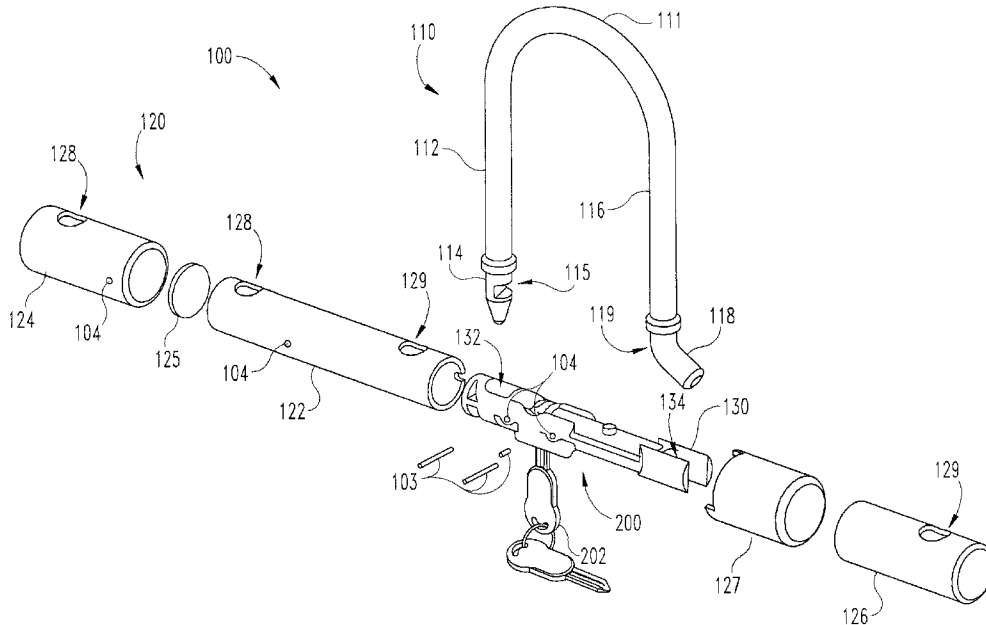




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(57) **Abrégé/Abstract:**

A hoop lock including a shackle, a crossbar, and a locking assembly operable to secure the shackle to the crossbar. The shackle may include a straight foot and a bent foot, and the locking assembly may engage the straight foot and the bent foot to secure the shackle to the crossbar.

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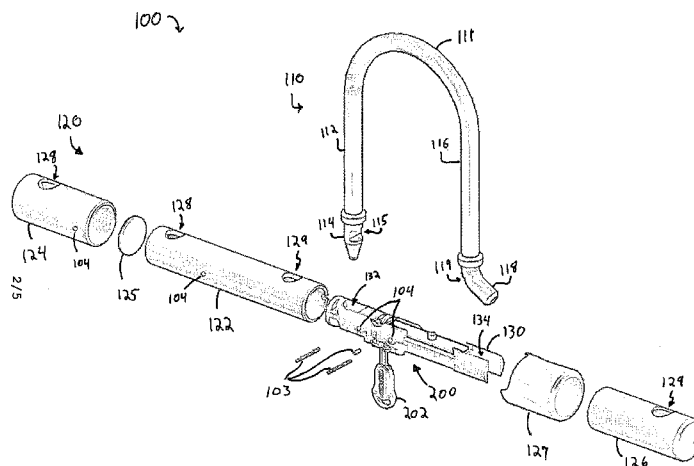


Fig. 2

(57) Abstract: A hoop lock including a shackle, a crossbar, and a locking assembly operable to secure the shackle to the crossbar. The shackle may include a straight foot and a bent foot, and the locking assembly may engage the straight foot and the bent foot to secure the shackle to the crossbar.

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## HOOP LOCK WITH DUAL LOCKING

[0001] TECHNICAL FIELD

[0002] The present invention generally relates to shackle locks, and more particularly, but not exclusively, to locks having a removable shackle.

### BACKGROUND

[0001] Shackle-type locks are commonly used to secure a portable object such as a bicycle to a stationary object such as a rack. Such locks are sometimes referred to as U-locks, hoop locks, or bicycle locks. Some locks of this type have certain limitations, such as those relating to resistance to tampering, attack, and high pull forces. Therefore, a need remains for further improvements in this technological field.

### SUMMARY

[0003] An exemplary hoop lock includes a shackle, a crossbar, and a locking assembly operable to secure the shackle to the crossbar. The shackle may include a straight foot and a bent foot, and the locking assembly may engage the straight foot and the bent foot to secure the shackle to the crossbar. Further embodiments, forms, features, aspects, benefits, and advantages of the present application shall become apparent from the description and figures provided herewith.

## BRIEF DESCRIPTION OF THE FIGURES

- [0004] FIG. 1 is an isometric view of a lock according to one embodiment.
- [0005] FIG. 2 is an exploded assembly view of the lock.
- [0006] FIG. 3 is an exploded assembly view of a locking subassembly according to one embodiment.
- [0007] FIG. 4 is a cross-sectional view of the lock in a locked state.
- [0008] FIG. 5 is an elevational view of the locking subassembly in the locked state.
- [0009] FIG. 6 is a cross-sectional view of the lock in an unlocked state.
- [0010] FIG. 7 is an elevational view of the locking subassembly in the unlocked state.

## DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

**[0011]** 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.

**[0012]** With reference to FIGS. 1 and 2, an exemplary lock 100 according to one embodiment includes a hoop or shackle 110 and a barrel or crossbar 120, which includes a housing 130 and a locking assembly 200. As described in further detail below, the shackle 110 and crossbar 120 are separable, and the locking assembly 200 is operable to selectively secure the crossbar 120 to the shackle 110. The lock 100 may be used to secure a first object 101 to a second object 102, for example to prevent theft or unauthorized separation of the objects 101, 102.

**[0013]** The shackle 110 includes an arcuate connecting portion 111 connecting a first leg 112 having a first foot 114 to a second leg 116 having a second foot 118. In the illustrated form, the legs 112, 116 are substantially parallel to one another, and the connecting portion 111 defines a semi-circle, such that the shackle 110 is substantially U-shaped. It is also contemplated that shackle 110 may be of another shape. By way of example, the connecting portion 111 may be substantially rectilinear.

**[0014]** The first foot 114 is substantially coaxial with the first leg 112, while the second foot 118 is angularly offset with respect to the second leg 116. As such, the first foot 114 may be considered a straight foot, and the second foot 118 may be considered an angled or bent foot. The first foot 114 includes a first notch 115, and the second foot 118 includes a second notch 119. As described in further detail below, the notches 115, 119 are engageable with the locking assembly 200 to selectively couple the shackle 110 to the crossbar 120. The shackle 110 may further include bumpers 117 adjacent the feet 114, 118.

**[0015]** The crossbar 120 includes a substantially cylindrical tube 122, and a sleeve 124 operable to receive a first end portion of the tube 122 such that an end cap 125 is retained on the first end of the tube 122. The crossbar 120 also includes a tube cover 126 operable to receive a second end portion of the tube 122, and may further include a dust cover 127. The tube 122 and sleeve

124 each include a first or proximal opening 128 operable to receive the first foot 114, and the tube 122 and tube cover 126 each include a second or distal opening 129 operable to receive the second foot 118. When assembled, the housing 130 and locking assembly 200 are retained within the tube 122 between the end cap 125 and the tube cover 126. During assembly, fasteners such as assembly pins 103 may be passed through openings 104 in the various elements of the crossbar 120 to secure the elements in their proper positions.

**[0016]** With additional reference to FIG. 3, the locking assembly 200 includes a lock cylinder 210, a cam 220 connected to the lock cylinder 210, a primary bolt 230 operable to engage the first or proximal foot 114, and a secondary bolt 240 operable to engage the second or distal foot 118. The housing 130 may include channels 136, 138 which receive at least a portion of the primary and secondary bolts 230, 240 to constrain motion of the bolts 230, 240 to a path substantially parallel to a longitudinal axis of the crossbar 120. As described in further detail below, the bolts 230, 240 are engaged with the cam 220 such that the bolts 230, 240 extend or retract in response to rotation of the cam 220.

**[0017]** The lock cylinder 210 includes a shell 212 coupled to the housing 130, and a spindle 214 which is rotatable with respect to the shell 212 upon insertion of a proper key 202. While the illustrated lock cylinder 210 is a rotary disc tumbler lock, it is also contemplated that other forms of lock cylinders, including those which utilize sliding wafers and/or pin tumblers, may be utilized. When assembled, the lock cylinder 210 is positioned in the housing 130 such that the keyway 215 thereof is aligned with openings 123 in the tube 122 and sleeve 124. The spindle 214 also includes a spindle extension 216 configured to engage the cam 220, such that when the proper key 202 is inserted and rotated, the spindle extension 216 rotates the cam 220.

**[0018]** While other configurations are contemplated, in the illustrated form, the lock cylinder 210 is offset from the longitudinal center of the crossbar 120, is positioned between the feet 114, 118, and is closer to the primary foot 114 than to the secondary foot 118. As such, the opening 123 in the tube 122 is also offset from the center of the crossbar 120, and is positioned longitudinally between and radially across from the openings 128, 129. Additionally, the keyway 215 is substantially parallel to a central axis of the opening 128, such that when the shackle 110 is coupled to the crossbar 120 and the key 202 is inserted, the shank of the key 202 is substantially parallel to the legs 112, 116. In embodiments which employ the dust cover 127, the dust cover 127 may also include an opening 123 which is selectively alignable with the

keyway 215, such that when the dust cover opening 123 is not aligned with the keyway 215, dirt and other contaminants are blocked from entering the keyway 215.

**[0019]** The cam 220 is configured to translate rotary motion of the spindle extension 216 to linear motion of the bolts 230, 240, and is rotationally coupled to the extension 216. For example, the cam 220 may include an opening 222 having a geometry corresponding to that of the extension 216. The cam 220 includes a projection or protrusion 223 operable to engage the primary bolt 230, and a cam arm 224 operable to engage the secondary bolt 240. The illustrated protrusion 223 is offset from a rotational axis 226 of the cam 220, and is provided in the form of an axial protrusion. In other words, the protrusion 220 extends in the direction of the rotational axis 226. Additionally, the illustrated cam arm 224 is a radial arm which extends away from the rotational axis 226 at least partially in the radial direction. As described in further detail below, rotation of the cam 220 in a first direction causes the bolts 230, 240 to retract toward unlocking positions, and rotation of the cam 220 in a second direction causes the bolts 230, 240 to extend toward locking positions.

**[0020]** The primary bolt 230 includes a channel 232 sized and configured to receive the cam protrusion 223, and an engagement end 234 operable to engage the first foot 114. More specifically, the engagement end 234 is configured to be received in the first notch 115, and may have a thickness corresponding to a width of the first notch 115. The primary bolt 230 may further include an undercut 236 having a depth corresponding to a width of the secondary bolt 240, such that a portion of the secondary bolt 240 may be positioned between the primary bolt 230 and the housing 130.

**[0021]** The secondary bolt 240 includes a post 242 operable to engage the cam arm 224, and an engagement end 244 operable to engage the second foot 118. More specifically, the engagement end 244 is configured to be received in the second notch 119, and may have a thickness corresponding to a width of the second notch 119. The secondary bolt 240 may further include an opening 246 and a pin 247 extending through the opening 246. A spring 248 may be positioned in a cavity 139 in the housing 130 and engaged with the pin 247 such that the secondary bolt 240 is biased toward the retracted or unlocking position.

**[0022]** With additional reference to FIGS. 4-7, operation of the exemplary hoop lock 100 will now be described. FIGS. 4 and 5 depict the lock 100 in the locked state, and FIGS. 6 and 7 depict the lock 100 in the unlocked state. More specifically, FIGS. 4 and 6 depict a cross-

sectional view of the lock 100, and FIGS. 5 and 7 depict an elevational view of the locking assembly 200.

**[0023]** With specific reference to FIGS. 4 and 5, when the lock 100 is in the locked state, the primary bolt 230 is engaged with the first foot 114, and the secondary bolt 240 is engaged with the second foot 118. More specifically, the primary bolt engagement end 234 is received in the first notch 115, and the secondary bolt engagement end 244 is received in the second notch 119. Engagement between the bolts 230, 240 and the feet 114, 118 securely couples the shackle 110 to the crossbar 120.

**[0024]** In the locked state, if a person were to cut the shackle 110, for example through one of the legs 112, 116 (see cut 109, FIG. 1), each of the feet 114, 118 would remain securely coupled to the crossbar 120. The notches 115, 119 and the bolts 230, 240 may be configured such that each of the legs 112, 116 is independently prevented from rotating about its longitudinal axis. In such forms, even if the shackle 110 is cut as described above, the connecting portion 111 cannot be pivoted to provide an opening through which one of the objects 101, 102 may pass.

**[0025]** The primary foot notch 115 has a first width, the secondary foot notch 119 has a second width, and each of the engagement ends 234, 244 has a thickness corresponding to the width of the notch 115, 119 in which the engagement end is received. The notch 119 in the angled foot 118 may have a lesser width than the notch 115 in the straight foot 114. For example, the angled foot 118 may be pre-stressed due to manufacturing processes, and providing the second notch 119 with a lesser width may improve the structural integrity of the angled foot 118 as compared to if the second notch 119 were to be provided with the same width as the first notch 115.

**[0026]** In the locked state, the cam protrusion 223 is positioned at an end of the primary bolt channel 232, and a radially outer surface of the cam arm 224 is engaged with the secondary bolt post 242. When no key is inserted in the lock cylinder 210, the spindle 214, and thus the cam 220, cannot be rotated. As such, the protrusion 223 and cam arm 224 retain the bolts 230, 240 in extended or locking positions, thereby deadlocking the bolts 230, 240. When a proper key 202 is used to rotate the spindle 214, the spindle extension 216 causes the cam 220 to rotate in an unlocking direction (counter-clockwise in FIG. 5). Rotation of the cam 220 causes the radially offset protrusion 223 to travel along an arcuate path 229, and causes the cam arm 224 to move away from the secondary bolt 240. As the protrusion 223 moves along the path 229, it slides

within the channel 232 and retracts the primary bolt 230. As the cam arm 224 moves away from the secondary bolt 240, the spring 248 urges the bolt 240 toward the retracted position.

**[0027]** With specific reference to FIGS. 6 and 7, when the key 202 is fully rotated, the lock 100 is in the unlocked state. In the unlocked state, the bolts 230, 240 are in retracted or unlocking positions, and are disengaged from the feet 112, 116 such that the shackle 110 can be removed from the crossbar 120. In the unlocked state, the cam protrusion 223 is positioned in the primary bolt channel 232 adjacent an edge of the primary bolt 230, and the post 242 abuts a side surface 225 of the cam arm 224. Additionally, the post 242 is positioned within the undercut 236 between the primary bolt 230 and the lock cylinder 210. In other words, when the locking assembly 200 is in the unlocked state, a portion of the primary bolt 230 overlaps a portion of the secondary bolt 240.

**[0028]** When the key 202 is subsequently rotated to transition the locking assembly 200 to the locked state, the cam protrusion 223 travels along the arcuate path 229 in the direction opposite that which it travels during the unlocking operation (clockwise in FIG. 7), and the cam arm 224 rotates toward the second foot 118. As the protrusion 223 moves along the arcuate path 229, it slides within the channel 232 and extends the primary bolt 230, thereby moving the engagement end 234 into the first notch 115. The engagement end 234 may include a tapered surface or chamfer 235, for example to allow for some misalignment between the engagement end 234 and the notch 115.

**[0029]** As the cam arm 224 rotates toward the second foot 118, the cam arm 224 urges the secondary bolt 240 in the direction of extension, thereby moving the engagement end 244 into the second notch 119. The cam arm 224 may include a rounded corner to provide for a smoother transition as the post 242 travels along the outer surface of the cam 220. As the secondary bolt 240 extends, the spring 248 is compressed between the pin 247 and the side surface of the cavity 139. Additionally, the pin 247 may slide along the inner surface of the tube 122, thereby preventing the secondary bolt 240 from pivoting during extension or retraction. In other words, the pin 247 is positioned partially between the secondary bolt 240 and an inner surface of the tube 122, thereby preventing the secondary bolt 240 from moving toward the inner surface.

**[0030]** As can be seen from the foregoing, the exemplary locking assembly 200 is operable in a locking state and an unlocking state. In the locking state, the bolts 230, 240 engage the feet 114, 118 to secure the shackle 110 to the crossbar 120. In the unlocking state, the bolts 230, 240 are

disengaged from the feet 114, 118, and the shackle 110 can be removed from the crossbar 120. Additionally, the state of the locking assembly 200 corresponds to the rotational position of the cam 220. In other words, the locking assembly 200 is operable in the locking state in response to a first rotational position of the cam 220, and is operable in the unlocking state in response to a second rotational position of the cam 220.

[0031] 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.

[0032] It should be understood that while the use of words such as preferable, preferably, 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 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.

## WHAT IS CLAIMED IS

1. A lock, comprising:

a shackle comprising a first leg including a first foot, and a second leg including a second foot, wherein one of the first and second feet is a straight foot and the other of the first and second feet is an angled foot, wherein the angled foot includes an offset portion that extends at an oblique angle relative to the straight foot, wherein the first foot includes a first notch, wherein the second foot includes a second notch, and wherein one of the first notch or the second notch is formed in the offset portion of the angled foot; and

a crossbar having openings configured to receive the first foot and the second foot, the crossbar including a locking assembly comprising:

a lock cylinder including a spindle which is rotatable upon insertion of a proper key;

a cam coupled to the spindle, wherein the cam is rotatable between a locking position and an unlocking position;

a first bolt engaged with the cam, wherein the first bolt is configured to engage the first foot when in a first extended position and to disengage from the first foot when in a first retracted position;

a second bolt engaged with the cam, wherein the second bolt is configured to engage the second foot when in a second extended position and to disengage from the second foot when in a second retracted position; and

a biasing member urging the second bolt from the second extended position toward the second retracted position;

wherein the cam is configured to drive the first bolt between the first extended position and the first retracted position when rotated between the locking position and the unlocking position;

wherein the cam is configured to drive the second bolt from the second retracted position to the second extended position when rotated from the unlocking position to the locking position;

wherein the biasing member is configured to drive the second bolt from the second extended position to the second retracted position when the cam is rotated from the locking position to the unlocking position;

wherein, with the bolts engaged with the feet, the shackle is secured to the crossbar; and

wherein, with the bolts disengaged from the feet, the shackle is removable from the crossbar.

2. A lock according to claim 1, wherein the lock cylinder is positioned between the first and second feet and is offset from a center location of the crossbar.

3. A lock according to claim 2, wherein the lock cylinder is nearer to the first foot than to the second foot.

4. A lock according to claim 3, further comprising a pin positioned at least partially between the second bolt and an inner surface of the crossbar, the pin preventing the second bolt from moving toward the inner surface.

5. A lock according to claim 4, wherein the pin is coupled to the second bolt, and wherein the biasing member is engaged with the pin and urges the second bolt away from the second foot.

6. A lock according to claim 5, wherein the first foot is the straight foot and the second foot is the angled foot; and

wherein the straight foot is axially aligned with the first leg and the angled foot is angularly offset with respect to the second leg;

wherein the straight foot includes the first notch and the angled foot includes the second notch; and

wherein a portion of the first bolt is received in the first notch when the first bolt is engaged with the straight foot, and a portion of the second bolt is received in the second notch when the second bolt is engaged with the angled foot.

7. A lock according to claim 6, wherein the first notch has a first width and the second notch has a second width less than the first width.

8. A lock according to claim 7, wherein the first bolt has a first thickness corresponding to the first width and the second bolt has a second thickness corresponding to the second width.

9. A lock according to claim 1, wherein with the bolts engaged with the feet, each of the legs is independently prevented from rotating.

10. A hoop lock, comprising:

a shackle including first and second substantially parallel legs, wherein the first leg includes a first foot aligned with the first leg, and the second leg includes a second foot angularly offset with respect to the second leg such that the second foot extends at an oblique angle relative to the first foot, wherein the first foot includes a first notch and the second foot includes a second notch;

a tube including a first opening configured to receive the first foot and a second opening configured to receive the second foot; and

a locking assembly positioned in the tube, the locking assembly comprising:

a lock cylinder including a spindle, wherein the spindle is rotatable in response to insertion of a proper key into the lock cylinder;

a cam rotationally coupled to the spindle, and including a radial arm and an axial protrusion, wherein the axial protrusion is radially offset from a rotational axis of the cam, and wherein the cam is asymmetric about the rotational axis;

a primary bolt including a channel, wherein the axial protrusion is received in the channel;

a secondary bolt including a post engaged with the radial arm; and

a biasing member urging the secondary bolt toward the cam;

wherein the locking assembly has a locking state in response to a first rotational position of the cam and an unlocking state in response to a second rotational position of the cam;

wherein, in the locking state, an engagement portion of the primary bolt is received in the first slot and an engagement portion of the secondary bolt is received in the second slot;

wherein, in the unlocking state, the engagement portions are not received in the slots;

wherein the secondary bolt has an extended position in the locking state and a retracted position in the unlocking state; and

wherein the biasing member urges the secondary bolt from the extended position toward the retracted position.

11. The hoop lock of claim 10, wherein in the unlocking state, the post is positioned between the primary bolt and the lock cylinder.

12. The hoop lock of claim 10, wherein the first notch has a first width, the second notch has a second width less than the first width, the primary bolt has a first thickness corresponding to the first width, and the secondary bolt has a second thickness corresponding to the second width.

13. A lock, comprising:

a shackle comprising a first leg including a straight foot, and a second leg including an angled foot, wherein the angled foot extends at an oblique angle relative to the straight foot, wherein the straight foot includes a first notch having a first width, and wherein the angled foot includes a second notch having a second width less than the first width; and

a crossbar selectively coupled to the shackle, wherein the crossbar comprises a tube having openings configured to receive the straight foot and the angled foot, wherein the crossbar further includes an asymmetric locking assembly positioned in the tube, and wherein the asymmetric locking assembly comprises:

a lock cylinder including a spindle which is rotatable upon insertion of a proper key, wherein the lock cylinder is seated in the tube and is nearer to the straight foot than to the angled foot;

a cam coupled to the spindle, the cam including a radial arm and an axial protrusion, wherein the axial protrusion is radially offset from a rotational axis of the cam, wherein the cam is asymmetric about the rotational axis;

a primary bolt including a channel in which the axial protrusion is received, wherein the primary bolt has a first length and a first thickness, and wherein the first thickness corresponds to the first width such that the first notch is operable to receive a first end portion of the primary bolt;

a secondary bolt including a post engaged with the arm, wherein the secondary bolt has a second length and a second thickness, wherein the second length is greater than the first length, and wherein the second thickness is less than the first thickness and corresponds to the second width such that the second notch is operable to receive a second end portion of the secondary bolt; and

a biasing member urging the secondary bolt away from the angled foot; wherein the cam is operable to rotate about the rotational axis between a locking position and an unlocking position;

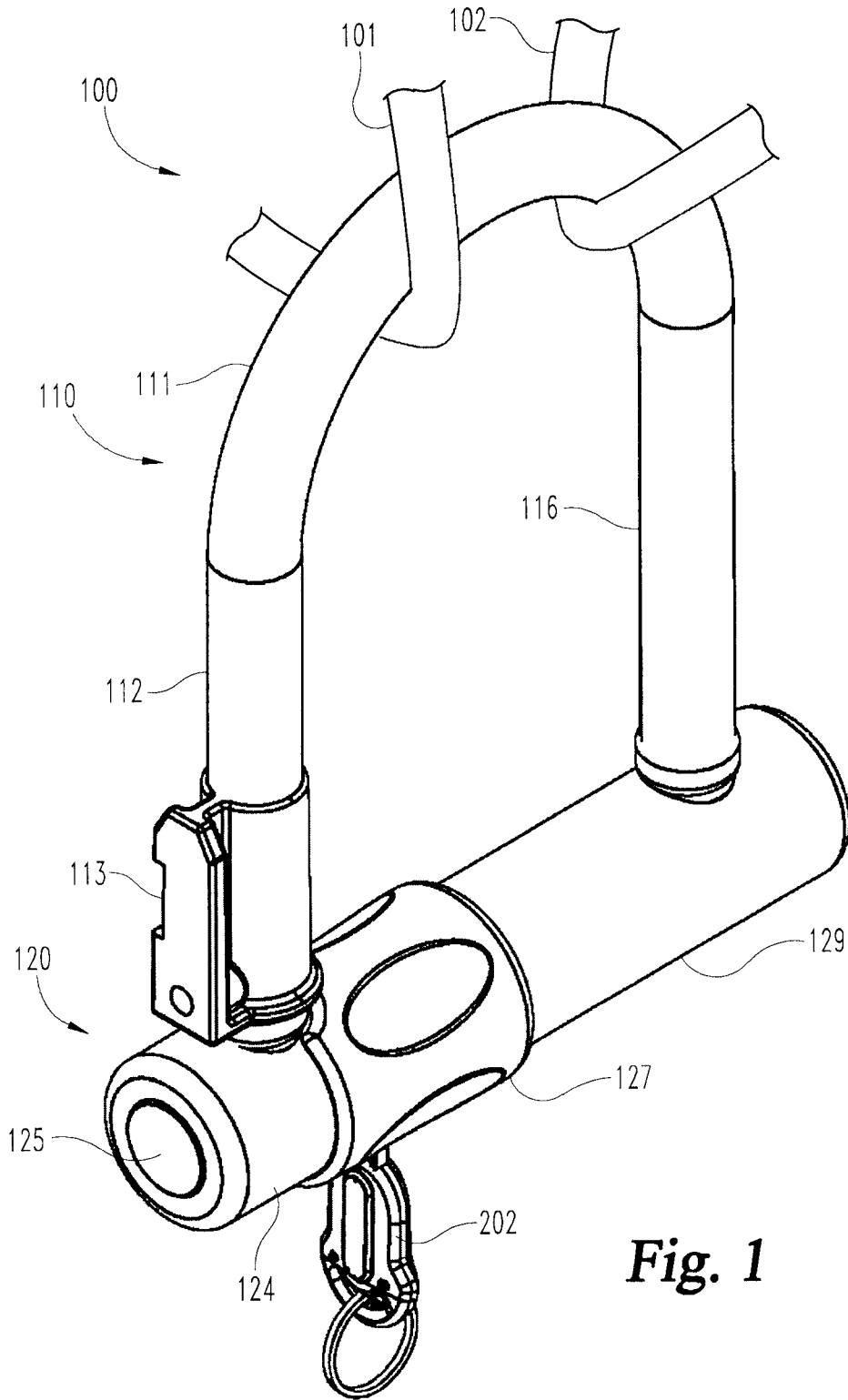
wherein the axial protrusion is configured to drive the primary bolt into engagement with the straight foot as the cam rotates from the unlocking position to the locking position, thereby causing the first end portion to enter the first notch;

wherein the axial protrusion is configured to drive the primary bolt out of engagement with the straight foot as the cam rotates from the locking position to the unlocking position, thereby causing the first end portion to exit the first notch;

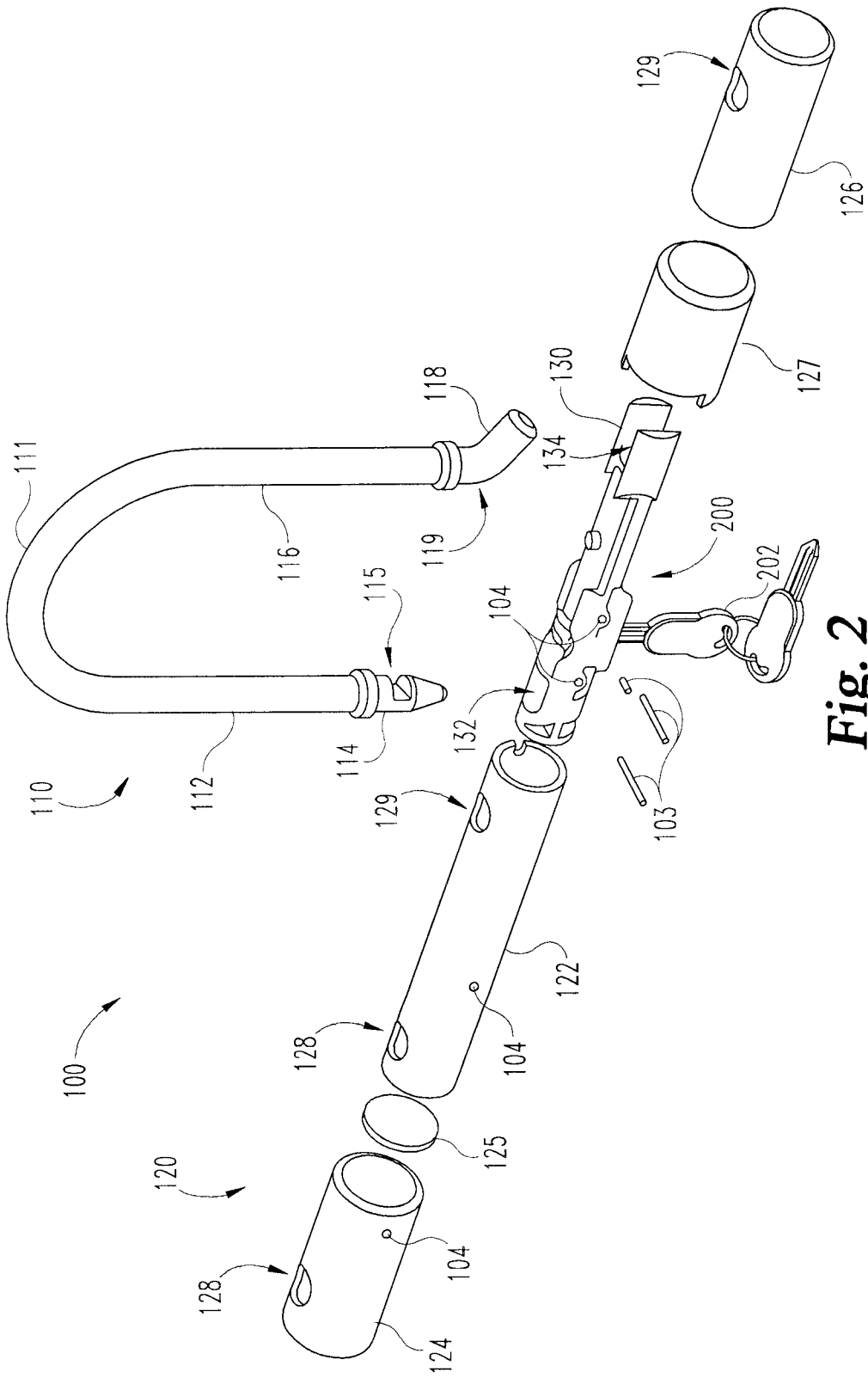
wherein the radial arm is configured to drive the secondary bolt into engagement with the angled foot as the cam rotates from the unlocking position to the locking position, thereby causing the second end portion to enter the second notch;

wherein the biasing member is configured to drive the secondary bolt out of engagement with the angled foot as the cam rotates from the locking position to the unlocking position, thereby causing the second end portion to exit the second notch.

14. The lock of claim 13, further comprising a pin positioned at least partially between the secondary bolt and an inner surface of the tube, wherein the pin is configured to prevent the secondary bolt from moving toward the inner surface.



**Fig. 1**



**Fig. 2**

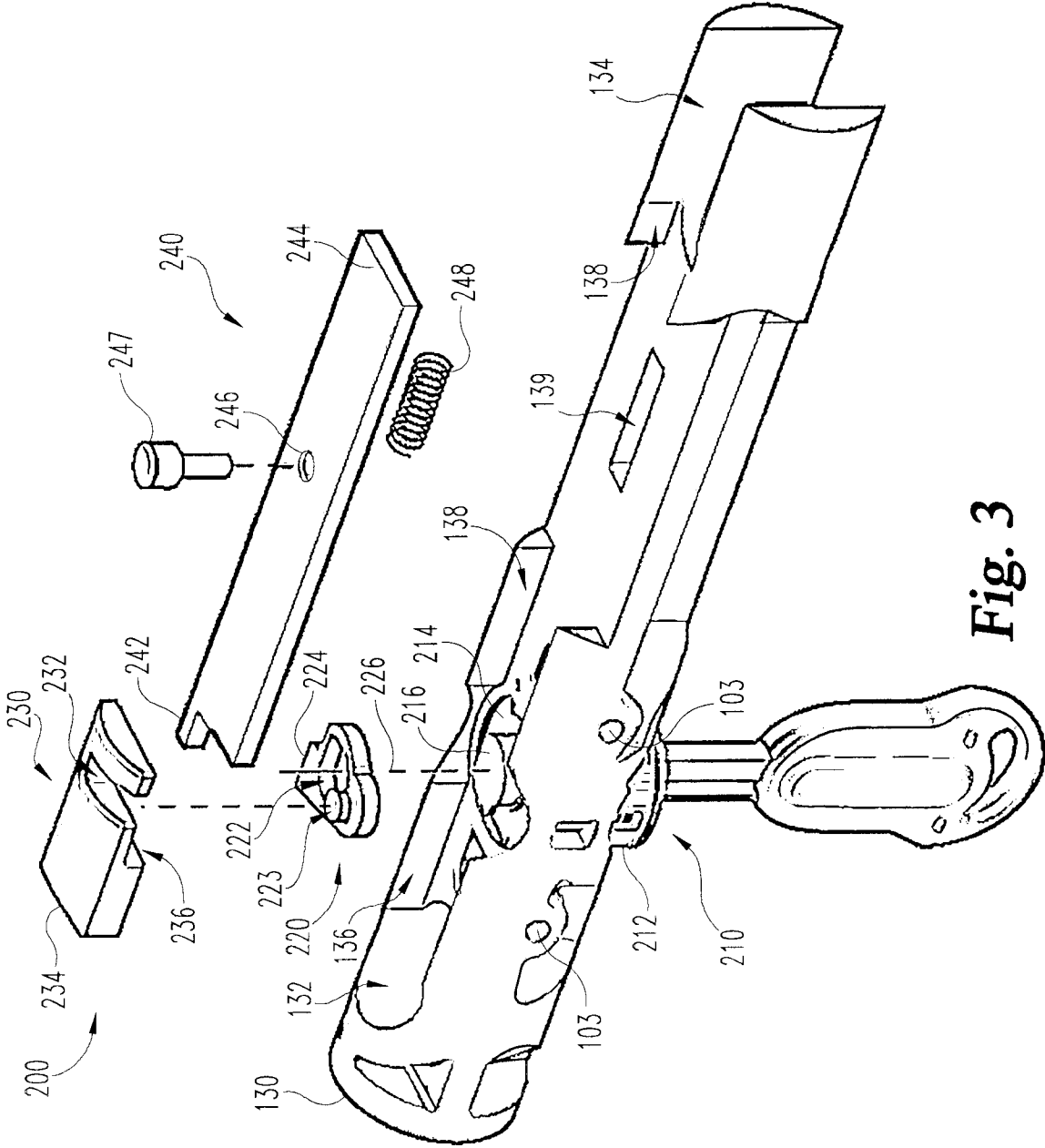
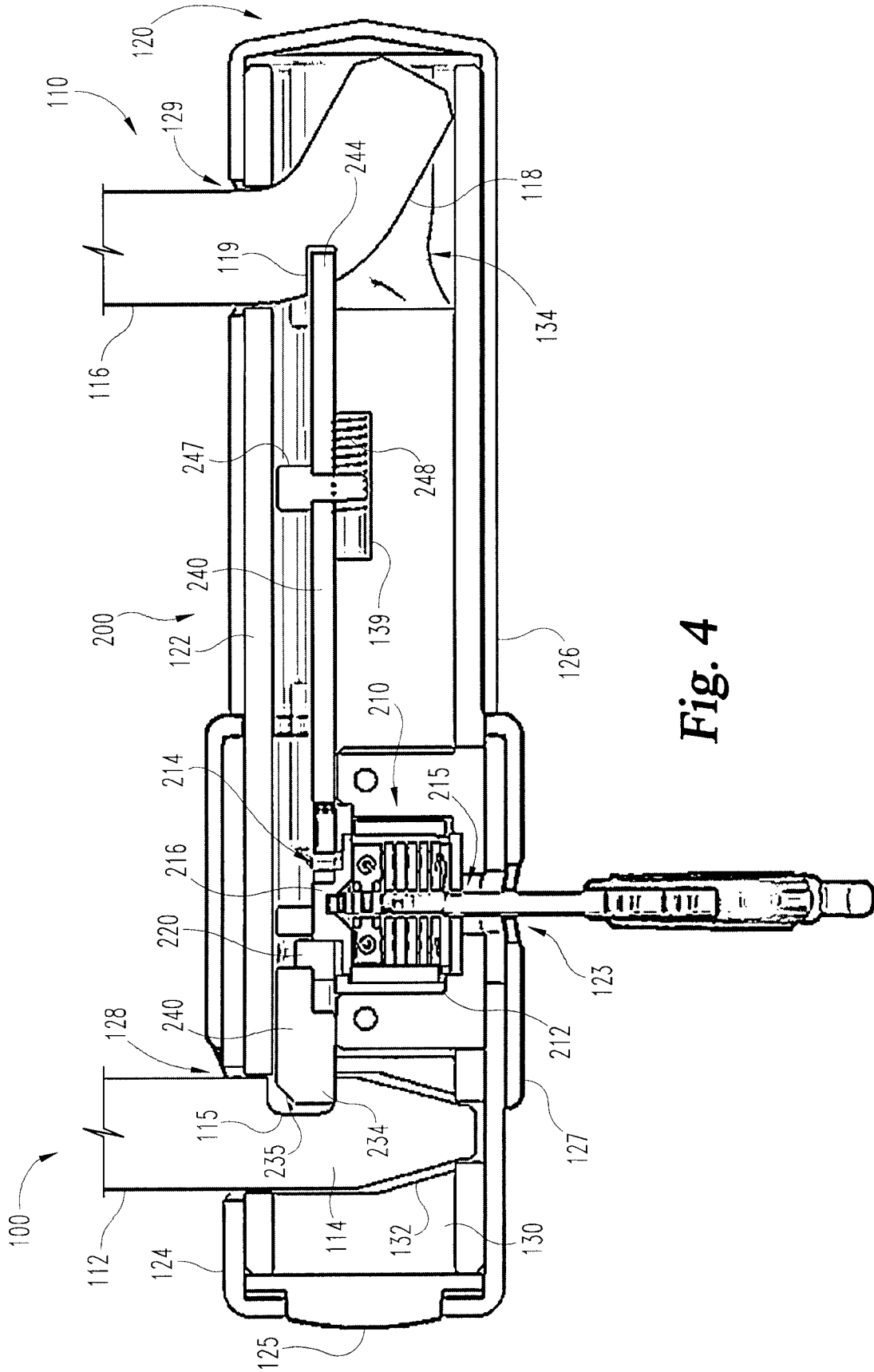
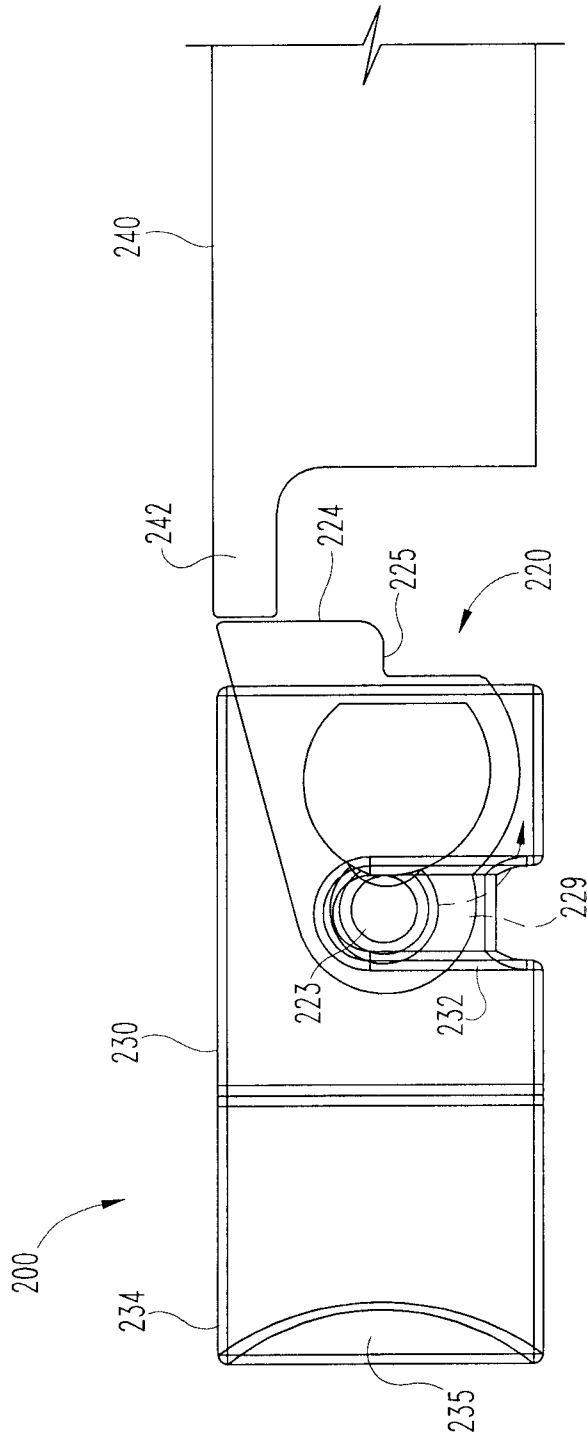


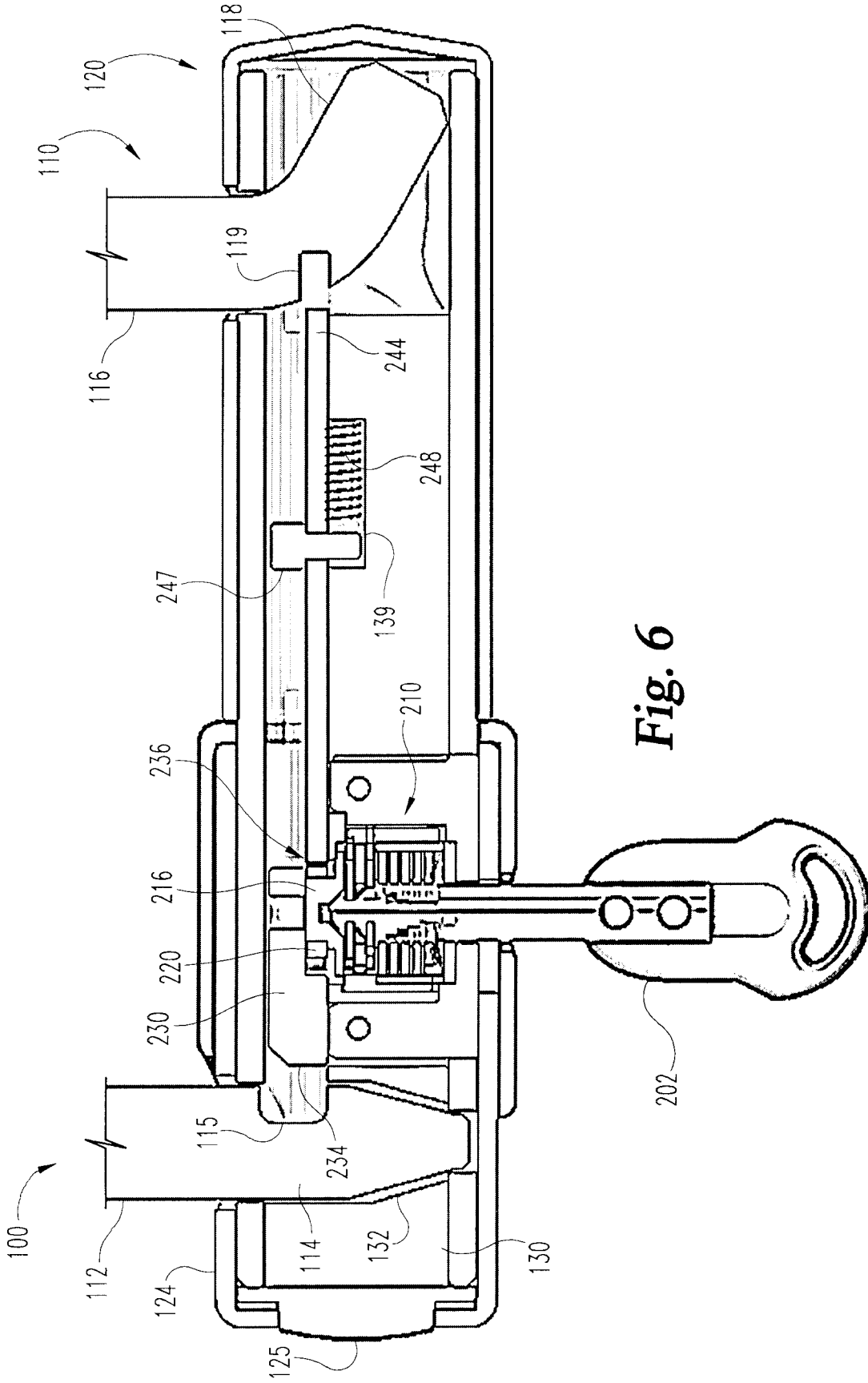
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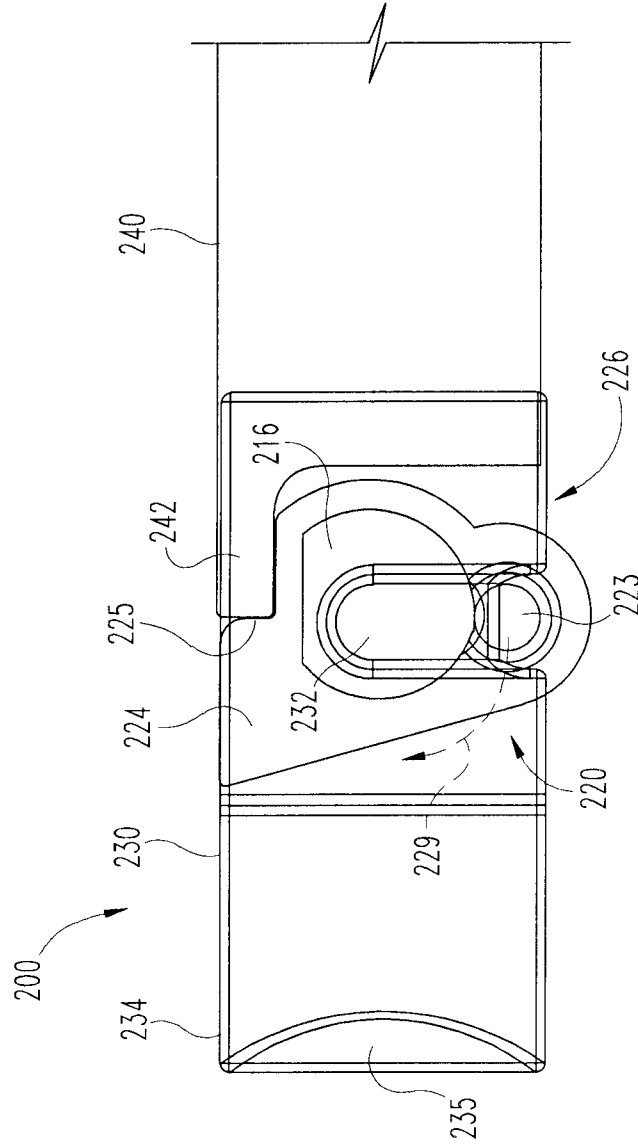
**Fig. 4**



**Fig. 5**



**Fig. 6**



**Fig. 7**

