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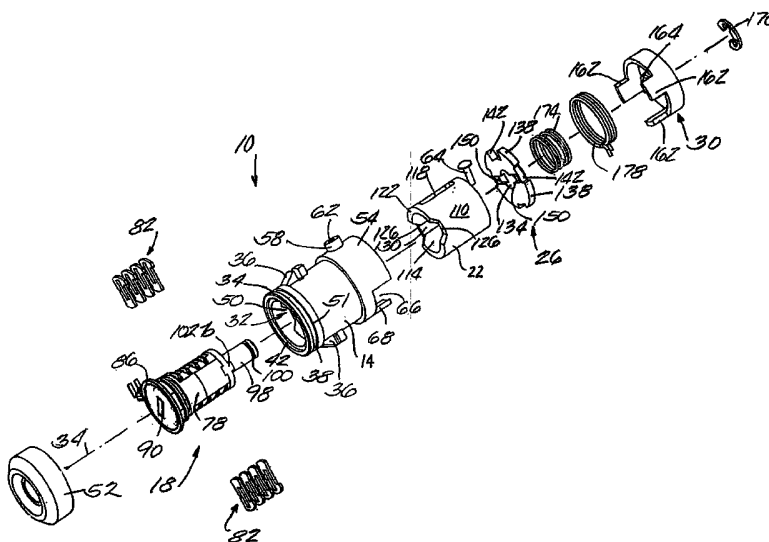
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(54) Title: **FREEWHEELING LOCK APPARATUS AND METHOD**



(57) Abstract: In some embodiments of the present invention, a freewheeling lock assembly is provided that includes a housing at least partially defining a cavity and having a central axis, an actuator rotatably coupled to the housing and substantially axially fixed with respect to the housing, a lock cylinder received within the cavity, having a locked configuration and an unlocked configuration, and rotatable with respect to the housing in both the locked and unlocked configurations, and a clutch having a sleeve and a disk that are received by the cavity and that selectively couple the lock cylinder and the actuator for rotation together in response to rotation of the lock cylinder in one of the locked and unlocked configurations. In some embodiments, the lock cylinder remains substantially axially stationary with respect to the housing when rotated.



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FREEWHEELING LOCK APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

5 A wide variety of keyed locks or locking mechanisms exist for preventing unauthorized or unwanted entry and/or use of various items and devices including without limitation vehicles, houses, drawers, doors, and the like. While conventional keyed locks and locking mechanisms are generally effective in preventing such unwanted entry and/or use, certain tools and methods have been devised to defeat or overcome the effectiveness of keyed locks in order to
10 forcefully gain entry to and/or use of the locked item.

One well-known manner of overcoming a lock is to pick the lock. Picking a lock requires a great deal of knowledge about the internal workings of the particular lock being picked, and is often relatively time consuming. In addition, locks are continually being improved to make the process of picking certain types
15 of locks extremely difficult, if not altogether impossible. Due to the inherent challenges of picking a lock, certain groups having primarily malicious intentions (most notably car thieves) have devised other commonly used methods for overcoming a lock. By inserting a rigid item (such as a screwdriver) into the lock instead of the appropriate key, and subsequently applying a sufficient torque to
20 that item, many locks can be overcome by force. Such locks typically fail in one of two manners when forced as just described. In a first failure mode, the internal components of the lock (e.g. the lock tumblers, the lock cylinder, and the like) are broken such that the lock cylinder can be rotated with respect to the lock housing. Generally, rotation of the lock cylinder is all that is required to defeat many locks.
25 In a second failure mode, the internal lock components remain intact while the lock housing itself breaks free of the structural item to which it is secured (e.g. a vehicle steering column or vehicle door). Oftentimes, dislodging the lock housing in this manner and rotating the entire lock assembly has the same effect as rotating the lock cylinder with respect to the housing, resulting in the lock being defeated.

30 In order to prevent the defeat of a lock by forcefully rotating the lock as just described, some lock designs employ strengthened lock components and strengthened connections between the lock and the object to which the lock is secured. However, these design changes have been largely unsuccessful because

the resulting locks are still subject to damage by attempts to overpower the lock, can often be overcome with even greater force, and are often excessively robust and expensive to manufacture and install. Furthermore, strengthening of the lock components can require a subsequent strengthening of the lock connection, which can then require additional strengthening of other lock components, resulting in a costly and on-going cycle of lock re-design.

Other attempts to protect keyed locks and locking mechanisms from being overpowered include the development of freewheeling locks. Freewheeling locks are constructed such that rotation of the lock cylinder with substantially any item other than the correct key inserted causes the lock cylinder to disengage from those lock components needed to unlock the lock (e.g., a lock drive mechanism). In this way, forced rotation of the lock cylinder does not result in unlocking or overcoming the lock.

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SUMMARY OF THE INVENTION

In an effort to improve upon known locks, some embodiments of the present invention provide a locking mechanism including a housing defining a cavity and a central axis and having a receiving end, a retaining end, and a first cam surface that is adjacent to the receiving end, and a sleeve received at least partially within the cavity and having a second cam surface engageable with the first cam surface of the housing, and a clutch surface. In such embodiments, a lock cylinder is received at least partially within the sleeve and has a locked configuration and an unlocked configuration. The lock cylinder and the sleeve are coupled for rotation together when the lock cylinder is in the locked configuration.

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Some embodiments of the present invention have a clutch member that is received at least partially within a housing cavity and is movable therein. The clutch member can be engaged with the lock cylinder for joint rotation when the lock cylinder is rotated in the unlocked configuration. When the lock cylinder is rotated in the locked configuration, the clutch member moves within the cavity and disengages the lock cylinder. An actuator is coupled to the clutch member such that the actuator rotates with the clutch member, and the actuator and the clutch member are axially movable with respect to each other.

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In addition, some embodiments of the present invention provide a lock assembly having a housing that at least partially defines a cavity and has a central axis, an actuator rotatably coupled to the housing and substantially axially fixed with respect to the housing, and a lock cylinder received at least partially within the cavity, having a locked configuration and an unlocked configuration, and rotatable with respect to the housing in both the locked and unlocked configurations. A clutch selectively couples the lock cylinder and the actuator for rotation together depending upon the configuration of the lock cylinder when the lock cylinder is rotated.

Other features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is further described with reference to the accompanying drawings, which show preferred embodiments of the present invention. However, it should be noted that the invention as disclosed in the accompanying drawings is illustrated by way of example only. The various elements and combinations of elements described below and illustrated in the drawings can be arranged and organized differently to result in embodiments which are still within the spirit and scope of the present invention.

Fig. 1 is a perspective view of a freewheeling lock mechanism according to an embodiment of the present invention;

Fig. 2 is a front exploded perspective view of the freewheeling lock mechanism of Fig. 1;

Fig. 3 is a rear exploded perspective view of the freewheeling lock mechanism of Fig. 1;

Fig. 4 is a cross-sectional view of the freewheeling lock mechanism of Fig. 1, taken along line 4-4 of Fig. 1;

Fig. 5 is a cross-sectional view of the freewheeling lock mechanism of Fig. 1, taken along line 5-5 of Fig. 7;

Fig. 6 is a perspective view of the freewheeling lock mechanism of Fig. 1, showing a portion of the freewheeling lock mechanism removed;

Fig. 7 is a perspective view of the freewheeling lock mechanism of Fig. 6, shown rotated in a locked condition;

Fig. 8 is a perspective view of the freewheeling lock mechanism of Fig. 6, shown partially rotated in an unlocked condition; and

5 Fig. 9 is a perspective view of the freewheeling lock mechanism of Fig. 6, shown fully rotated in an unlocked condition.

Before the various embodiments of the invention are described in detail, it is to be understood that the present invention is not limited in its application to the
10 details of construction and the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of
15 “including” and “comprising” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figs. 1-9 illustrate a locking mechanism 10 according to an embodiment of
20 the invention. With reference to Figs. 1-3, the locking mechanism 10 includes an outer housing 14, a lock cylinder 18 received within the housing 10, and a sleeve 22 also received with the housing 10 and surrounding at least a portion of the lock cylinder 18. The embodiment illustrated in Figs. 1-9 also includes an intermediate engagement member in the form of a clutch disk 26, and an actuator element 30.

25 The housing 14 provides a generally cylindrical, open-ended cavity 32 and defines a central axis 34. In this regard, the housing 14 can take any shape within which the lock cylinder 18 can be received, and in some embodiments (such as that shown in the figures) is generally round. The housing 14 can enclose any amount of the lock cylinder 18 desired, such as by surrounding the length of the
30 lock cylinder as shown in the figures.

The housing 14 can include outwardly extending mounting protrusions 36 that are securable to, among other things, a vehicle door or vehicle steering column that is to be lockably secured by the locking mechanism 10. The

mounting protrusions 36 can take a variety of different forms and are generally determined by the device or mechanism (e.g. a vehicle part or assembly) to which the locking mechanism 10 is to be secured.

5 A cylinder-receiving end 38 of the housing 14 includes an internal lip 42 in the housing 14 for limiting travel of the sleeve 22 toward the cylinder-receiving end 38 of the housing 14. In other embodiments, sleeve travel in this direction can be limited in any other manner desired, such as by one or more bosses, pins, neck portions, and other features of the housing 14 (as well as element attached to the housing 14), each of which falls within the spirit and scope of the present
10 invention.

For purposes that will be described in greater detail below, the housing 14 also includes a cam surface 46 extending radially into the cavity 32 and facing axially away from the receiving end 38. The cam surface 46 defines one or more axially extending cam projections 50 within the cavity 32. In some embodiments
15 of the invention, the cylinder-receiving end 38 further includes an outer groove 51 that is configured to engage an end cap 52 of the locking mechanism 10. The end cap 52 can be shaped to generally overlie and surround the cylinder-receiving end 38 of the housing 14 when engaged with the outer groove 51. Alternatively, the end cap 52 (where used) can be directly or indirectly attached to the housing 14 in
20 any other conventional manner.

Opposite the cylinder-receiving end 38 of the housing 14 is a retaining end 54. The retaining end 54 of the housing 14 can be the same size as the cylinder-receiving 38 end or can have any other size desired, and in some embodiments (such as that illustrated in the figures) is somewhat diametrically enlarged with
25 respect to the receiving end 38 of the housing 14.

For purposes that will be described below, the retaining end 54 of the housing 14 illustrated in the figures includes a radially outwardly extending boss 58 that surrounds a through hole 62 communicating with the cavity 32. The through hole 62 receives a pin 64 that extends radially into the cavity 32.
30 Although the boss 58 is not required, the boss 58 provides strength for the housing 14 adjacent to the pin 64. The retaining end 54 can also include one or more axially and circumferentially extending notches or cutouts 66 that define a return-spring reaction tab 68 on the housing 14.

The lock cylinder 18 is received within the cavity 32 and can take any conventional lock cylinder form. By way of example, the lock cylinder 18 in the illustrated embodiment includes a barrel portion 78 that houses a plurality of lock tumblers 82. Other types of tumbler or pin-type lock cylinders can be employed in conjunction with the present invention as desired. Although the lock cylinder 18 can have any shape, the lock cylinder 18 illustrated in the figures includes an end flange 86 that seats against the internal lip 42 in the housing 14 when the lock cylinder 18 is inserted into the cavity 32. The internal lip 42 assists in properly positioning the lock cylinder 18 with respect to the housing 14, and can be replaced with any number of other elements and structure capable of performing the same function (including those described above with reference to the internal lip 42).

At one end of the lock cylinder 18 is a key slot 90 that receives a key (not shown). When an appropriate key is inserted into the lock cylinder 18, the lock tumblers 82 engage the key and move within the barrel portion 78 to predetermined positions such that the lock cylinder 18 is placed in an unlocked state. If no key or an incorrect key is inserted into the lock cylinder 18, one or more of the lock tumblers 82 will be improperly positioned, and the lock cylinder 18 will remain in a locked state.

In some embodiments of the present invention, the lock cylinder 18 also includes a sidebar 94 that radially extends from the barrel portion 78 when the lock cylinder 18 is in the locked state. In such embodiments, the sidebar 94 can be operatively coupled to the lock tumblers 82 such that when the appropriate key is inserted and the lock tumblers 82 move to their predetermined positions, the sidebar 94 moves radially inwardly with respect to the barrel portion 78 to a retracted position corresponding to the unlocked state of the lock cylinder 18. In alternate embodiments of the present invention, such a sidebar is not employed. Instead, when the lock cylinder 18 is in the locked state, one or more of the tumblers 82 extend radially outwardly from the lock cylinder 18 to engage a housing or other adjacent element and to thereby prevent rotation of the lock cylinder 18. When an appropriate key is inserted into the lock cylinder 18, all of the tumblers are retracted into the barrel portion 78 to permit rotation of the lock cylinder 18. The specific operation of and interaction between the key and the

lock tumblers 82 (as well as between the lock tumblers 82 and the sidebar 94, where employed) are well known in the art and are therefore not discussed further herein. While one specific type of lock cylinder 18 is illustrated in the drawings, substantially any type of rotatable lock cylinder is suitable for use with the present invention.

The lock cylinder 18 in the illustrated embodiment also has an axially extending boss 98 (substantially aligned with the central axis 34 when the lock cylinder 18 is received within the cavity 32) that helps to maintain the position of the lock cylinder 18 in the locking mechanism 10. The boss 98 can have any shape desired, such as the generally cylindrical shape shown in the figures. With continued reference to the illustrated embodiment, one or more dogs 102 extend axially away from the barrel portion 78 and radially outwardly from the boss 98. As illustrated, two dogs 102a, 102b are provided at substantially diametrically opposed positions, one of which (102a) is substantially radially aligned with the sidebar 94. The dog 102a is configured to extend radially beyond the barrel portion 78 such that the dog 102a and the sidebar 94 extend from the barrel portion (substantially the same distance in the illustrated embodiment) when the lock cylinder 18 is in the locked condition and the sidebar 94 is extended. In some embodiments, the boss 98 includes a circumferential groove 100 extending around its distal end for receiving a clip 170 that retains the elements of the locking mechanism 10 in their proper relative positions.

The sleeve 22 in the illustrated embodiment is generally tubular and is received within the annular space formed between the housing 14 and the lock cylinder 18 when the lock cylinder 18 is inserted into the cavity 32. An outer surface 110 of the sleeve 22 faces the housing 14, and an inner surface 114 of the sleeve 22 faces the barrel portion 78 of the lock cylinder 18. The sleeve 22 has at least one aperture or recess 118 within which tumblers 82 of the lock cylinder 18 can be received. The sleeve 22 can have a single aperture or recess 118 in those embodiments of the present invention having one set of tumblers 82 located in one circumferential position in the lock cylinder 18. Alternatively, the sleeve 22 can have multiple apertures or recesses 118, such as where multiple sets of tumblers 82 are located in different circumferential locations in the lock cylinder 18. For

example, the sleeve 22 in the illustrated embodiment has two diametrically opposed elongated slots 118 corresponding to two sets of tumblers 82.

5 The apertures or recesses 118 in the sleeve 22 can have substantially any shape and can be positioned substantially anywhere along the sleeve 22. In some embodiments of the invention, the apertures or recesses 118 may be excluded altogether. The shape and positioning of the apertures or recesses 118 is largely dependent upon the configuration of the lock cylinder 18. By way of example only, the sleeve 22 in the illustrated embodiment has two axially elongated slots 118 for receiving the lock tumblers 82 that extend beyond the barrel portion 78
10 when the lock cylinder 18 is in the locked state. When the tumblers 82 are extended into the elongated slots 118, the tumblers 82 prevent rotation of the lock cylinder 18 with respect to the sleeve 22. The axially elongated slots 118 can also perform drainage functions for the locking mechanism 10.

One end of the sleeve 22 includes a generally annular cam surface 122 that
15 engages the cam surface 46 of the housing 14. The cam surface 122 provides one or more axial cam recesses 126 that are configured to receive one or more cam projections 50 of the housing 14. The other end of the sleeve 22 includes a generally annular clutch-engaging surface 128 that slidably engages the clutch disk 26, depending upon the state (e.g. locked or unlocked) of the lock cylinder
20 18. As will be described further below, the "clutch" portion of the lock mechanism is provided by the sleeve 22 and the disk 26, which selectively drivingly or slidably engage one another.

For those embodiments of the present invention employing a sidebar 94 as described above, the sleeve 22 can also include an aperture or recess 130 for
25 receiving the sidebar 94. As with the apertures or recesses 118 of the sleeve 22, the aperture or recess 130 for the sidebar 94 can have any shape and location suitable for receiving the sidebar 94. In the illustrated embodiment for example, the aperture or recess 130 is an axially extending groove 130 recessed with respect to the inner surface 114 for receiving the sidebar 94 when the sidebar 94 is
30 extended. In some preferred embodiments of the invention, the engagement between the sidebar 94 and the aperture or recess 130 alleviates the need for engagement between the tumblers 82 and the apertures or recesses 118. In this respect, some embodiments of the invention can include tumblers 82 that do not

extend from the lock cylinder 18 regardless of the condition (e.g. locked or unlocked) of the lock cylinder 18.

5 With continued reference to the illustrated embodiment of the present invention, the overall length of the sleeve 22 is selected such that when the end flange 86 of the lock cylinder 18 is engaged with the internal lip 42 of the housing 14, the cam projections 50 are aligned with and received by the cam recesses 126, and the dogs 102a, 102b of the lock cylinder 18 extend axially beyond the clutch-engaging surface 128 toward the retaining end 54 of the housing 14 (see Fig. 4).

10 The engagement member or clutch disk 26 can have any shape desired, dependent at least partially upon the shape and position of the boss 98 and the sleeve 22. With reference to Figs. 2 and 3 for example, the engagement member or clutch disk 26 is generally round, is received by the retaining end 54 of the housing 14 and includes a central aperture 134 that receives the boss 98 of the lock cylinder 18. The clutch disk 26 can include two or more (e.g. four as
15 illustrated) radially extending protrusions 138 that define substantially equally angularly spaced apart cutouts or notches 142 therebetween. In some embodiments, one side of the clutch disk 26 includes a substantially annular protrusion 146 that surrounds the central aperture 134, while the other side of the clutch disk 26 includes one or more axial recesses 150 that extend radially
20 outwardly from the central aperture 134. In the illustrated embodiment for example, the clutch disk 26 includes two recesses 150 that are substantially diametrically opposed to each other (although other numbers and arrangements of such recesses 150 are possible depending at least in part upon the number and arrangement of the dogs 102a, 102b on the lock cylinder 18). The recesses 150
25 are adapted and configured to receive the dogs 102a, 102b of the lock cylinder 18, such that rotational movement of the lock cylinder 18 is transmitted to the clutch disk 26 due to driving engagement between the dogs 102a, 102b, and the recesses 150.

30 The actuator element 30 can perform a single function or can perform two or more functions. For example, the actuator element 30 can be employed to retain elements of the locking mechanism 10 in place, can be employed to connect the locking mechanism 10 to the device controlled thereby, and/or can be employed to assist in properly positioning the lock cylinder 18 within the locking

mechanism 10. In the illustrated embodiment, the actuator element 30 has at least some portion that is received by the retaining end 54 of the housing 14 and includes a central aperture 154 that receives the boss 98 of the lock cylinder 18. The actuator element 30 can include an end wall 158 that defines the end of the locking mechanism 10.

The actuator element 30 can also include one or more (e.g. three as illustrated) angularly spaced-apart dogs or projections 162 that extend axially inwardly with respect to the cavity 32, as well as a protrusion 164 (e.g., an annular projection as shown in the figures) that also extends axially inwardly with respect to the cavity 32. The axial dogs or projections 162 can take any shape desired, including rod-shaped or bar-shaped elements extending from the actuator element 30. However, in some embodiment such as that shown in the figures, the axial dogs or projections 162 are shaped to match features of the clutch disk 26 with which they mate.

If employed, the protrusion 164 can surround any part or all of the aperture 154. Also if employed, the projections 162 can be shaped and arranged to extend into the notches 142 formed in the clutch disk 26 such that rotational movement of the clutch disk 26 (e.g. in response to rotational movement of the lock cylinder 18 and driving engagement of the dogs 102a, 102b and the recesses 150) imparts rotational movement to the actuator element 30 due to driving engagement between the projections 162 and the clutch protrusions 138. For reasons that will become apparent below, at least one of the notches 142 in the clutch disk 26 is not engaged or otherwise occupied by the projections 162.

The lock mechanism 10 can be connected to a latch or other mechanism to be locked by a number of different elements and structure on the lock mechanism 10. By way of example only, the lock mechanism 10 in the illustrated embodiment has a lock output tab 166 extending from the actuator element 30. More specifically, the actuator element 30 in this embodiment includes a lock output tab 166 extending axially and radially away from the end wall 158. The lock output tab 166 can be connected to, among other things, a latching device or an ignition switch for a vehicle such that rotational movement of the actuator element 30 moves the lock output tab 166 and locks/unlocks a connected device. As an alternative to a lock output tab 166, the actuator element 30 can have an

actuator shaft extending axially from the actuator element 30, substantially aligned with the central axis 34 of the locking mechanism 10 and coupled to a vehicle ignition, door latch, or other mechanism for locking and unlocking the mechanism by rotation of the actuator shaft. In still other embodiments, the actuator element
5 30 can have one or more apertures, bosses, flanges, fingers, or other connecting points to which one or more cables, rods, levers, or other elements can be connected for transmitting motion from the locking mechanism 10 to a device connected thereto.

The above-described lock output tab 166, axially extending shaft, and
10 alternative connecting points of the actuator element 30 are only a small number of examples of lock output mechanisms. Many elements and mechanisms for transmitting rotational movement of the lock mechanism to rotational, translational, and other types of movement for actuation of various devices (e.g. door latches and vehicle ignitions) are well known to those skilled in the art. Each
15 of these actuating elements and devices can be used in combination with the teachings of the present invention and fall within the spirit and scope of the present invention. The use of the locking mechanism 10 in a vehicle and/or for locking and unlocking a door latch is merely exemplary. Many other uses and applications for the locking mechanism 10 according to the present invention
20 would be contemplated by those of skill in the art.

As mentioned above, the end of the boss 98 extending away from the barrel portion 78 of the lock cylinder 18 has a circumferential groove 100 for receiving a clip 170. In this regard, when the locking mechanism illustrated in the figures is assembled (see Figs. 4 and 5), a portion of the lock cylinder boss 98
25 extends beyond the end wall 158 of the actuator element 30 such that the circumferential groove 100 in the end of the boss 98 is exposed. The retaining element 170 (e.g., a C or E-clip, a retaining ring, and the like) is positioned in the circumferential groove 100 to secure the components of the locking mechanism 10 within the housing 14. In other embodiments of the present invention, the boss 98
30 (or at least the end thereof) can be threaded so that a nut or other conventional fastener can be used in place of or in addition to the retaining element 170. In still other embodiments, the actuator element 30 is retained in place with respect to the housing 14 and the other elements of the locking mechanism 10 by one or more

inter-engaging lips and grooves (e.g., a circumferential groove in the housing 14 within which a flange, lip, rib, or other circumferential protrusion of the actuator element 30 extends, and the like). Still other manners of connection between the actuator element 30 and the lock cylinder 18 are possible, each permitting relative rotation between the actuator element 30 and the housing 14 and each falling within the spirit and scope of the present invention.

In some embodiments of the present invention such as that shown in the figures, it is desirable to bias the clutch disk 26 toward the sleeve 22. A number of different spring elements in a number of different locations can be employed for this purpose. In the illustrated embodiment for example, the locking mechanism 10 includes a biasing element in the form of a helical compression spring 174 located between the clutch disk 26 and the actuator element 30. In other embodiments, other types of spring elements can be employed, such as leaf springs, resilient bushings, Belleville washers, and the like. The spring 174 in the illustrated embodiment surrounds and receives the annular protrusions 146, 164, although such protrusions are not required to bias the clutch disk 26 as described above. The spring 174 is compressed between the clutch disk 26 and the actuator element 30 such that a biasing force is applied to the clutch disk 26, thereby biasing the clutch disk recesses 150 into engagement with the lock cylinder dogs 102a, 102b. In addition to biasing the clutch disk 26 into engagement with the lock cylinder 18, the spring 174 can also provide a biasing force between the lock cylinder 18 and the actuator element 30, thereby reducing the amount of rattling that occurs between various lock components of the locking mechanism 10.

In addition to the compression spring 174, another biasing element can also be provided to bias the lock cylinder 18 and/or the actuator element 30 toward a predetermined angular orientation with respect to the housing 14. For example, a torsion spring 178 can be connected to the housing 14 and to the actuator element 30 or clutch disk 26 to bias the actuator element 30, clutch disk 26, and lock cylinder 18 toward an unactuated position. In the illustrated embodiment, the torsion spring 178 engages the reaction tab 68 on the housing 14 and at least one of the projections 162 of the actuator element 30 in such a way that rotation of the actuator element 30 with respect to the housing 14 creates an angular biasing force in the torsional spring 178. The biasing force acts against

rotation of the actuator element 30 and urges the actuator element 30 back toward its original angular position. One having ordinary skill in the art will appreciate that other types of springs and spring elements can be employed to urge the actuator element 30 and/or lock cylinder 18 to an unactuated position with respect to the housing 14, and that such springs and spring elements can be connected to provide this biasing force in a number of different manners, each one of which falls within the spirit and scope of the present invention. For example, some embodiments of the invention can include a single spring that functions as the compression spring 174 and the torsion spring 178.

In some embodiments, it is desirable to limit movement of the actuator element 30 in the unlocked state of the locking mechanism 10 and/or to limit movement of the clutch disk 26 in the locked state after the dogs 102a, 102b of the lock cylinder 18 are disengaged from the clutch disk 26. In the embodiment shown in Figs. 1-9, the pin 64 of the locking mechanism 10 provides this limit. The through hole 62 (see Figs 4 and 5) in the housing, and therefore the pin 64, is positioned such that when the lock cylinder 18 has not been rotated, the pin 64 is substantially angularly aligned with one of the notches 142 in the clutch disk 26 (see Fig. 6). Specifically, the pin 64 is radially aligned with the notch 142 that is not engaged or occupied by the axial projections 162 of the actuator element 30. In addition, the pin 64 is axially offset from the clutch disk 26 toward the retaining end 54 of the housing 14.

If the lock cylinder 18 is rotated with the proper key inserted, the actuator element 30 will rotate until one of the actuator element projections 162 engages the pin 64, thereby preventing further rotation of the actuator element 30 and lock cylinder 18 (see Fig. 9). The pin 64 and projection 162 are configured to allow sufficient rotation of the actuator element 30 (e.g. through the angle Ω) such that the device to which the actuator element 30 is coupled (e.g. a door latch, a vehicle ignition switch, and the like) can be effectively actuated. As will be described in greater detail below, if the lock cylinder 18 is rotated without the proper key inserted, the clutch disk 26 is axially moved until the pin 64 is received within a notch 142 of the clutch disk to prevent frictional engagement of the sleeve 22 and clutch disk 26 from turning the clutch disk 26 (or at least to limit the rotation of the clutch disk 26).

Given the arrangement and configuration of the various components described above, the locking mechanism 10 provides free rotation of the lock cylinder 18 within the housing 14 when an attempt to rotate the lock cylinder 18 is made using substantially any item other than the appropriate key (e.g. the wrong key, a screwdriver, or the like). As used herein, "free rotation" of the lock cylinder 18 means that rotation of the lock cylinder 18 does not impart significant rotational movement to the actuator element 30 or otherwise imparts insufficient rotational movement to the actuator element 30 to fully actuate the device connected to the locking mechanism 10. By restricting the amount of rotational movement transmitted from the lock cylinder 18 to the actuator element 30 to a relatively small angle (e.g. the angle α of Fig. 7, which is significantly smaller than the angle Ω of Fig. 9), operation of the device or mechanism to which the actuator element 30 is coupled is precluded. Of course, if the appropriate key is inserted into the lock cylinder 18, rotation of the lock cylinder 18 results in less restricted rotation (and in some embodiments, unrestricted rotation) of the actuator element until such time as the actuator element projection 162 engages the pin 64. Accordingly, by using the appropriate key, the locking mechanism 10 is fully operational to lock/unlock or activate/deactivate the associated device or mechanism to which the actuator element 30 is coupled.

With continued reference to the embodiment of the present invention illustrated in Figs. 1-8, when substantially any item other than the appropriate key is used to rotate the lock cylinder 18, the lock cylinder 18 remains in the locked condition such that the sidebar 94 remains extended and projects into the groove 130 in the sleeve 22 (see Figs. 4 and 5). As such, the lock cylinder 18 and the sleeve 22 are substantially rotatably fixed to each other. In alternative embodiments, the tumblers 82 may also or alternatively extend from the lock cylinder 18 and project into the slots 118 to rotatably fix the lock cylinder 18 to the sleeve 22. In response to coupled rotation of the lock cylinder 18 and the sleeve 22 together, the cam projections 50 in the housing 14 and the cam recesses 126 in the sleeve 22 engage each other and urge the sleeve 22 axially toward the retaining end 54 of the housing 14.

As the sleeve 22 moves axially along the housing 14, the clutch-engaging surface 128 of the sleeve 22 engages the clutch disk 26 such that the clutch disk

26 is urged against the biasing force of the compression spring 174 axially toward the retaining end 54 of the housing 14. As the clutch disk 26 moves axially in this manner, the clutch recesses 150 become disengaged from the dogs 102a, 102b. At this time, the lock cylinder 18 and the clutch disk 26 are no longer drivingly coupled for rotation together. In addition, movement of the sleeve 22 as described above brings the sleeve groove 130 over the radially extending drive dog 102a, thereby bringing the sleeve groove 130 and drive dog 102a into driving relationship. Substantially simultaneously, and also due to axial movement of the clutch disk 26, the clutch disk notch 142 that is not occupied by one of the actuating element projections 162 receives the pin 64.

The angle of rotation of the clutch disk 26 (and therefore, of the actuator element 30 in its locked state) can vary widely depending at least in part upon the size of the notch 142 and the radial clutch protrusions 138. Similarly, the angle of rotation of the actuator element 30 in its unlocked state can vary widely depending at least in part upon the distance between the pin 64 and the axial projection 162 that limits movement of the actuator element 30. In some embodiments, the angle of rotation of the clutch disk 26 in the locked state of the locking mechanism 10 is less than about 30 degrees. In other embodiments, this angle is about 15 degrees or less.

Once the clutch protrusion 138 engages the pin 64 in the locked state of the locking mechanism 10, further rotation of the clutch disk 26 is prevented. During axial movement of the clutch disk 26 in some embodiments, the clutch notches 142 and the axial projections 162 of the actuator element 30 slide axially with respect to each other such that there is substantially no axial movement of the actuator element 30 with respect to the housing 14. The locking mechanism 10 and the device to which the mechanism 10 is attached are configured such that the small amount of actuator element rotation that occurs as the clutch disk 26 is disengaged from the lock cylinder 18 does not fully operate, actuate, or otherwise influence the state (e.g., locked or unlocked) of the device.

With continued reference to the embodiment illustrated in Figs. 1-9, as the lock cylinder 18 and the sleeve 22 continue to rotate together, the cam recesses 126 disengage the cam projections 50, and the clutch recesses 150 disengage the dogs 102a, 102b (see Fig. 5). Also, the clutch disk 26 and the actuator element 30

remain substantially stationary (both axially and rotationally) with respect to the housing 14 due to engagement between the clutch disk 26 and the pin 64 while the clutch-engaging surface 128 slidably engages the clutch disk 26. In the illustrated embodiment having two cam recesses 126 and two cam projections 50, once the lock cylinder 18 and the sleeve 22 have been rotated approximately 180 degrees, the cam recesses 126 and cam projections 50 are once again aligned (albeit with an opposite cam recess 126 and cam projection 50) and the biasing force of the compression spring 174 urges the clutch disk 26 and the sleeve 22 axially toward the cylinder-receiving end 38 of the housing 14, thereby re-engaging the cam recesses 126 with the cam projections 50, and the clutch recesses 150 with the lock cylinder dogs 102a, 102b. Still further rotation of the lock cylinder 18 in a forceful manner repeats the disengagement/re-engagement cycle. Accordingly, the lock cylinder 18 can be continuously rotated by an improper key or other object without imparting significant rotational force to the actuator element 30, tumblers 82, or sidebar 94, thereby preventing alteration of or damage to the locking mechanism 10 and preventing the device connected thereto from becoming unlocked. Regardless of whether the lock cylinder 18 is rotated in the locked or unlocked condition, the lock cylinder 18 remains substantially axially fixed with respect to the housing.

In other embodiments of the present invention in which fewer or more apertures or recesses 118, 130 are provided in the sleeve 22, the lock cylinder 18 can be rotated different amounts before being re-engaged with the housing 14 in a manner similar to that described above. For example, in embodiments having a single set of tumblers 82 and a single elongated aperture 118 in the sleeve 22, the lock cylinder 18 can be rotated approximately 360 degrees to become re-engaged with the sleeve 22.

In some embodiments, if the lock cylinder 18 is forcibly rotated when in the locked condition through a sufficient angle to result in axial translation of the sleeve 22, but not so far as to allow the lock cylinder dogs 102a, 102b to re-engage with the clutch recesses 150, engagement between the radially extending cylinder dog 102a and the sidebar groove 130 of the sleeve 26 facilitates returning the lock to an operative mode using the appropriate key. Specifically, when the appropriate key is inserted into a partially rotated lock cylinder 18, the sidebar 94

and/or the tumblers 82 (depending upon the configuration of the lock cylinder 18) are retracted from the groove 130 and/or the elongated apertures 118, respectively, so that the sidebar 94 and/or the tumblers 82 no longer couple the sleeve 22 and the lock cylinder 18 for rotation together. With this in mind, the radially
5 extending dog 102a and the groove 130 are configured to couple the lock cylinder 18 and the sleeve 22 for rotation together when the sidebar 94 and/or the tumblers 82 are retracted. Thus, the lock cylinder 18 can be restored to a normal operating condition by rotating the lock cylinder 18 with the appropriate key fully inserted until such time as the cam projections 50 and the cam recesses 126 are again
10 aligned, the sleeve 22 snaps axially toward the receiving end 38 of the housing 14 (under influence of the spring 174), and the clutch disk 26 snaps axially toward the receiving end 38 of the housing as the dogs 102a, 102b are once again received within the clutch recesses 150.

During normal operation of the embodiment illustrated in Figs. 1-9, when
15 the appropriate key is inserted into the lock cylinder 18, the sidebar 94 (and/or the tumblers 82 if so configured) retracts into the barrel portion 78 of the lock cylinder 18 such that the lock cylinder 18 and the sleeve 22 are no longer coupled for rotation together. It will be appreciated that for locks that do not include a sidebar (e.g. "tumbler locks"), the tumblers fully retract within the barrel portion
20 78 of the lock cylinder 18 to decouple the lock cylinder 18 from the sleeve 22.

When the lock cylinder 18 is subsequently rotated, the sleeve 22 remains substantially stationary with respect to the housing 14. As such, there is substantially no axial movement of the sleeve 22 or the clutch disk 26, and the clutch recesses 150 remain engaged with the lock cylinder dogs 102a, 102b. In
25 addition, because the radial clutch disk protrusions 138 do not engage the pin 64, the clutch disk 26 is free to rotate with respect to the housing 14. Thus, as the lock cylinder 18 is rotated, the clutch disk 26 and the actuator element 30 are also rotated due to the engagement between the dogs 102a, 102b and the recesses 150 as well as the engagement between the clutch disk notches 142 and the actuator
30 element projections 162. Rotation of the actuator element 30 through a sufficient angle results in operation of the device to which the actuator element is coupled (e.g., actuation of the device to a locked or unlocked state). Once the lock cylinder 18 has been sufficiently rotated, the torsional spring 178 (if employed)

returns the lock cylinder 18 to its original angular orientation with respect to the housing 14. Regardless of whether the lock cylinder 18 is rotated with the appropriate key inserted or not, the lock cylinder 18 can remain substantially axially fixed with respect to the housing 14.

5 In addition to preventing forceful turning of the lock cylinder 18 by inserting an object into the key slot 90, the locking mechanism 10 also prevents substantial rotation of the actuator element 30 by grasping, pulling, or otherwise directly manipulating the actuator element 30. For example, if the locking mechanism 10 is installed in a vehicle door, attempts to overcome the lock may be made by inserting a thin piece of metal including a small hook (often referred to as a “slim-jim”) between the outer door housing and the door glass. The hook is then engaged with the lock output tab 166 in an effort to move the lock output tab 166 sufficiently to unlock the vehicle door. If such an attempt to overcome the locking mechanism 10 is made, the lock output tab 166 will only be movable through the relatively small angle α such that unlocking of the door is substantially prevented. Specifically, as the actuator element 30 is rotated, the driving engagement between the projections 162 and the clutch protrusions 138 causes the clutch disk 26 to rotate with respect to the housing 14. Also, the driving engagement between the clutch recesses 150 and the dogs 102a, 102b impart rotation to the lock cylinder 18 which in turn imparts rotation to the sleeve 22 due to the engagement between the sidebar 94 (which remains extended) and the groove 130. As discussed above, rotation of the sleeve 22 with respect to the housing 14 causes the sleeve 22 and the clutch disk 26 to move axially toward the retaining end 54. Such axial movement of the clutch disk 26 causes one of the radial clutch disk protrusions 138 to engage the pin 64, thereby preventing further rotation of the clutch disk 26. Because the clutch disk 26 and the actuator element 30 are substantially always coupled for rotation together, preventing further rotation of the clutch disk 26 prevents further rotation of the actuator element 30. As such, once the actuator element 30 is rotated through the relatively small angle α , further rotation of the actuator element 30 (which would result in unlocking of the door) is substantially prevented.

The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the

concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention as set forth in the appended claims. For
5 example, a number of alternatives exist to the use of a pin 64 and housing through-hole 62 for limiting rotation of the clutch disk 26 and/or the actuator element 30. In some embodiments, the housing 14 can be provided with one or more internal projections, fingers, bosses, or other features that are integral with the housing 14 or are otherwise secured to the housing 14 and that perform the
10 same or similar functions as the pin 64.

Furthermore, the housing 14 can be constructed of two or more elements or portions, such as a receiving end 38 and a retaining end 54 connected together in any conventional manner. Such a two-piece housing 14 can be configured to receive a pin as described above, can include integrally formed radially inwardly
15 extending projections on one or both of the ends 38, 54, can include other types of projections (e.g. axial projections formed on the retaining end 54) that engage the clutch disk 26 and/or the actuator element 30 upon axial movement of the clutch disk 26 to prevent rotation thereof, and the like.

The dogs 102a, 102b in the illustrated embodiment are located at an end of
20 the barrel portion 78 of the lock cylinder 18, and are spaced on opposite sides of the boss 98 extending from the barrel portion 78. It should be noted, however, that other elements and features of the lock cylinder 18 could be employed to selectively drivably engage the clutch disk 26 as described above. The bar-shaped dogs 102a, 102b illustrated in Figs. 3 and 4 can be replaced by one or more
25 elements having any shape that mates with one or more recesses in the clutch plate 26. By way of example only, the bar-shaped dogs 102a, 102b can be replaced by one or pins axially extending from the barrel portion 78 of the lock cylinder 18 into apertures in the clutch disk 26, one or more flanges or ribs that extend radially from the clutch disk 26 and that can be received within axially-extending recesses,
30 grooves, or other apertures in the end of the barrel portion 78 of the lock cylinder 18, and the like. Any other engaging or mating elements on the lock cylinder 18 and clutch disk 26 can be employed for enabling the lock cylinder 18 to be

releasably engaged with the clutch disk 26 for selectively transmitting rotational force from the lock cylinder 18 to the clutch disk 26.

Although the elements of the lock cylinder 18 can have the same shape as recesses in the clutch disk 26, such correspondence is not required to practice the present invention. In still other embodiments, the lock cylinder 18 and clutch disk 26 have sufficient frictional engagement between one another that additional features or elements intended for transmitting rotational force to the clutch disk 26 are not necessary. It should also be noted that element(s) on the lock cylinder 18 for transmitting rotary force to the clutch disk 26 need not necessarily be located at the end of the barrel portion 78 of the lock cylinder 18, but can instead extend from or otherwise be located on the boss 98 of the lock cylinder 18.

It will be appreciated by one having ordinary skill in the art that a number of elements in the present invention can have significantly different shapes and structure while still performing the same or similar functions as those described above. Such elements fall within the spirit and scope of the present invention. For example, the sleeve 22 of the locking mechanism 10 need not necessarily surround the lock cylinder 18 as described above and illustrated in the figures. Instead, the lock cylinder 18 can be any body or frame that can transmit axial force to the clutch disk 26 as described above, that has a cam surface as also described above, and that can transmit rotational force from the tumblers 82 and sidebar 94 to the cam recesses 126 for generating disengagement from the housing 14. As used herein and in the appended claims, the term "sleeve" refers to all such elements capable of functioning in this manner.

The cam recesses 126 of the sleeve 22 and the cam projections 50 of the housing 14 provide camming action that generates disengagement of the sleeve 22 from the housing 14 when sufficient torque is exerted upon the sleeve 22. In this regard, any cam surface on the sleeve 22 and any cooperating cam surface on the housing 14 can be selected to cause axial separation of these elements in reaction to such torque. Specifically, cam recesses and cam projections can be located on the housing 14 and sleeve 22, respectively. In addition, the cam surfaces can be stepped, curved, ramped, or can take any shape capable of producing the axial displacement just described. If desired, multiple cam surfaces (e.g., multiple

recesses, projections, steps, ramps, and the like) can be employed about the sleeve 22 and the inside of the housing 14 for the same purpose.

CLAIMS

What is claimed is:

1. A locking mechanism comprising:
a housing defining a cavity and having a central axis, the housing
5 including a receiving end, a retaining end, and a first cam surface adjacent the
receiving end;
a sleeve received at least partially within the cavity and including a
second cam surface engageable with the first cam surface, and a clutch surface;
a lock cylinder received at least partially within the sleeve and
10 having a locked configuration and an unlocked configuration, the lock cylinder
and the sleeve being coupled for rotation together when the lock cylinder is in the
locked configuration;
a clutch member received at least partially within the cavity and
movable therein, the clutch member engaged with the lock cylinder for rotation
15 therewith when the lock cylinder is rotated in the unlocked configuration, the
clutch member movable within the cavity to a position disengaged from the lock
cylinder when the lock cylinder is rotated in the locked configuration; and
an actuator coupled to the clutch member for rotation therewith, the
actuator and the clutch member being axially movable with respect to each other.
20
2. The locking mechanism of claim 1, wherein the actuator is
substantially secured against axial movement with respect to the housing.
3. The locking mechanism of claim 1, wherein the clutch member is
25 axially slidable with respect to the actuator and engages the actuator for imparting
rotation thereto.
4. The locking mechanism of claim 1, wherein:
the lock cylinder includes a sidebar that is movable between an
30 extended position and a retracted position; and
the sidebar is movable to the retracted position in response to
insertion of an appropriate key into the lock cylinder.

5. The locking mechanism of claim 4, wherein the sleeve includes at least one of an axially extending groove and aperture substantially facing the lock cylinder and receiving the sidebar when the sidebar is in the extended position, thereby coupling the sleeve to the lock cylinder for rotation therewith.

5

6. The locking mechanism of claim 1, wherein the cam surfaces are movable in camming contact with one another to axially move the sleeve in the locked configuration of the lock cylinder.

10

7. The locking mechanism of claim 6, wherein the clutch is movable by the sleeve to a position in which the clutch member is disengaged from the lock cylinder and is engaged with the housing, the sleeve and lock cylinder rotatable with respect to the clutch and housing when the lock cylinder is engaged with the housing.

15

8. The locking mechanism of claim 1, wherein:
the clutch member includes an axially recessed portion and the lock cylinder includes an axially extending dog; and
the clutch member is movable to and from a position in which the axially recessed portion of the clutch member receives the dog and the lock cylinder is engaged with the clutch member.

20

9. The locking mechanism of claim 1, further comprising a radially inwardly-extending pin at least partially received within the housing, the clutch having a notch within which the pin is received when the clutch member is disengaged from the lock cylinder.

25

10. A lock assembly comprising:
a housing at least partially defining a cavity and having a central axis;
an actuator rotatably coupled to the housing and substantially axially fixed with respect to the housing;

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a lock cylinder received at least partially within the cavity and having a locked configuration and an unlocked configuration, the lock cylinder rotatable with respect to the housing in both the locked and unlocked configurations; and

5 a clutch selectively coupling the lock cylinder and the actuator for rotation together in response to rotation of the lock cylinder in one of the locked and unlocked configurations.

10 11. The locking mechanism of claim 10, wherein the clutch includes:
a sleeve received within the cavity and within which is received the lock cylinder; and
a clutch disk engageable with the sleeve.

15 12. The locking mechanism of claim 11, wherein the sleeve cooperates with the housing when the lock cylinder is rotated in the locked configuration to disengage the clutch disk from the sleeve.

20 13. The locking mechanism of claim 10, wherein the clutch has an engaged state in which rotation of the lock cylinder generates rotation of the actuator, and a disengaged state in which rotation of the actuator is restricted..

25 14. The locking mechanism of claim 13, wherein the actuator is rotatable in both the engaged and disengaged states of the clutch, the actuator having a smaller range of rotation when the clutch is in the disengaged state than when the clutch is in the engaged state.

 15. The locking mechanism of claim 13, wherein the clutch is biased toward the engaged state.

30 16. The locking mechanism of claim 10, wherein the clutch couples the lock cylinder and the actuator for rotation together when the lock cylinder is rotated in the unlocked configuration.

17. The locking mechanism of claim 10, wherein:
the clutch is slidably engageable with the actuator; and
at least part of the clutch is movable axially within the chamber.

5

18. The locking mechanism of claim 10, wherein at least part of the
clutch is movable within the chamber to a position in which rotation of the
actuator and the at least part of the clutch is restricted.

19. The locking mechanism of claim 10, wherein the housing receives
a pin that extends into the cavity, and wherein the clutch is releasably engageable
with the pin to limit rotation of at least part of the clutch.

20. The locking mechanism of claim 10, wherein the lock cylinder is
substantially axially fixed with respect to the housing.

21. A freewheeling locking mechanism comprising:
a housing defining a cavity and having a central axis;
an actuator rotatably coupled to the housing;
a lock cylinder received within the cavity and including a
retractable protrusion, the lock cylinder having an unlocked configuration
corresponding to the presence of a properly coded key in the lock cylinder, and a
locked configuration corresponding to the absence of the properly coded key in
the lock cylinder, the retractable protrusion having a position extended from the
lock cylinder when the lock cylinder is in the locked configuration and a position
retracted within the lock cylinder when the lock cylinder is in the unlocked
configuration, the lock cylinder being rotatable with respect to the housing in both
the locked and unlocked configuration;

a clutch moveable from an engaged state in which the actuator is
movable to an unlocked position by rotation of the lock cylinder and a disengaged
state in which the actuator is not movable to the unlocked position by rotation of
the lock cylinder, the clutch movable to the disengaged state responsive to rotation
of the lock cylinder in the locked configuration; and

30

a second protrusion coupling the lock cylinder and the clutch for rotation together when the lock cylinder is in the unlocked configuration and the clutch is in the disengaged state, and facilitating returning the clutch to the engaged state using the properly coded key.

5

22. A lock assembly, comprising:

a lock cylinder rotatable about an axis;

a clutch plate releasably engageable with the lock cylinder;

at least one dog coupled to and rotatable with the clutch plate, the

10

clutch plate axially movable with respect to the at least one dog and the lock cylinder, the clutch plate having a first axial position in which the clutch plate is engaged with the lock cylinder and in which the at least one dog is rotatable through a first range of motion, and a second axial position in which the clutch plate is disengaged from the lock cylinder and in which the at least one dog has a smaller range of motion than the first range of motion.

15

23. The lock assembly as claimed in claim 22, wherein the at least one dog has substantially no range of motion in the second position of the clutch plate.

20

24. The lock assembly as claimed in claim 22, wherein the at least one dog is coupled to a common member, the common member being substantially axially stationary with respect to the lock cylinder.

25

25. The lock assembly as claimed in claim 22, further comprising a sleeve within which the lock cylinder is at least partially received, the sleeve axially movable with respect to the lock cylinder and having an end in contact with the clutch plate.

30

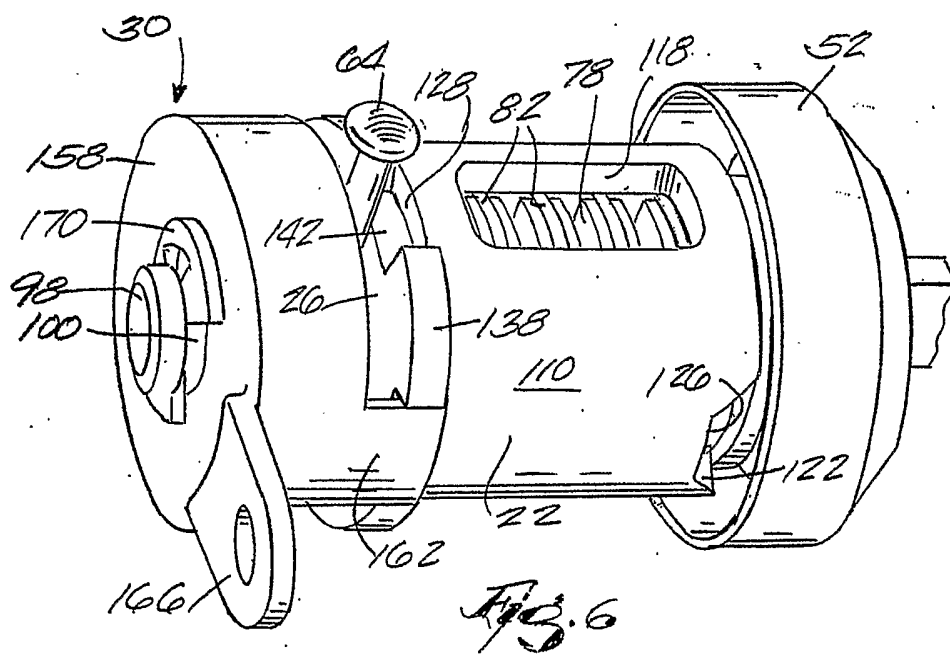
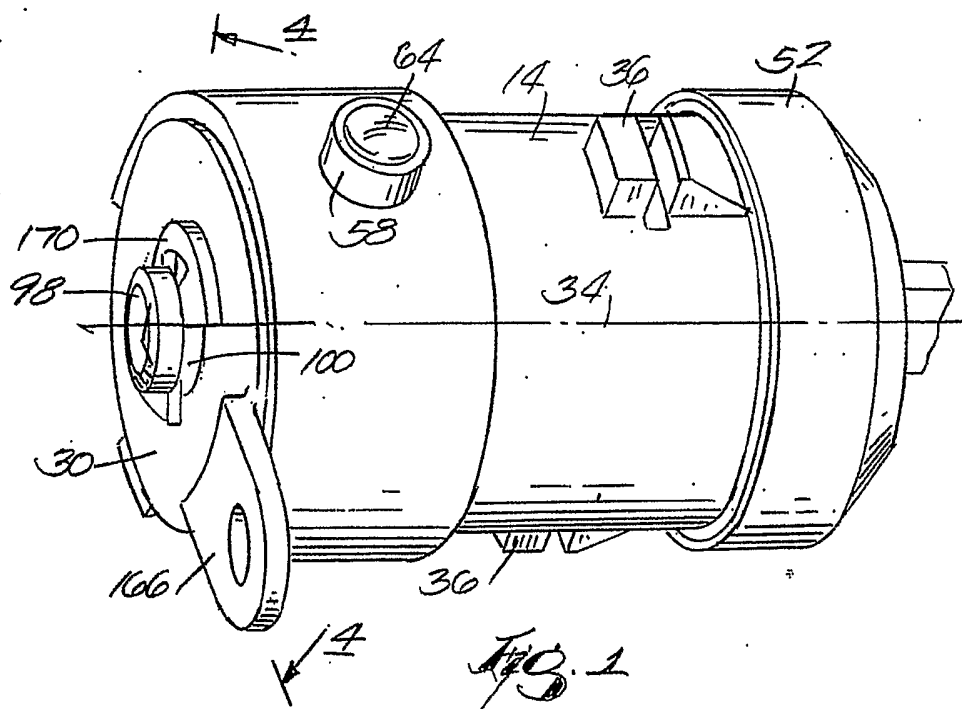
26. The lock assembly as claimed in claim 25, further comprising a projection extending from the lock cylinder into releasable engagement with the sleeve, the sleeve axially movable with respect to the lock cylinder between a first position in which the projection is drivably engaged with the sleeve and a second position in which the projection drivably disengaged from the sleeve.

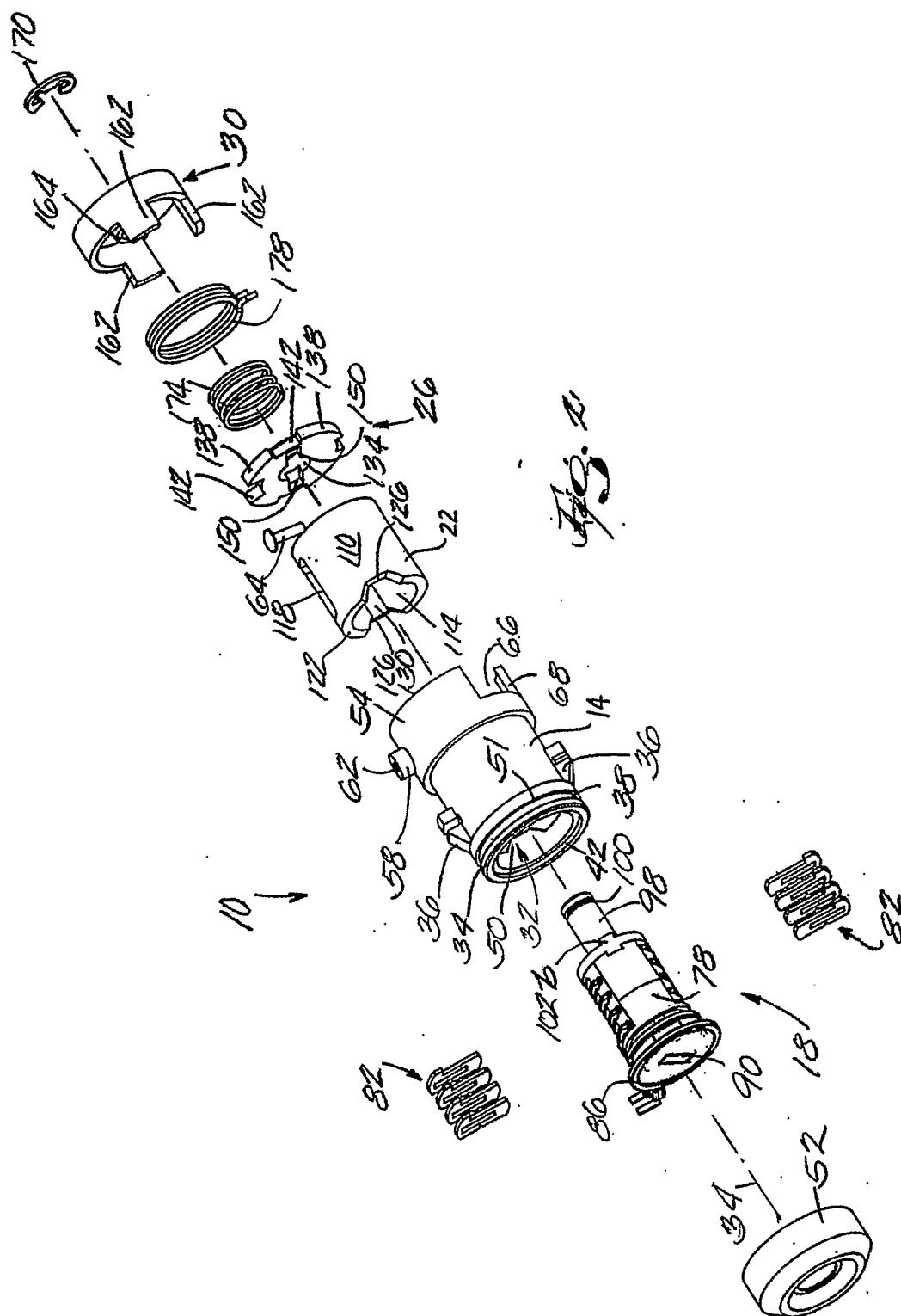
27. A method of preventing overtorque of a cylinder lock assembly connected to a device locked and unlocked by the cylinder lock assembly, the method comprising:

- 5 moving a clutch plate axially away from a cylinder lock;
disengaging the clutch plate from driving engagement with the cylinder lock;
moving the clutch plate axially with respect to a connection point on the cylinder lock assembly to which the device is connected;
10 rotating the cylinder lock with respect to the clutch plate; and
preventing sufficient rotation of the connection point to unlock the device responsive to rotating the cylinder lock.

28. The method as claimed in claim 27, wherein the connection point is
15 on a member coupled to the clutch plate and movable with respect to the clutch plate, the method further comprising moving the clutch plate axially with respect to the member.

29. The method as claimed in claim 28, further comprising
20 compressing a spring between the member and the clutch plate while moving the clutch plate axially with respect to the member.





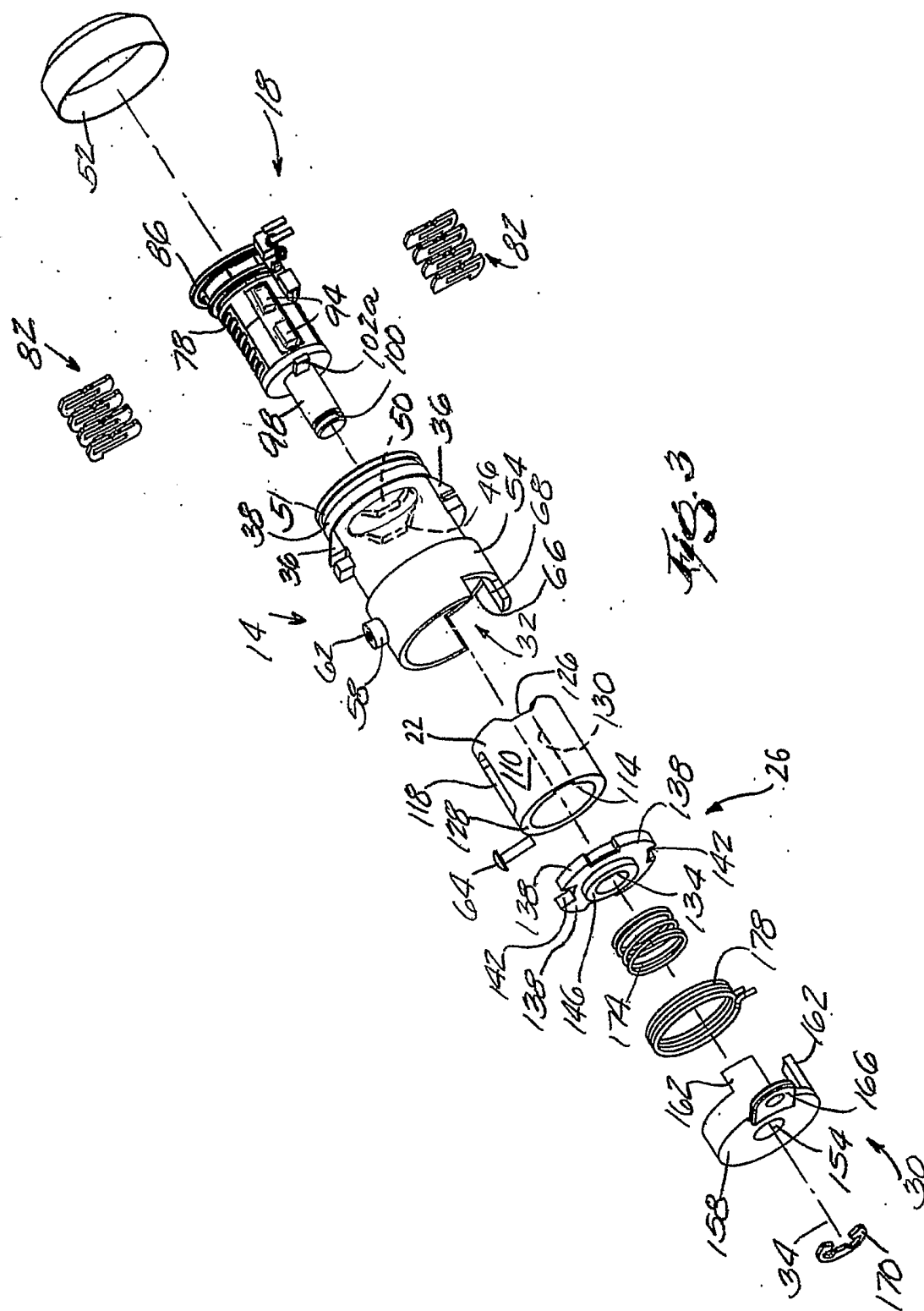


FIG. 3

