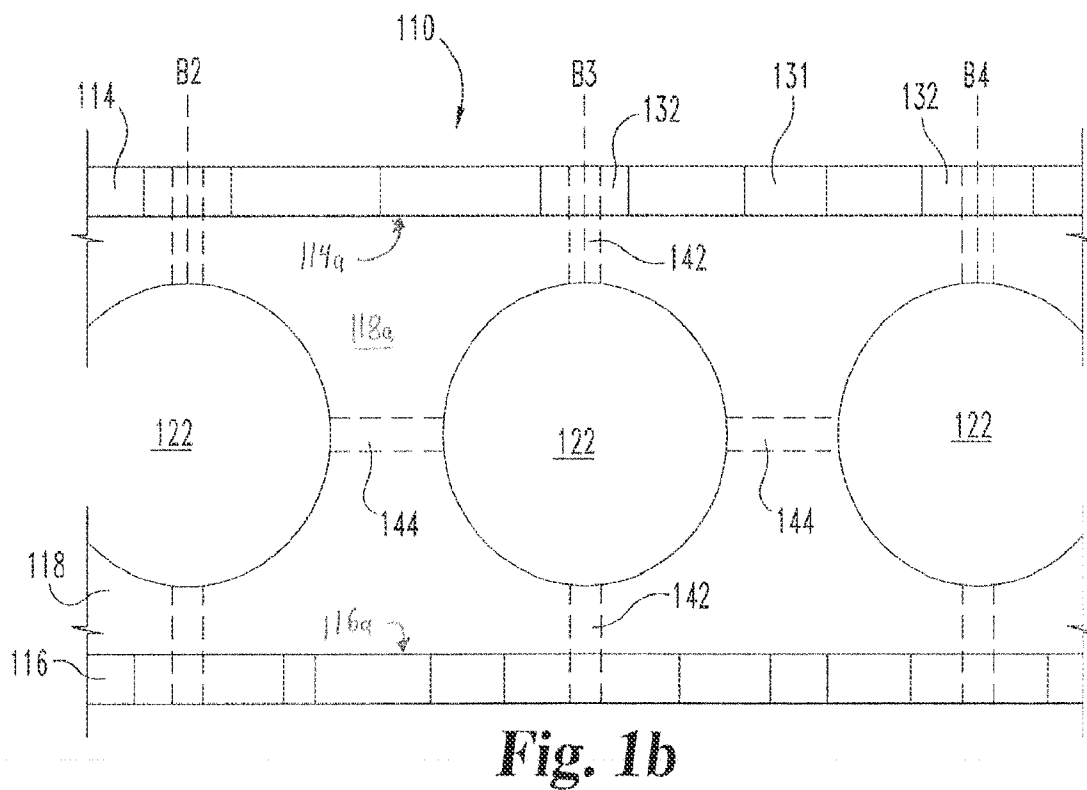
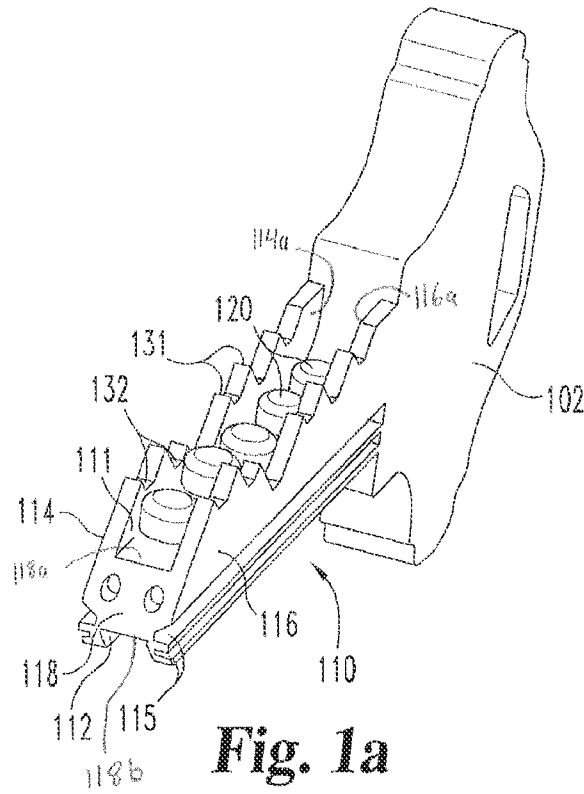
20 a plug positioned in the cavity, the plug including a passage configured to receive the key;

a plurality of tumblers, each tumbler being operable between a locked state in which the tumbler prevents rotation of the plug with respect to the housing and an
25 unlocked state in which the tumbler does not prevent rotation of the plug with respect to the housing; and

a plurality of protrusions in the passage, each of the plurality of protrusions configured to urge one of the rigid members into a position in which the rigid member urges one of the tumblers into the unlocked state.

30 13. The system of claim 12, wherein the first blade is configured to urge at least some of the tumblers into the unlocked state.

1/4



2/4

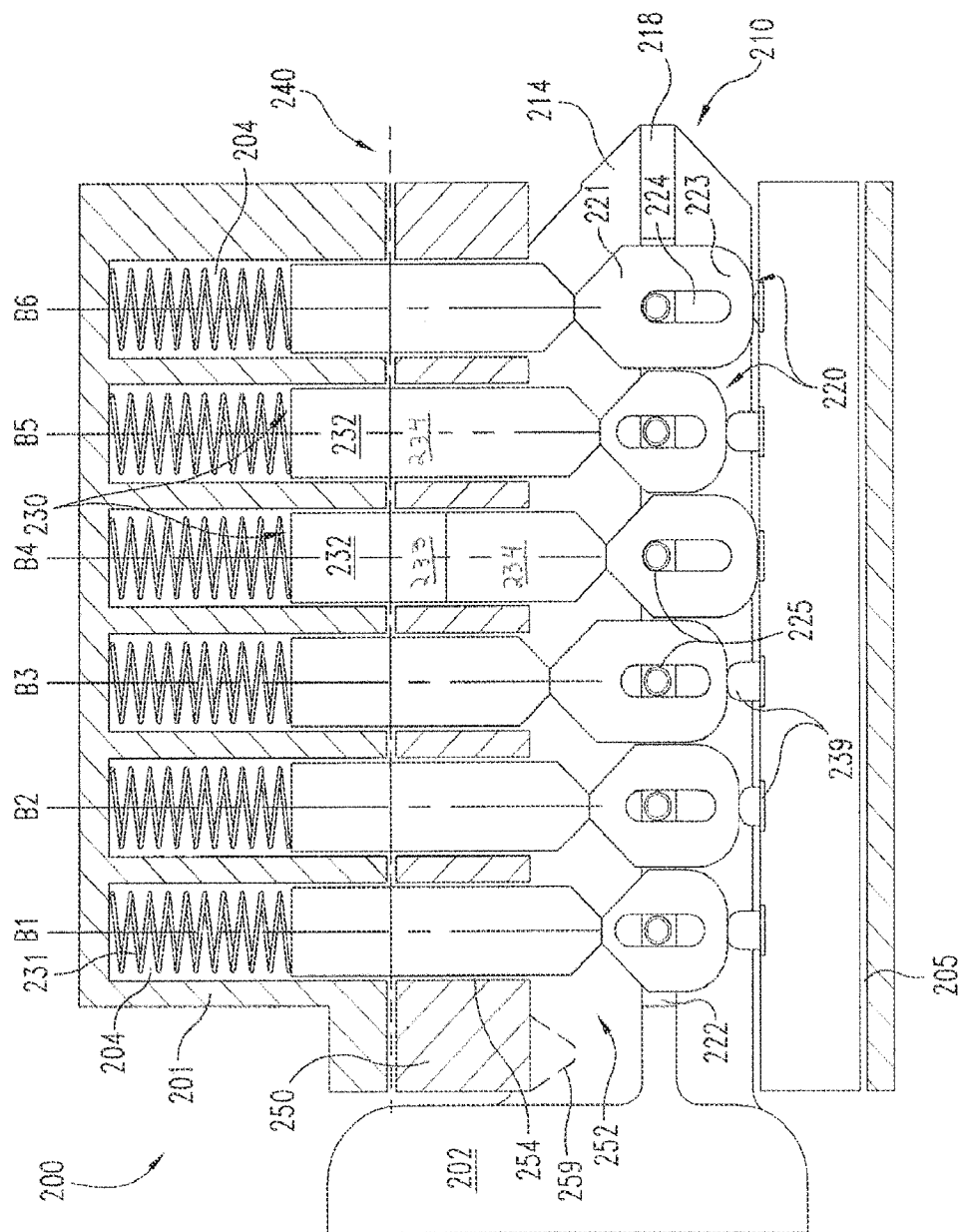


Fig. 2

3/4

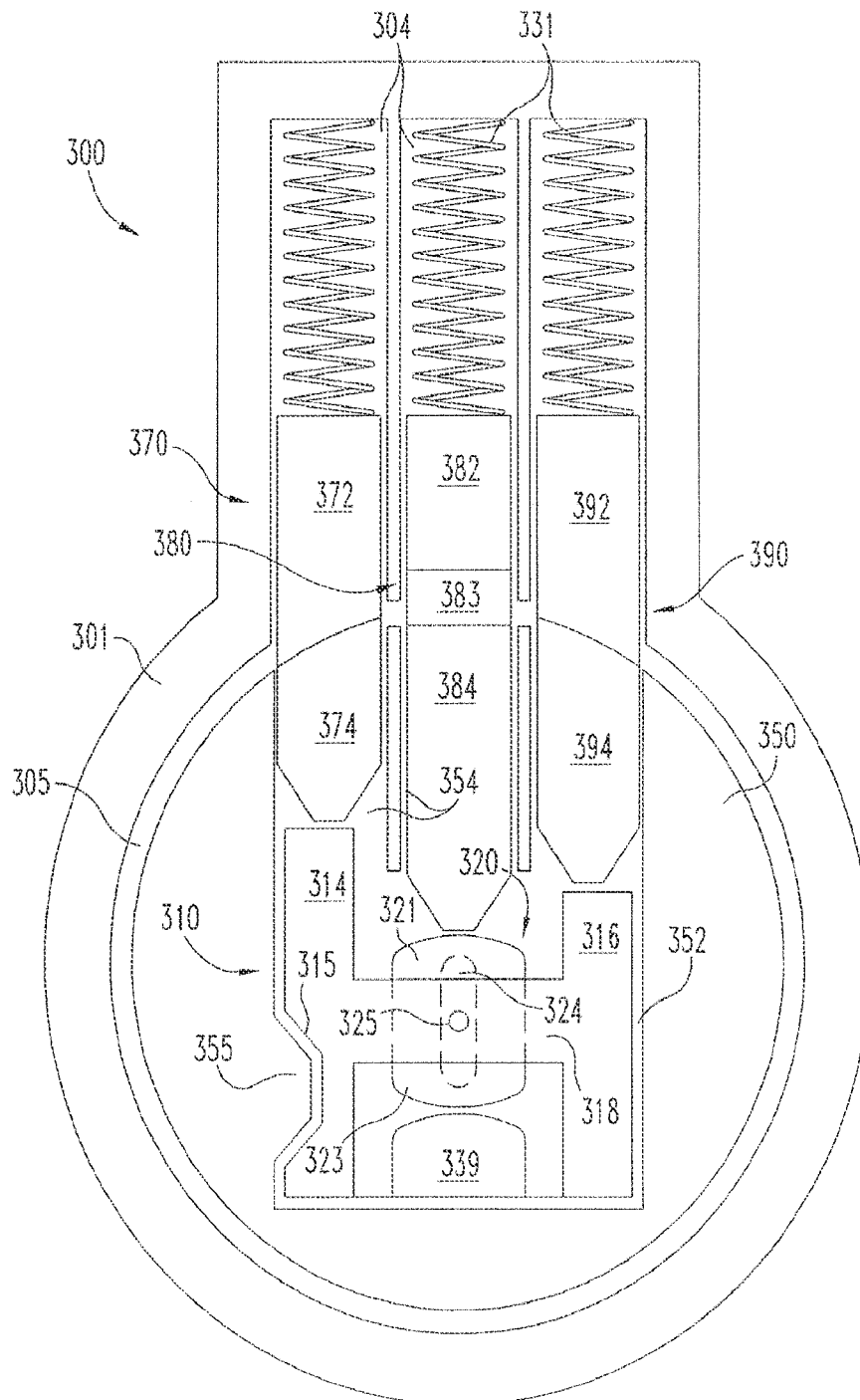


Fig. 3

4 / 4

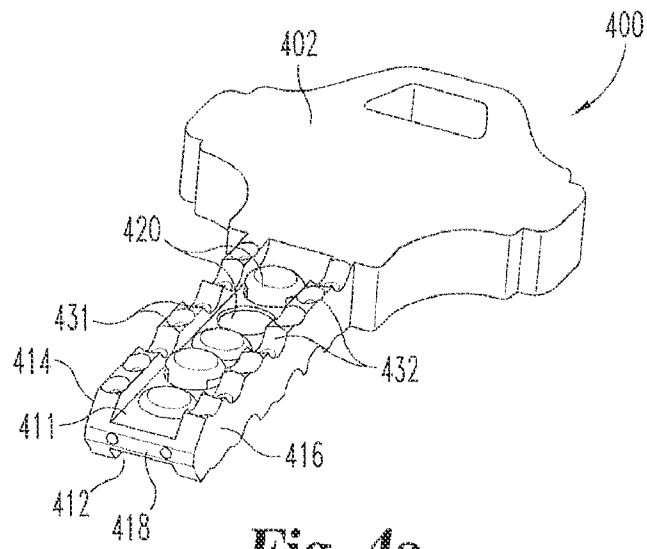


Fig. 4a

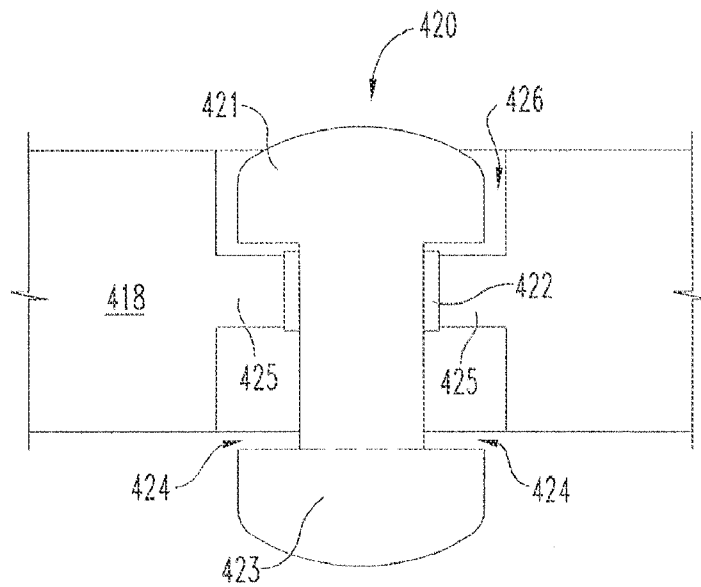


Fig. 4b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/040216

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - E05B 19/12 (2013.01) USPC - 70/401 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8) - E05B 19/007, 19/08, 19/14, 19/12, 19/18, 27/00, 27/02, 27/06, 27/10 (2013.01) USPC - 70/358, 360, 378, 395, 398, 401, 409, 492, 493 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched CPC - E05B 19/0017, 19/007, 19/14, 19/18, 35/003, 35/14 (2013.01) Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase, Google Patents		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,222,383 A (FANN et al) 29 June 1993 (29.06.1993) entire document	1-13
Y	US 5,520,035 A (EIZEN et al) 28 May 1996 (28.05.1996) entire document	1-13
A	US 4,603,565 A (STRASSMEIR) 05 August 1986 (05.08.1986) entire document	1-13
A	US 4,126,025 A (MIYAMAE) 21 November 1978 (25.11.1978) entire document	1-13
☐ Further documents are listed in the continuation of Box C. ☐		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 21 August 2013		Date of mailing of the international search report 09 SEP 2013
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774