US006708538B1

(12) **United States Patent**
Walby

(10) **Patent No.: US 6,708,538 B1**
(45) **Date of Patent: Mar. 23, 2004**

(54) **DOORKNOB LOCK APPARATUS OPERABLE BY COMBINATION OR KEY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/694,391**

(22) Filed: **Oct. 23, 2000**

(51) **Int. Cl.**[7] **E05B 37/00**
(52) **U.S. Cl.** **70/285**; 70/284; 70/DIG. 71; 70/315
(58) **Field of Search** ..... 70/285, 284, DIG. 71, 70/312, 314, 315, 318, 306, 308, 309

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(74) *Attorney, Agent, or Firm*—Simpson & Simpson, PLLC

(57) **ABSTRACT**

A lock apparatus operable by combination or key includes a cylinder plug secured at a reference orientation relative to a frame by a plurality of detent wafers biased for engagement with a primary keyway in the frame, and a combination dial mounted coaxially about the cylinder plug and operably connected to the detent wafers by a plurality of cam rings mounted about the frame and cylinder plug for engaging a plurality of associated radial push pins arranged to force the detent wafers out of the primary keyway. The detent wafers are removed from engagement with the keyway by insertion of a key within the cylinder plug or by entry of a combination using the dial to allow rotation of the cylinder plug and an output nut carried thereby away from the cylinder plug's reference orientation. A ratchet-driven cam tube is provided for automatically scrambling the cam rings during operation of the lock apparatus. The combination can be changed by adjusting the relationship between the dial and a first-cam ring driven by the dial. The lock apparatus is suitable for retrofitting with an existing doorknob or deadbolt.

13 Claims, 9 Drawing Sheets

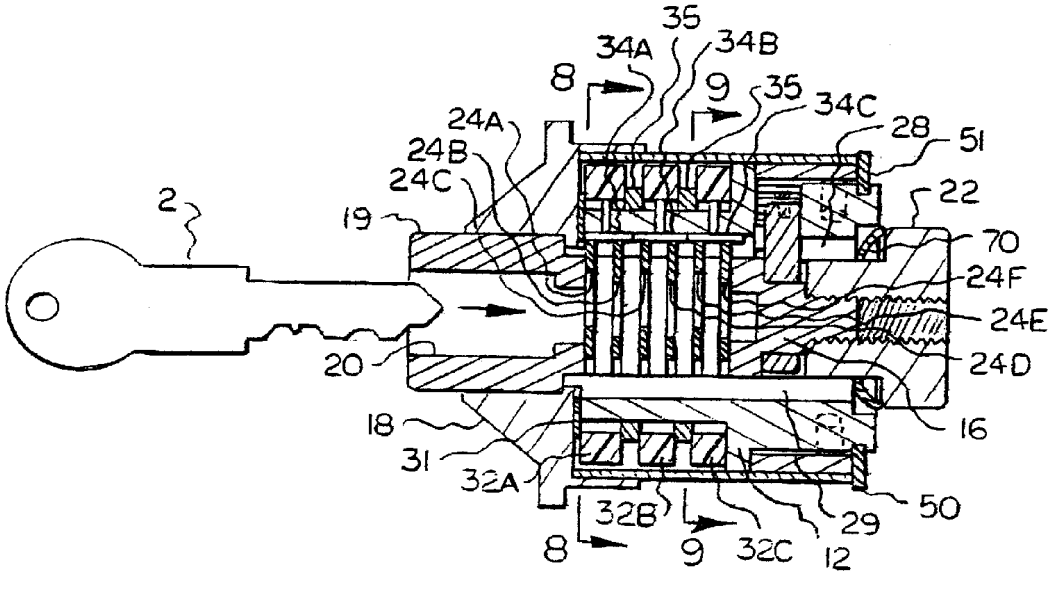


FIG. 1

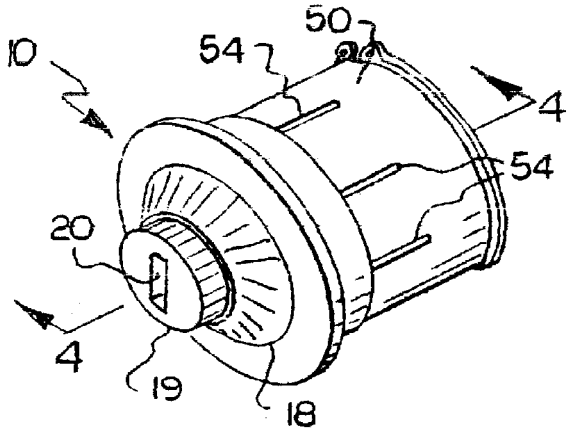


FIG. 4

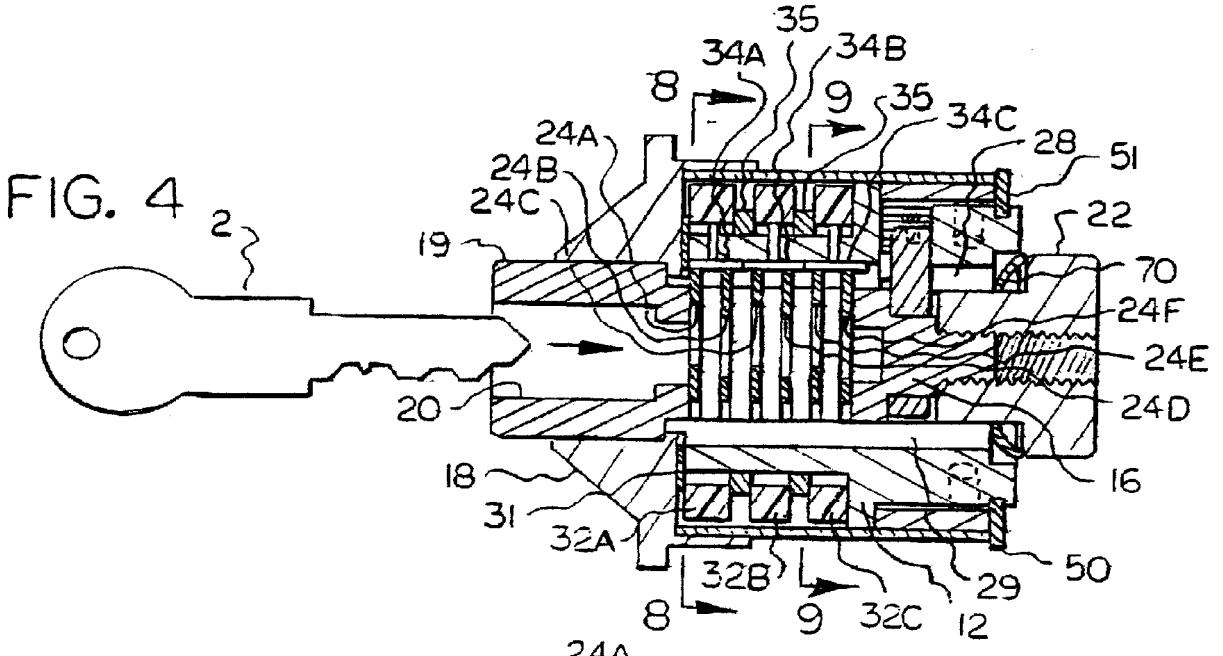


FIG. 6

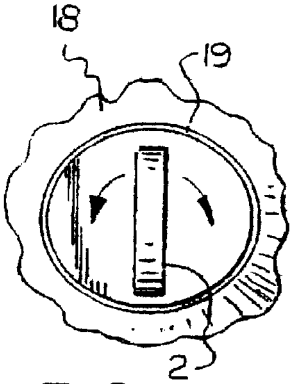
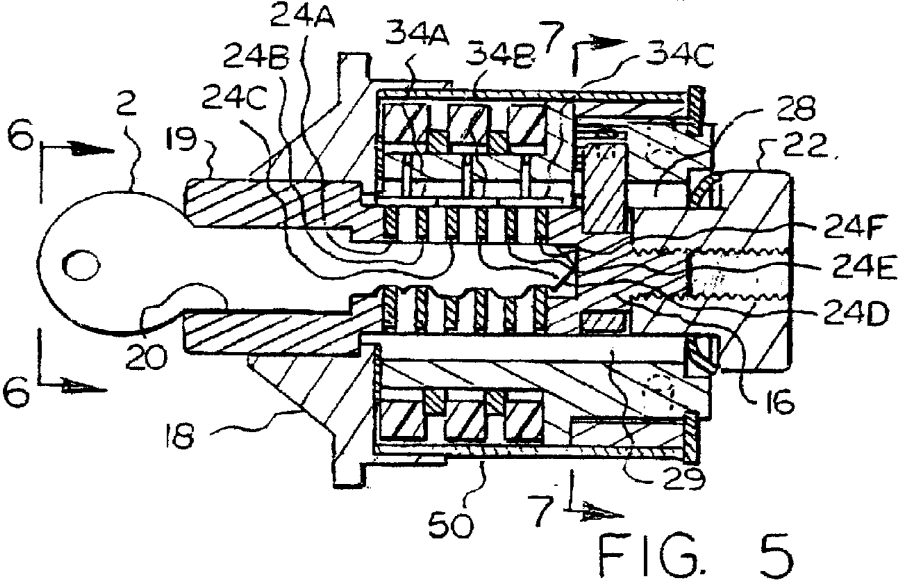


FIG. 5



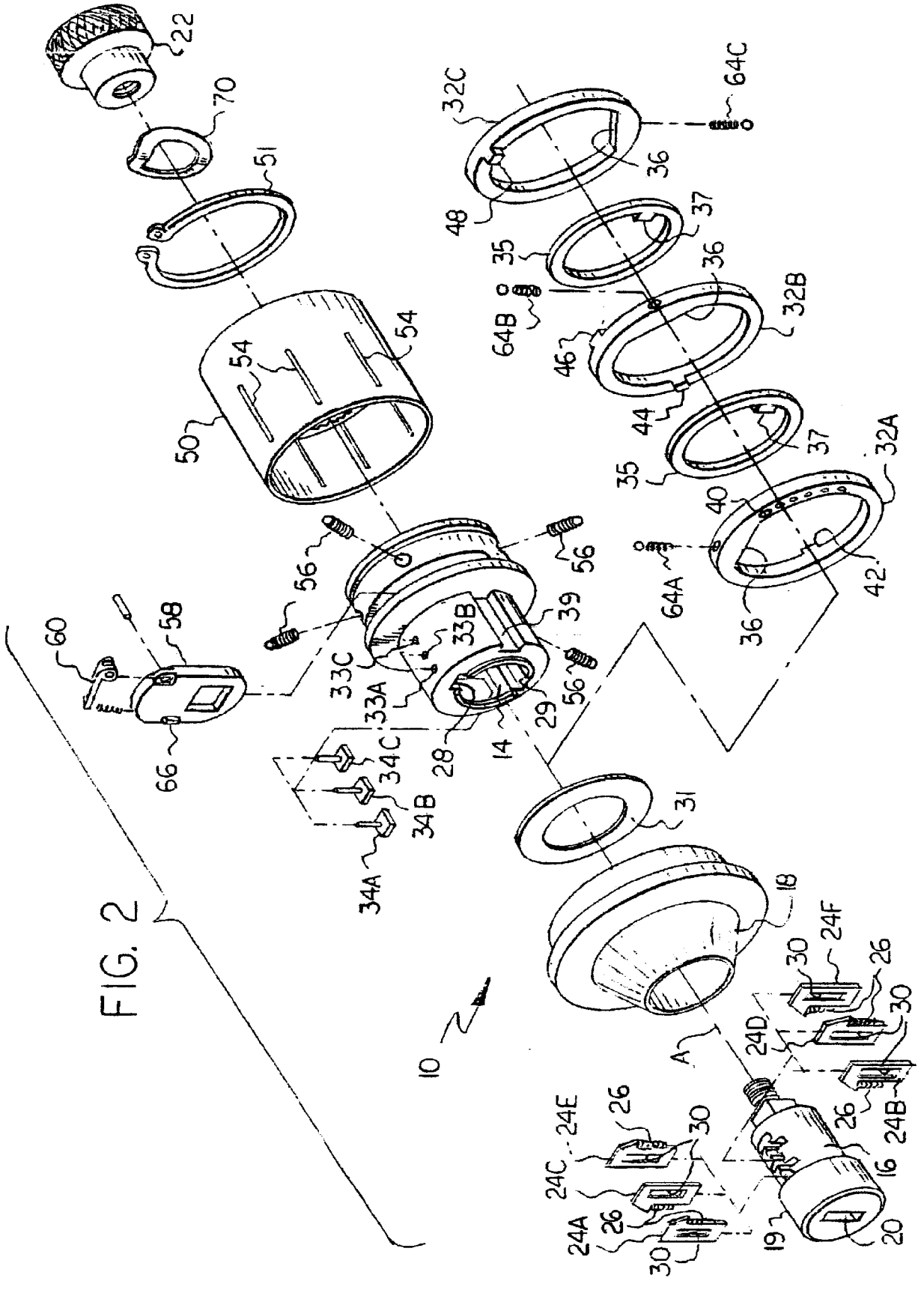

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FIG. 2

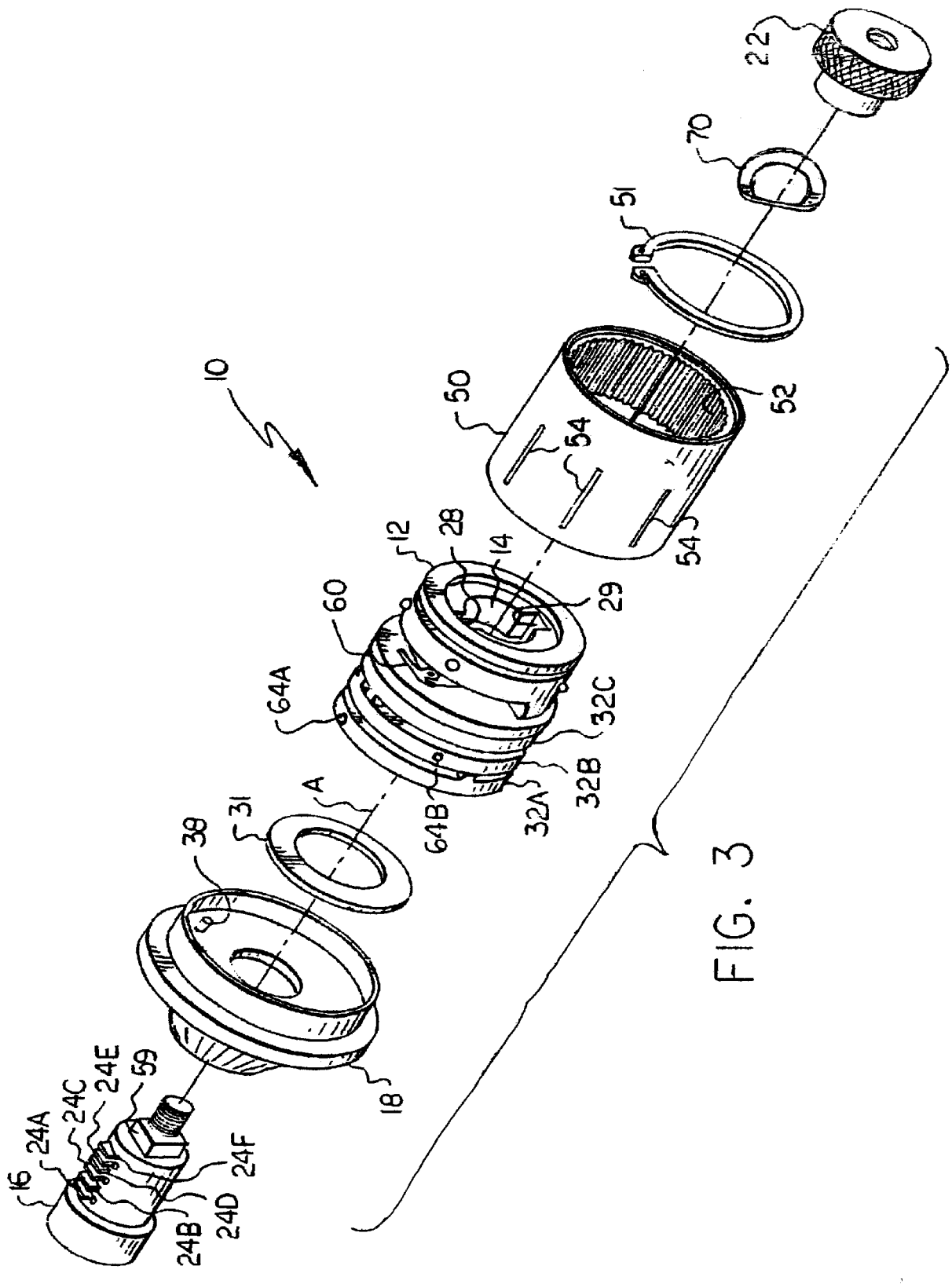
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FIG. 3

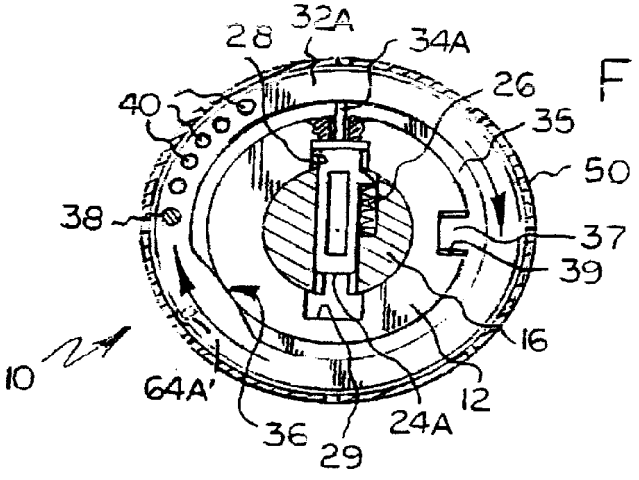


FIG 8

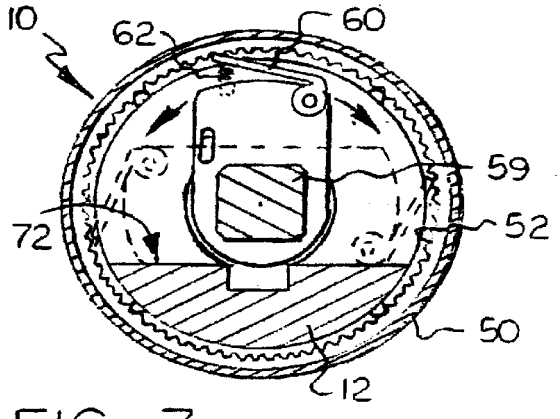


FIG. 7

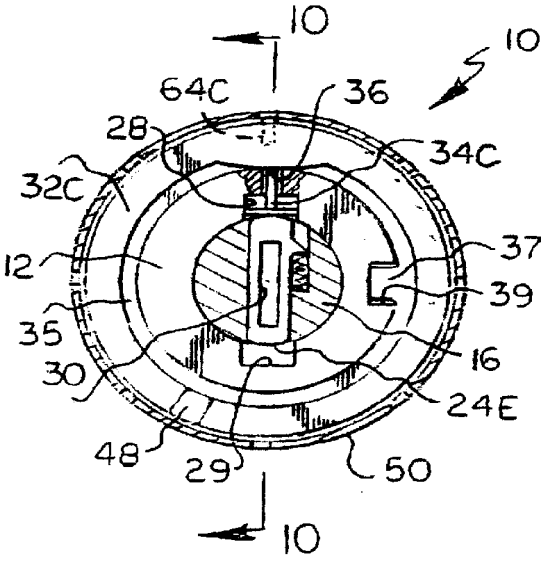


FIG. 9

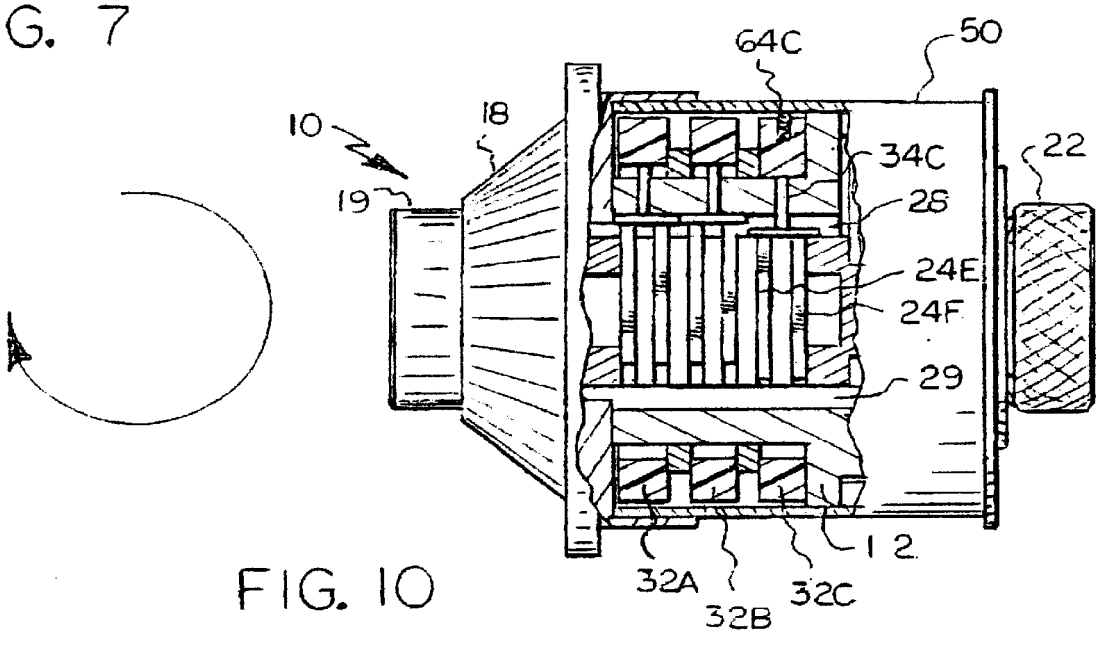


FIG. 10

FIG. 11

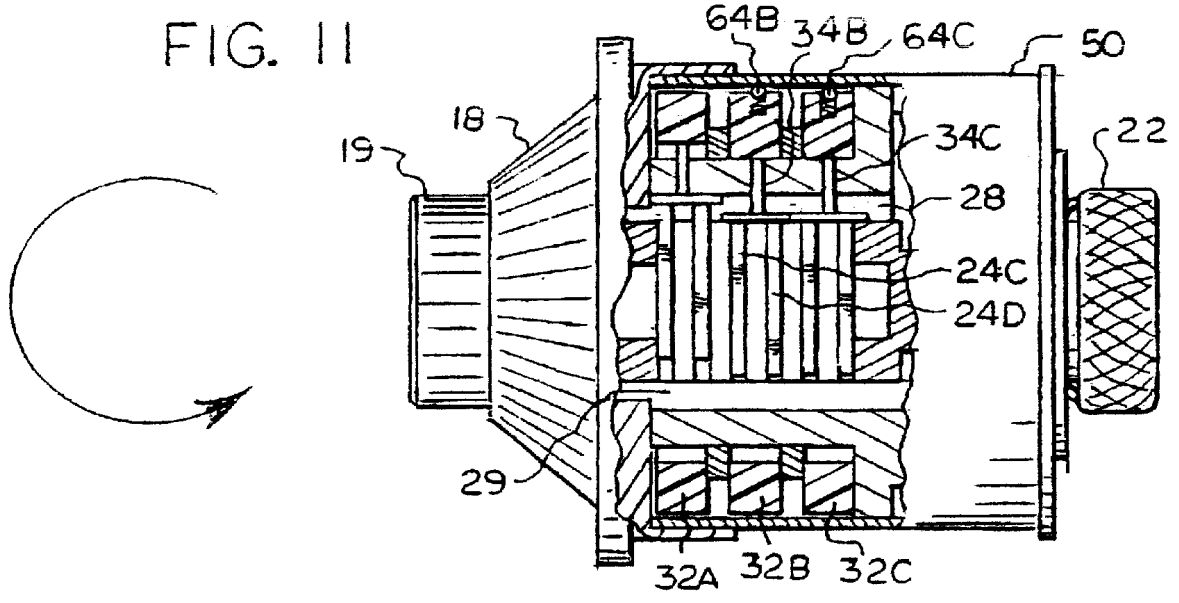
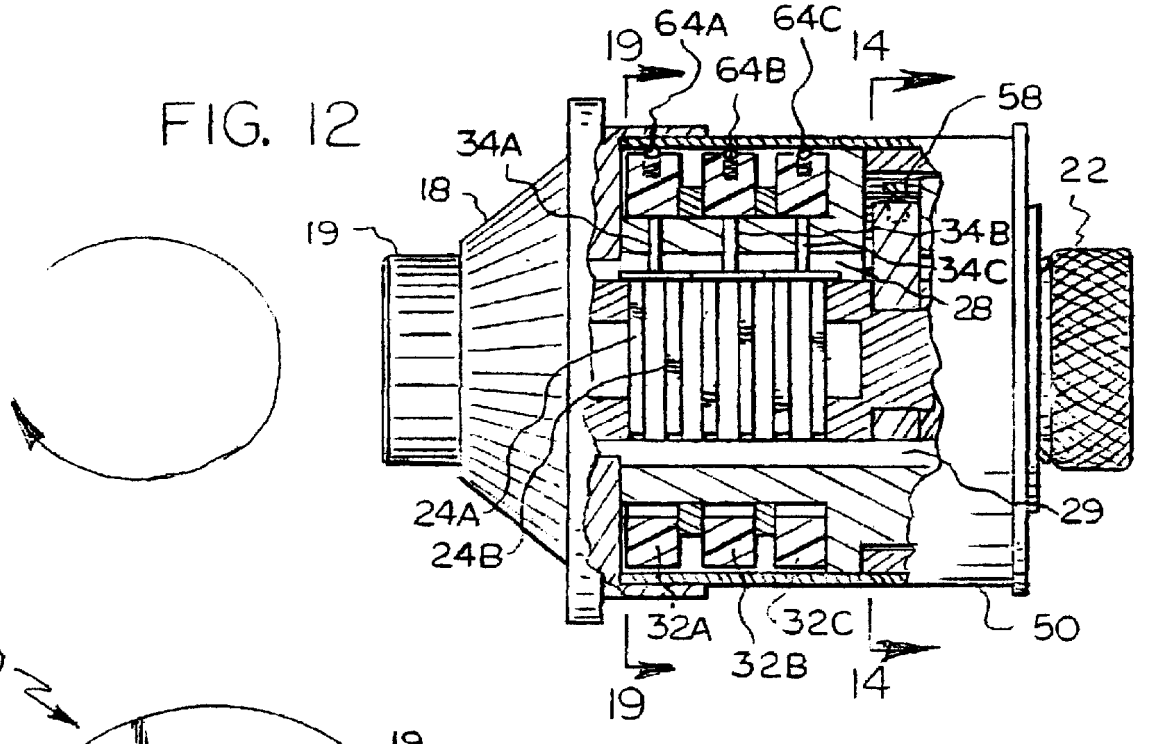


FIG. 12



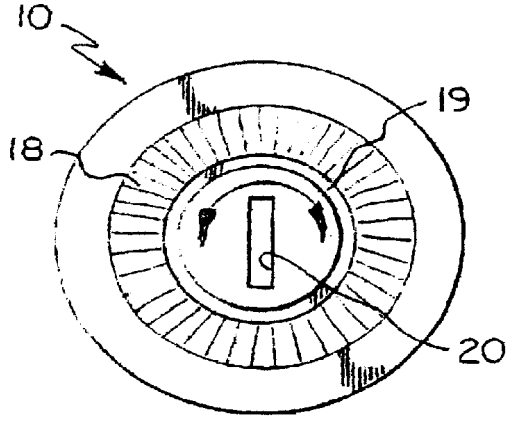


FIG. 13

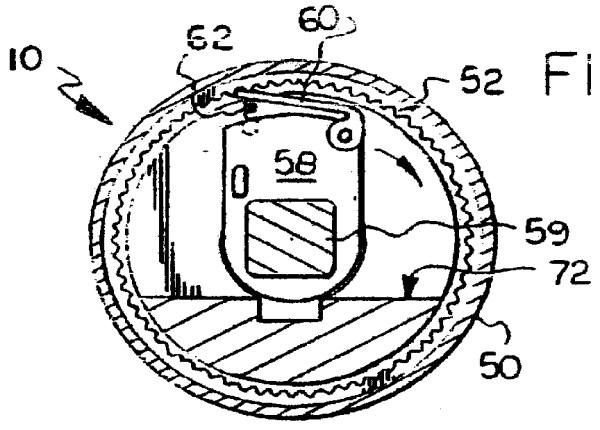


FIG. 14

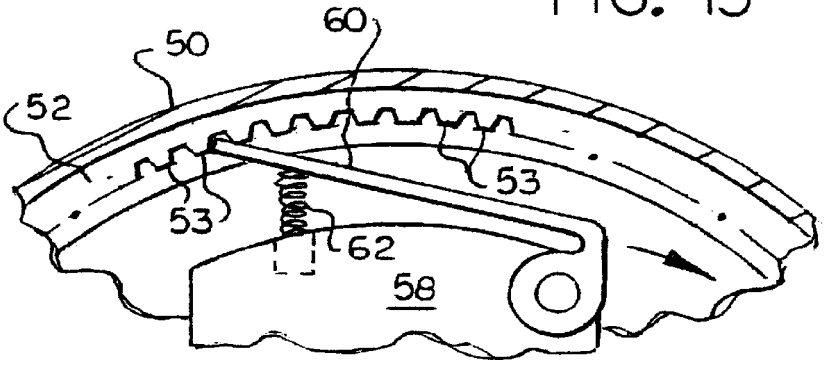


FIG. 15

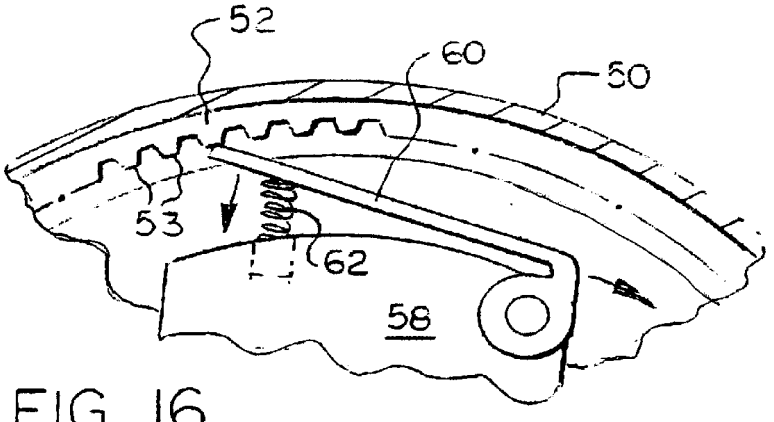


FIG. 16

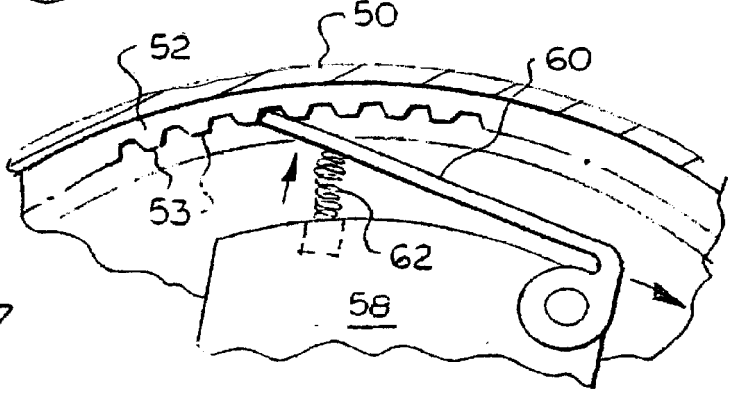


FIG. 17

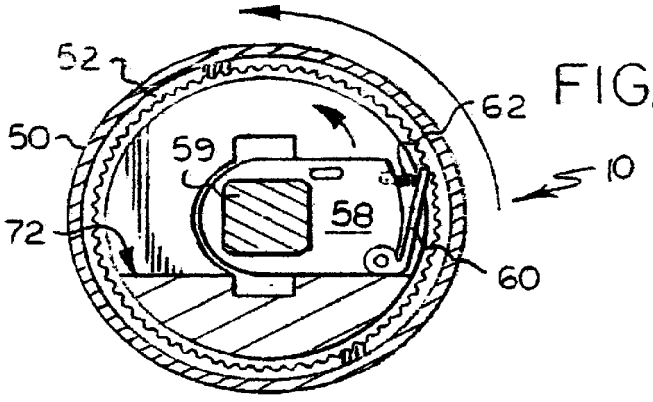


FIG. 18

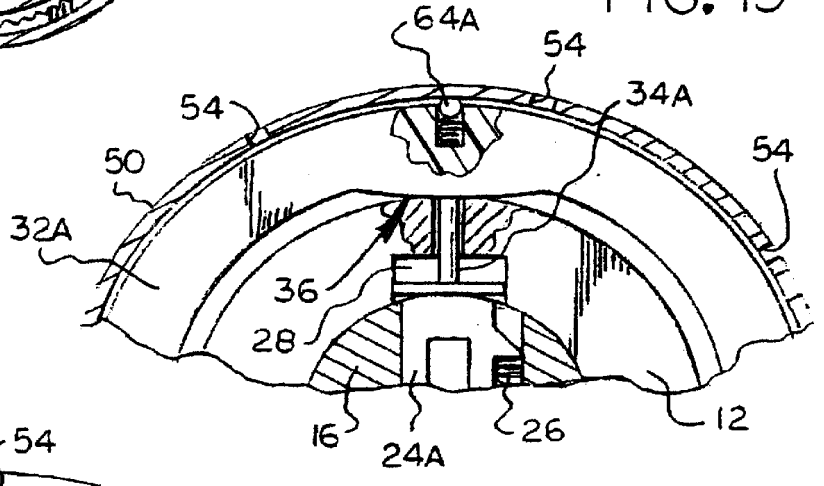


FIG. 19

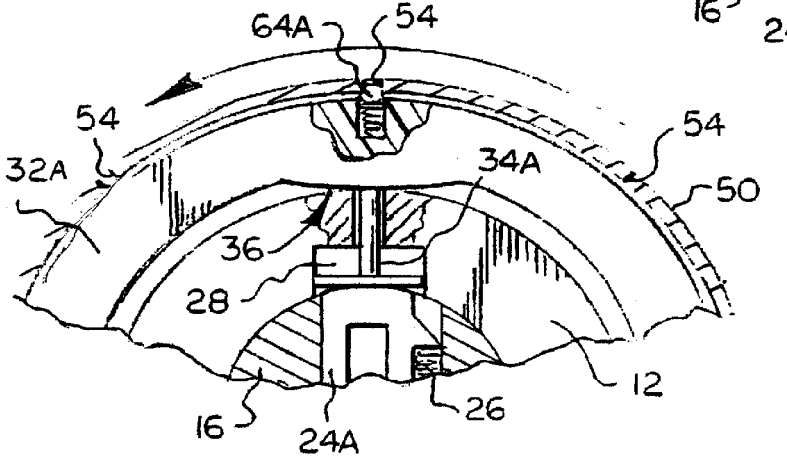


FIG. 20

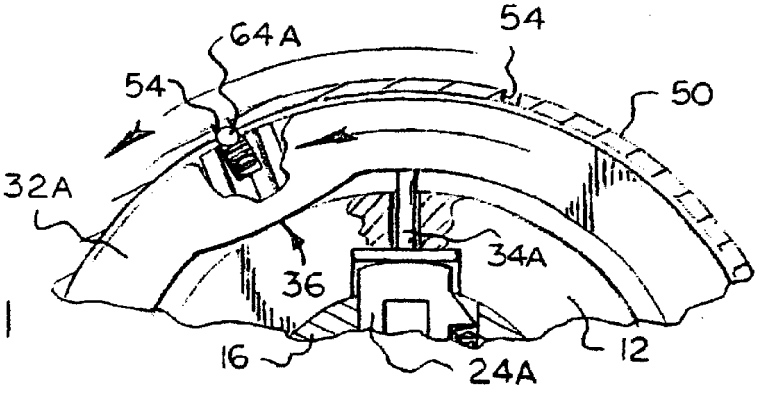


FIG. 21

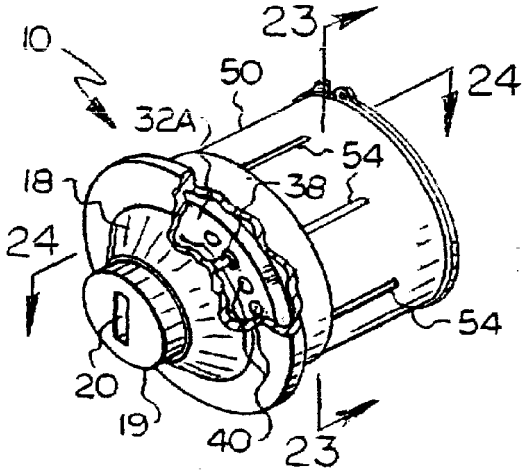


FIG 22

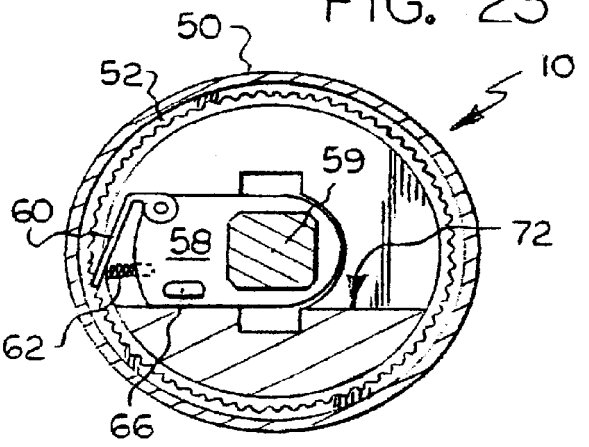


FIG. 23

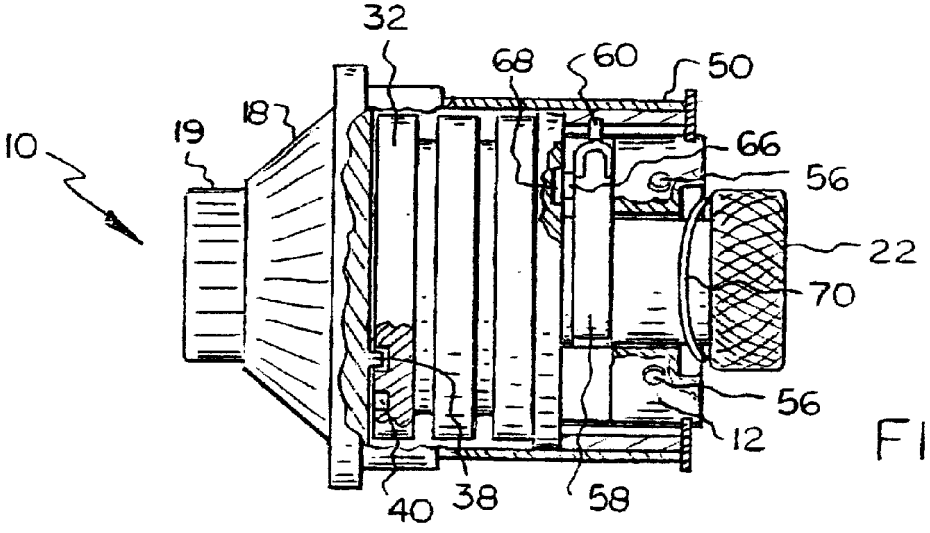


FIG. 24

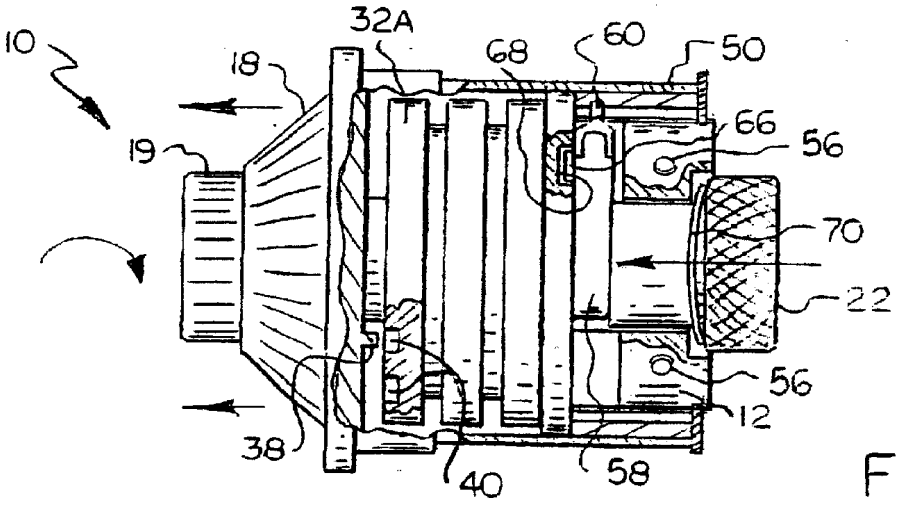
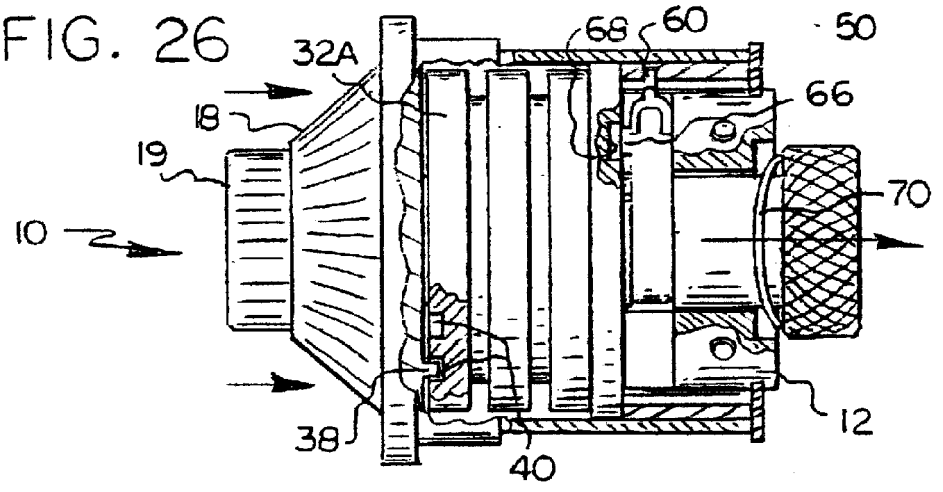


FIG. 25

FIG. 26



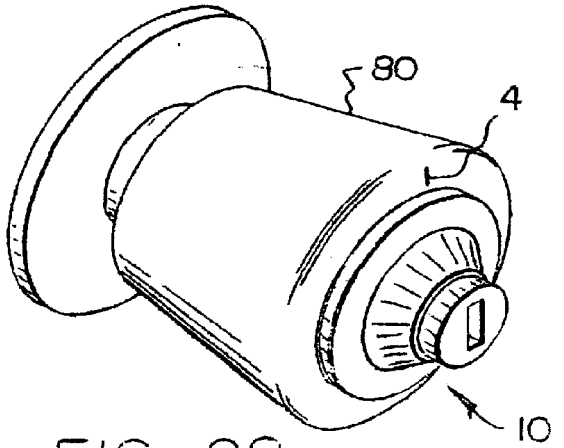


FIG. 28

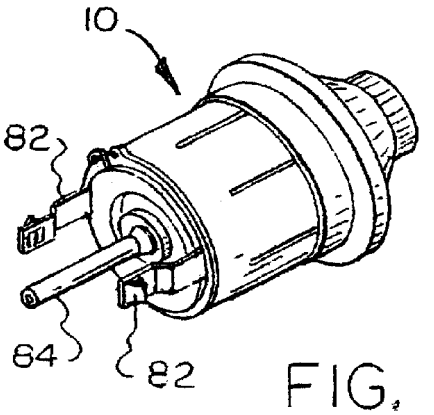


FIG. 27

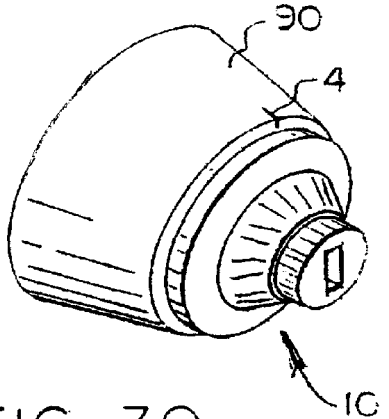


FIG. 30

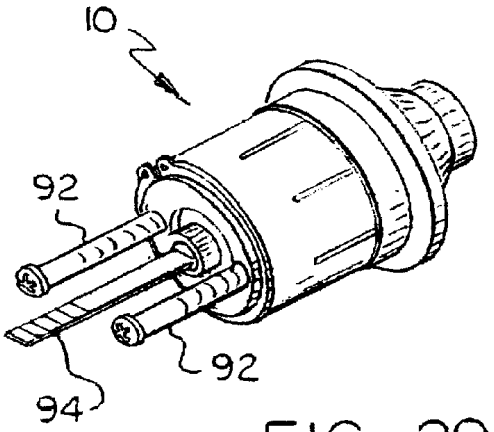


FIG. 29

DOORKNOB LOCK APPARATUS OPERABLE BY COMBINATION OR KEY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to door locking devices, and more particularly to a doorknob lock apparatus that is independently operable by dial entry of a combination or by a key.

2. Description of the Related Art

The need for reliable door locking systems for use at businesses and residences is widely recognized. It is also recognized that a lock capable of operation using a combination or a key offers versatility and convenience over common cylinder locks operable by key only. Consequently, efforts have been made to provide such a lock, as evidenced by prior art U.S. Pat. Nos. 3,353,383; 4,936,122; 5,113,675; and 5,475,996.

While perhaps suitable for specialized applications, the lock mechanisms described in the prior art generally require significant modification or replacement of the existing door and/or lockset. Even in prior art lock mechanisms that are capable of use with an existing lockset, installation is difficult and often requires cutting holes into the door, attaching mounting plates, installing wires, and performing other time consuming and costly steps.

Many electro-mechanical combination/key lock systems of the prior art, for example that of U.S. Pat. No. 4,936,122, require a battery power source having a finite lifetime, such that malfunction occurs when the battery is unable to properly energize the system.

BRIEF SUMMARY OF THE INVENTION

Accordingly, it is a principal object of the present invention to provide an improved convenient lock apparatus employing both key and combination actuating mechanisms by means of which the lock apparatus can be operated either by using a key or by entering the combination.

It is another object of the present invention to provide an improved lock apparatus that fits within the small volume allotted for prior art cylinder lock mechanisms.

It is yet another object of the present invention to provide a combination lock apparatus wherein the combination can be changed quickly and easily without disassembling the lock apparatus.

It is a further object of the present invention to provide a lock apparatus that is retrofittable or adaptable to a doorknob, deadbolt, locker, desk or the like.

It is a further object of the present invention to provide a lock apparatus wherein cam rings for combination operation are automatically scrambled before or as the lock apparatus is re-locked.

It is a further object of the present invention to provide an improved lock apparatus that avoids complicated and costly production and that is easy to assemble.

It is a further object of the present invention to provide a lock apparatus operable by combination or key wherein the combination cannot be determined from a key.

It is a further object of the present invention to provide an improved lock apparatus having an output nut for simple adaptation of the lock apparatus to an existing cylinder lock mechanism.

It is yet a further object of the present invention to accomplish the above objects in a completely mechanical lock apparatus that does not rely upon electrical devices requiring a power source.

In view of these and other objects that will become apparent to the reader, an improved lock apparatus of the present invention generally comprises a frame having an axially extending cylinder bore therethrough, a cylinder plug partially received by the cylinder bore having a keyhole, and a dial mounted coaxially about a front portion of the cylinder plug for combination entry. A front portion of the cylinder plug protrudes from the dial to form a knob, and an output nut is threadably mated with a rear end of the cylinder plug. A plurality of axially spaced detent wafers is slideably held within a plurality of respective radial slots in the cylinder plug, and each detent wafer is spring-biased to engage a primary keyway in the frame to prevent rotation of the cylinder plug relative to the frame. The arrangement defines a predetermined rotational reference orientation of the cylinder plug relative to the frame for maintaining a locked condition. The detent wafers are withdrawn from the primary keyway when a key is inserted in the keyhole, thereby allowing the cylinder plug to be rotated from its reference orientation. The cylinder plug rotation is transmitted through the output nut to move a locking member and achieve an unlocked condition.

The detent wafers are also withdrawn from the primary keyway by entry of a predetermined combination of numbers using the dial. The dial is operably connected to the wafers by a plurality of cam rings arranged about the frame, each cam ring having a cam surface for radially depressing an associated push pin communicating through the frame to one or more detent wafers. The dial rotationally drives a first cam ring adjacent thereto, and the first cam ring serves to drive a next adjacent cam ring, and so on, such that when the combination is entered in the correct manner the cam surface of each cam ring is in depressing engagement with an associated push pin to remove the plurality of detent wafers from the primary keyway.

A cam tube is provided about the cam rings and coupled by way of a ratchet mechanism to the cylinder plug so that the plurality of cam rings is in a scrambled state whenever the lock apparatus is re-locked. In the preferred embodiment, the cam tube includes an internal toothed portion adjacent its rear end, and a plurality of axially elongated slots angularly spaced about cam tube forward of the internal toothed portion. A plurality of spring plungers is mounted at angularly spaced intervals about the frame to engage toothed portion to provide suitable resistance to rotation of the cam tube relative to the frame. A carrier mounted on the cylinder plug supports a ratchet arm such that the carrier and ratchet arm rotate together with the cylinder plug. A free end of the ratchet arm operatively engages the internal toothed portion of the cam tube to rotate the cam tube with the cylinder plug in one rotational direction only. Each cam ring includes a spring plunger arranged to engage one of the plurality of slots in the cam tube upon alignment therewith to cause the cam rings to rotate with the cam tube and cylinder plug to scramble the cam rings either as the cylinder plug is rotated away from its reference orientation during unlocking or back to its reference orientation during relocking.

The lock apparatus preferably allows the combination to be easily changed without the need to disassemble the lock apparatus. Since the combination is determined by the specific driving orientation between the dial and first cam ring as defined by a drive pin coupling these parts, this driving orientation can be adjusted through axially directed separation against a spring bias and relative rotation between

the dial and first cam ring to reset the drive pin within a different one of a plurality of angularly spaced drive holes in the coupled part.

The lock apparatus of the present invention is sized for incorporation or retrofit into a doorknob, deadbolt or other lock mechanism. For example, the lock apparatus of the present invention could be used in lockers, desks, or other settings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The nature and mode of operation of the present invention will now be more fully described in the following detailed description of the preferred embodiment taken with the accompanying drawing figures, in which:

FIG. **1** is a perspective view of a lock apparatus formed in accordance with a preferred embodiment of the present invention;

FIG. **2** is an exploded perspective view of the lock apparatus shown in FIG. **1**;

FIG. **3** is an alternate exploded perspective view of the lock apparatus shown in FIG. **1**;

FIG. **4** is a cross-sectional view of the lock apparatus taken generally along the line **4**—**4** in FIG. **1**;

FIG. **5** is a cross-sectional view similar to that of FIG. **4**, however showing the insertion of a key into the lock apparatus;

FIG. **6** is a partial front view taken generally along the line **6**—**6** in FIG. **5**;

FIG. **7** is a cross-sectional view of the lock apparatus taken generally along the line **7**—**7** in FIG. **5**;

FIG. **8** is a cross-sectional view of the lock apparatus taken generally along the line **8**—**8** in FIG. **4**;

FIG. **9** is a cross-sectional view of the lock apparatus taken generally along the line **9**—**9** in FIG. **4**, however showing operation of a third cam ring of the present invention during combination entry;

FIG. **10** is a side view of the lock apparatus, partially sectioned generally along the line **10**—**10** in FIG. **9**, showing operation of the third cam ring;

FIG. **11** is a view similar to that of FIG. **10**, however showing operation of a second cam ring of the present invention;

FIG. **12** is a view similar to that of FIG. **11**, however showing operation of a first cam ring of the present invention;

FIG. **13** is a front view of the lock apparatus shown in FIG. **1**;

FIG. **14** is a cross-sectional view of the lock apparatus taken generally along the line **14**—**14** in FIG. **12**;

FIGS. **15**–**17** are a series of enlarged cross-sectional views showing operation of a ratchet of the present invention;

FIG. **18** is a view similar to that of FIG. **14**, however showing a cylinder plug and ratchet arm carrier of the present invention rotated 90 degrees in a clockwise direction from a reference orientation;

FIG. **19** is an enlarged cross-sectional view taken generally along the line **19**—**19** in FIG. **12**;

FIGS. **20** and **21** are a series of enlarged cross-sectional views similar to the view of FIG. **19**, however showing rotation of a cam tube of the present invention;

FIG. **22** is a perspective view of the lock apparatus partially sectioned to show driving connection between a dial of the present invention and the first cam ring;

FIG. **23** is a cross-sectional view of the lock apparatus taken generally along the line **23**—**23** in FIG. **22**;

FIG. **24** is a cross-sectional view of the lock apparatus taken generally along the line **24**—**24** in FIG. **22**;

FIG. **25** is a view similar to that of FIG. **24** showing axially directed separation of the dial from the first cam ring for changing a combination of the lock apparatus;

FIG. **26** is a view similar to that of FIG. **24** showing axially directed return of the dial into driving connection with the first cam ring after the combination has been changed;

FIG. **27** is a perspective view of a lock apparatus of the present invention adapted for retrofitted installation into a doorknob;

FIG. **28** is a perspective view showing the lock apparatus of FIG. **27** installed in a doorknob;

FIG. **29** is a perspective view of a lock apparatus of the present invention adapted for retrofitted installation into a deadbolt lock; and

FIG. **30** is a perspective view showing the lock apparatus of FIG. **29** installed in a deadbolt lock.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Attention is directed initially to FIGS. **1**–**3** of the drawings, wherein a lock apparatus formed in accordance with a preferred embodiment of the present invention is shown and designated generally by the reference numeral **10**. Lock apparatus **10** comprises a frame **12** having a cylinder bore **14** extending in a direction of axis A through the frame, a cylinder plug **16** partially accommodated by cylinder bore **14** for enabling key operation of the lock apparatus, and a dial **18** mounted coaxially about a front portion of cylinder plug **16** for enabling combination operation of the lock apparatus. A portion of cylinder plug **16** protrudes from dial **18** to form a knob **19** that is preferably knurled or otherwise textured on its external circumferential surface to facilitate manipulation thereof.

Referring now to FIGS. **4** and **5** in addition to FIGS. **1**–**3**, cylinder plug **16** includes a keyhole **20** opening through knob **19** into which a key **2** is received, and an output nut **22** is threadably or otherwise mated with a rear end of the cylinder plug. Detent means in the form of a plurality of axially spaced wafers **24**A–**24**F is provided for preventing rotation of cylinder plug **16** about axis A relative to frame **12**. More specifically, each wafer **24**A–**24**F is slideably held within a respective radial slot in cylinder plug **16** and biased by a spring **26** to engage a primary keyway **28** extending in an axial direction along cylinder bore **14** in frame **12**, and each wafer includes an opening **30** for receiving inserted key **2**. A secondary keyway **29** is provided opposite primary keyway **28** for temporarily accommodating ends of the wafers **24**A–**24**F as key **2** is inserted progressively through the wafer openings **30**. As can be understood, cylinder plug **16** normally resides in a predetermined rotational reference orientation relative to frame **12** when no key is inserted, and is securely kept in the reference orientation by the plurality of wafers **24**A–**24**F engaging primary keyway **28**. For example, in the present embodiment, the reference orientation can be thought of as ninety degrees based on the major axis orientation of elongated keyhole **20** of cylinder plug **16** as seen in FIG. **1**.

To operate lock apparatus **10** using key **2**, the key is simply inserted until all of the wafers **24**A–**24**F are forced by the key against the urging of springs **26** to withdraw the

wafers from within keyways **28** and **29**, as shown in FIG. **5**. After all the wafers **24**A–**24**F have been withdrawn from keyways **28** and **29**, the user can grip the exposed end of key **2** and rotate the key, as shown in FIG. **6**, to angularly displace cylinder plug **16** from the reference orientation. Rotational motion of the cylinder plug is imparted to output nut **22**, which is connected in a suitable manner to a locking member or bolt acting between the door and the doorframe, such that the locking member is moved to an unlocked position. Re-locking is accomplished by rotating the key and cylinder plug in an opposite angular direction to return the cylinder plug to its reference orientation.

Dial **18** is mounted coaxially about the front end of cylinder plug **16** that protrudes from frame **12**, and is independently rotatable about axis A relative to the cylinder plug and frame. Dial **18** is operably connected to detent wafers **24**A–**24**F by way of a plurality of cam rings **32**A, **32**B, and **32**C disposed about frame **12** and a plurality of associated **10** push pins **34**A, **34**B, and **34**C. A washer **31** is situated between dial **18** and first cam ring **32**A. The cam rings **32**–**32**C are spaced axially from one another by non-rotating spacers **35** between first cam ring **32**A and second cam ring **32**B, and between second cam ring **32**B and third cam ring **32**C, with spacers **35** being prevented from rotating by internal tabs **37** received within an external keyway **39** in frame **12**. Each cam ring includes an internal cam surface **36** for engaging an outer end of an associated push pin which is slidably mounted within a respective radially extending guide hole **33**A, **33**B or **33**C through frame **12**. An inner end of each push pin **34**A–**34**C is enlarged to bear against two adjacent wafers **24**A–**24**B, **24**C–**24**D, and **24**E–**24**F, respectively. Although the preferred embodiment described herein employs six wafers and three cam rings with three associated push pins each engaging two adjacent wafers, other arrangements are possible wherein the number of total wafers differs, and/or the number of wafers per cam ring and push pin differs. For example, an embodiment having four total wafers, four cam rings, and four push pins would fall under the scope of the present invention.

Dial **18** is connected to rotationally drive first cam ring **32**A by a drive pin **38** extending in an axial direction from a rear face of dial **18** for receipt within one of a plurality of angularly spaced drive holes **40** in an opposing front face of first cam ring **32**A. First cam ring **32**A includes a driver **42** protruding from a rear face thereof for engaging a corresponding follower **44** protruding from a front face of second cam ring **32**B. Likewise, second cam ring **32**B includes a driver **46** protruding from a rear face thereof for engaging a corresponding follower **48** protruding from a front face of third cam ring **32**C.

FIGS. **8**–**13** illustrate operation of lock apparatus **10** by entry of a predetermined combination of numbers using dial **18**. Combination entry is performed in a manner commonly known in connection with combination padlocks having a three-number combination. More specifically, dial **18** is rotated at least two complete revolutions in a clockwise direction and stopped when the first number of the combination is aligned with a fixed marker **4** on a doorknob or deadbolt casing (see FIGS. **28** and **30**), or with an unmarked location such as a "twelve o'clock" position. During this step, first cam ring **32**A is rotationally driven by dial **18** causing successive engagement of driver **42** with follower **44** and driver **46** with follower **48** to transmit rotational motion to third cam ring **32**C until cam surface **36** of third cam ring **32**C forces push pin **34**C downward as shown in FIGS. **9** and **10** to thereby remove wafers **24**E and **24**F from primary keyway **28**. Dial **18** is then rotated in a counter-clockwise direction as indicated in FIG. **11** through one complete revolution and stopped when the second number of the combination is aligned with the fixed marker or location. This step causes driver **42** to come into reverse driving engagement with follower **44** on second cam ring **32**B to rotate the second cam ring in a counter-clockwise direction to a position wherein cam surface **36** of second cam ring **32**B forces push pin **34**B downward as shown in FIG. **11** to thereby remove wafers **24**C and **24**D from primary keyway **28**. The total degree of rotation is insufficient, however, to bring driver **46** into reverse driving engagement with follower **48**, thereby allowing third cam ring **32**C to remain in its previous orientation. Finally, dial **18** is rotated again in a clockwise direction until the third number of the combination is aligned with the fixed marker or location, thereby rotating first cam ring **32**A until its cam surface **36** forces push pin **34**A downward as shown in FIG. **12** to remove wafers **24**A and **24**B from primary keyway **28** without disturbing second cam ring **32**B or third cam ring **32**C. Once the combination has been entered, all of the detent wafers **24**A–**24**F are removed from engagement with primary keyway **28** and cylinder plug **16** can be rotated about axis A away from its reference orientation with respect to frame **12**. Such rotation of cylinder plug **16** can be in either rotational direction as illustrated in FIG. **13**, and is accomplished without key **2** by manipulating knob **19**.

Lock apparatus **10** preferably comprises a mechanism whereby cam rings **32**A–**32**C are "scrambled" from depressing engagement with associated push pins **34**A–**32**C incident to rotation of cylinder plug **16** back to its reference position when a user locks the door. As will be appreciated from the following portion of the description, cam rings **32**–**32**C are scrambled regardless of whether the preceding unlocking of lock apparatus **10** was by key or by combination. Additional reference is now made to FIGS. **14**–**21** for describing the scrambling mechanism. Lock apparatus **10** comprises a cam tube **50** arranged coaxially about cam rings **32**–**32**C, frame **12**, and cylinder plug **16**. Cam tube **50** is secured by a snap ring **51** fitting within an annular groove in frame **12** to prevent axially directed movement of the cam tube relative to the frame. Cam tube **50** is provided with an internal toothed portion **52** adjacent its rear end, and a plurality of axially elongated slots **54** angularly spaced about cam tube **50** forward of internal toothed portion **52**. A plurality of spring plungers **56** is mounted at angularly spaced intervals about frame **12** to engage toothed portion **52**, thereby introducing suitable resistance to rotation of cam tube **50** relative to frame **12**. A carrier **58** has a proximal end mounted on a square cross-section portion **59** of cylinder plug **16** and a distal end which supports an elastically deformable ratchet arm **60** such that the carrier and ratchet arm rotate together with the cylinder plug about axis A. Ratchet arm **60** is fixed at one end thereof to the distal end of carrier **58**, and has a free end biased by a spring **62** for operative engagement with teeth **53** of internal toothed portion **52** of cam tube **50**. Depending upon the elastic deformation qualities of ratchet arm **60**, spring **62** may not be necessary.

It will be recalled that when a user unlocks and then re-locks a door by operating lock apparatus **10**, the user rotates cylinder plug **16** in one angular direction to unlock the door and then in an opposite angular direction to re-lock the door. For example, the user can rotate cylinder plug **16** in a clockwise direction as shown in FIG. **14** to unlock the door, and then in a counter-clockwise direction as shown in FIG. **18** to re-lock the door. During clockwise rotation of

cylinder plug **16**, the free end of ratchet arm **60** is forced against the urging of spring **62** toward carrier **58** as it moves over each tooth **53**, and the cam tube **50** remains rotationally fixed relative to frame **12** by virtue of spring plungers **56**, as illustrated in FIGS. **15–17**. Conversely, during counter-clockwise rotation of cylinder plug **16**, the free end of ratchet arm **60** engages a tooth **53** at an angle favorable to imparting sufficient torque to cam tube **50** to overcome the rotational resistance offered by spring plungers **56** such that the cam tube rotates together with the cylinder plug, carrier, and ratchet arm. As cam tube **50** rotates in the counter-clockwise direction in accordance with FIGS. **19–21**, one of the plurality of slots **54** on the cam tube will become aligned with a plurality of spring plungers **64**A–**64**C respectively located on the exterior of cam rings **32**–**32**C opposite cam surface **36**. Spring plungers **64**A–**64**C are thus forced into engagement with the aligned slot **54**, and as a consequence cam rings **32**A–**32**C are rotated together with cam tube **50**, ratchet arm **60**, carrier **58**, and cylinder plug **16** until the cylinder plug is returned to its reference orientation. Ratchet arm **60** may of course be arranged in an opposite manner such that cam tube **50** and cam rings **32**–**32**C rotate clock-wise with clockwise rotation of the cylinder plug. It will be appreciated that the cam rings are scrambled either as the user unlocks the door or as the user re-locks the door, depending upon the arrangement of ratchet arm **60** and the initial direction of rotation as the door is unlocked. It is also noted that elongated slots **54** are preferred recesses for receiving ball plungers **64**A–**64**C due to ease of manufacturing and thickness limitations in cam tube **50**, however such recesses could be in the form of individual through-holes for the respective ball plungers, individual non-through recesses in the internal wall of cam tube **50**, or non-through elongated recesses in the internal wall of cam tube **50**.

Another feature preferably incorporated into lock apparatus **10** enables the dial combination to be changed as desired. As seen in FIG. **22**, dial **18** includes drive pin **38** extending in a rearward direction from the dial and received within one of a plurality of angularly spaced drive holes **40** provided in the front face of first cam ring **32**A. Depending upon which of the plurality of holes **40** receives drive pin **38**, a specific driving orientation is established between dial **18** and first cam ring **32**A which determines the combination numbers. Thus, to change the combination, dial **18** must be separated in an axial direction from first cam ring **32**A to withdraw drive pin **38** from within a drive hole **40**, dial **18** must be rotated relative to first cam ring **32**A, and then dial **18** and first cam ring **32**A must be moved together in an axial direction to insert drive pin **38** within a new drive hole **40**, thereby establishing a new drive orientation and a new combination. FIGS. **23–26** illustrate the structure and procedural steps in connection with changing the combination. As can be seen in FIG. **24**, a front side of carrier **58** includes a protrusion **66**, and frame **12** includes a recess **68** in an annular face thereof opposite the front side of the carrier. Normally, protrusion **66** does not reside within recess **68** because carrier arm is not in a rotational position wherein the protrusion is aligned with the recess, and because a spring washer **70** mounted between frame **12** and output nut **22** urges output nut **22**, carrier **58**, cylinder plug **16**, and dial **18** axially to the right in FIG. **24** relative to frame **12**. The location of recess **68** is chosen such that cylinder plug **16** must be moved away from its reference orientation to bring protrusion **66** into alignment with recess **68**. In the embodiment presently described, cylinder plug **16** is rotated counter-clockwise until further rotation is prevented by engagement of carrier **58** with a horizontal surface **72** of frame **12**, approximately ninety degrees from the reference orientation as shown in FIG. **23**, to bring protrusion **66** into alignment with recess **68**. Once alignment is achieved, the user is able to pull dial **18**, cylinder plug **16**, carrier **58**, and output nut **22** in an axial direction against the urging of spring washer **70** to the left as shown in FIG. **25** just enough to withdraw drive pin **38** from an existing drive hole **40**, thereby separating the driving connection between dial **18** and first cam ring **32**A. Dial **18** is then rotated relative to first cam ring **32**A to align drive pin **38** with a new drive hole **40**, and dial **18** is released. FIG. **26** shows dial **18**, cylinder plug **16**, carrier **58**, and output nut **22** being forced to the right by spring washer **70** upon completion of the combination change. It will be appreciated that the combination may only be changed by a person having either the key or knowledge of the combination. From a structural standpoint, the male/female mating between drive pin **38** and drive hole **40** may be reversed such that drive holes **40** are located on dial **18** and drive pin **38** is located on first cam ring **32**A. Likewise, protrusion **66** can be formed on frame **12** and recess **68** can be provided in carrier **58** to achieve the desired function. It is noted that knob **19** of cylinder plug **16** bears against a lip on frame **12** to provide an annular gap for an inner portion of dial **18** so that the dial is not pinched between the knob and frame by force from spring washer **70**.

FIGS. **27** and **28** show a manner of mounting lock apparatus **10** within a standard door knob **80** using spring clips **82**. A drive shaft **84** is connected to output nut **22** for transmitting rotational motion to a locking member or mechanism (not shown). FIGS. **29** and **30** show a manner of mounting lock apparatus **10** within a standard deadbolt casing **90** using fasteners **92**. A drive member **94** is connected to output nut **22** for transmitting rotational motion to a locking member or mechanism (not shown). Accordingly, the lock apparatus of the present invention is easily adapted for retrofit with an existing doorknob or deadbolt. Of course, the lock apparatus of the present invention can also be provided as part of a newly manufactured doorknob, deadbolt, locker door, desk drawer, file cabinet drawer, or other lock mechanism.

What is claimed is:

1. A lock apparatus comprising:

a frame;

an output nut;

a cylinder plug mounted at least partially within said frame for rotation about an axis from a rotational reference orientation relative to said frame, said cylinder plug being operably connected to said output nut;

a dial rotatable about said axis relative to said cylinder plug;

detent means movable between an engaged position for preventing rotation of said cylinder plug from said reference orientation and a released position for enabling rotation of said cylinder plug from said reference orientation;

said detent means being moved from said engaged position to said released position by insertion of a key within said cylinder plug; and

said detent means being moved from said engaged position to said released position by entry of a predetermined combination using said dial;

whereby said lock apparatus can be operated either by inserting said key into said cylinder plug or by entering said combination using said dial.

2. The lock apparatus according to claim **1**, wherein said cylinder plug includes a knob portion for rotating said cylinder plug without said key.

3. The lock apparatus according to claim 1, wherein said detent means includes a plurality of wafers spaced in an axial direction along said cylinder plug for movement between a radially flush condition and a radially projecting condition and said frame includes an internal keyway, said plurality of wafers being biased toward said radially projecting condition to engage said internal keyway to prevent rotation of said cylinder plug from said reference orientation, and said plurality of wafers being held in said radially flush condition by said frame once said cylinder plug is rotated from said reference orientation.

4. The lock apparatus according to claim 3, wherein said plurality of wafers is connected to said dial by a plurality of slidable push pins extending radially through said frame to act on said plurality of wafers, and a plurality of cam rings are operably coupled to said dial and arranged about said frame to depress said plurality of push pins to force said plurality of wafers into said radially flush condition when said combination is entered.

5. The lock apparatus according to claim 4, wherein each of said plurality of push pins acts on more than one of said plurality of wafers.

6. The lock apparatus according to claim 4, further comprising:

a ratchet arm mounted on said cylinder plug for rotation therewith;

a cam tube arranged about said plurality of cam rings and said ratchet arm, said cam tube having an internal toothed portion cooperating with said ratchet arm such that said cam tube rotates with said cylinder plug in a first rotational direction but does not rotate with said cylinder plug in a second rotational direction opposite said first rotational direction, and said cam tube having a plurality of recesses;

a plurality of plungers carried one by each of said cam rings, each of said plurality of plungers being biased for engagement with one of said plurality of recesses upon alignment therewith to cause said plurality of cam rings to rotate with said cam tube and said cylinder plug in said first rotational direction;

whereby said plurality of cam rings is rotated away from depressing engagement with said plurality of push pins when said cylinder plug is rotated in said first rotational direction during operation of said lock apparatus.

7. The lock apparatus according to claim 6, wherein said plurality of recesses comprises a plurality of axially elongated slots angularly spaced about said cam tube.

8. The lock apparatus according to claim 4, wherein said plurality of cam rings comprises a first cam ring rotatably driven by said dial and operably connected to at least one other cam ring of said plurality of cam rings.

9. The lock apparatus according to claim 8, wherein a rotational driving orientation between said dial and said first cam ring is adjustable for changing said combination.

10. The lock apparatus according to claim 9, further comprising biasing means for maintaining said dial in driving engagement with said first cam ring, said dial being movable against the urging of said biasing means to disengage said dial from driving engagement with said first cam ring to permit adjustment of said rotational driving orientation between said dial and said first cam ring.

11. The lock apparatus according to claim 10, wherein said dial is mounted on said cylinder plug, said output nut is attached to said cylinder plug, and said biasing means comprises a spring acting between said output nut and said frame.

12. A lock apparatus comprising:

a dial for entering a combination of numbers by sequenced rotations of said dial;

a plurality of cam rings for unlocking said lock apparatus when said predetermined combination of numbers is entered, said plurality of cam rings including a first cam ring having a plurality of angularly spaced drive holes facing said dial;

a drive pin extending from said dial and received within one of said plurality of drive holes to rotatably couple said first cam ring with said dial at a chosen drive orientation that determines said combination; and

biasing means for urging said dial and first cam ring axially together to maintain said rotational coupling;

said dial being axially separable from said first cam ring against the urging of said biasing means when said lock apparatus is unlocked to permit relative rotation between said dial and said first cam ring;

whereby said drive orientation can be changed by causing said drive pin to be received within a different one of said plurality of drive holes to change said combination.

13. A lock apparatus comprising:

a dial for entering a combination of numbers by sequenced rotations of said dial, said dial having a plurality of angularly spaced drive holes;

a plurality of cam rings for unlocking said lock apparatus when said predetermined combination of numbers is entered, said plurality of cam rings including a first cam ring having a drive pin extending therefrom and received within one of said plurality of drive holes to rotatably couple said first cam ring with said dial at a chosen drive orientation that determines said combination; and

biasing means for urging said dial and first cam ring axially together to maintain said rotational coupling;

said dial being axially separable from said first cam ring against the urging of said biasing means when said lock apparatus is unlocked to permit relative rotation between said dial and said first cam ring;

whereby said drive orientation can be changed by causing said drive pin to be received within a different one of said plurality of drive holes to change said combination.

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