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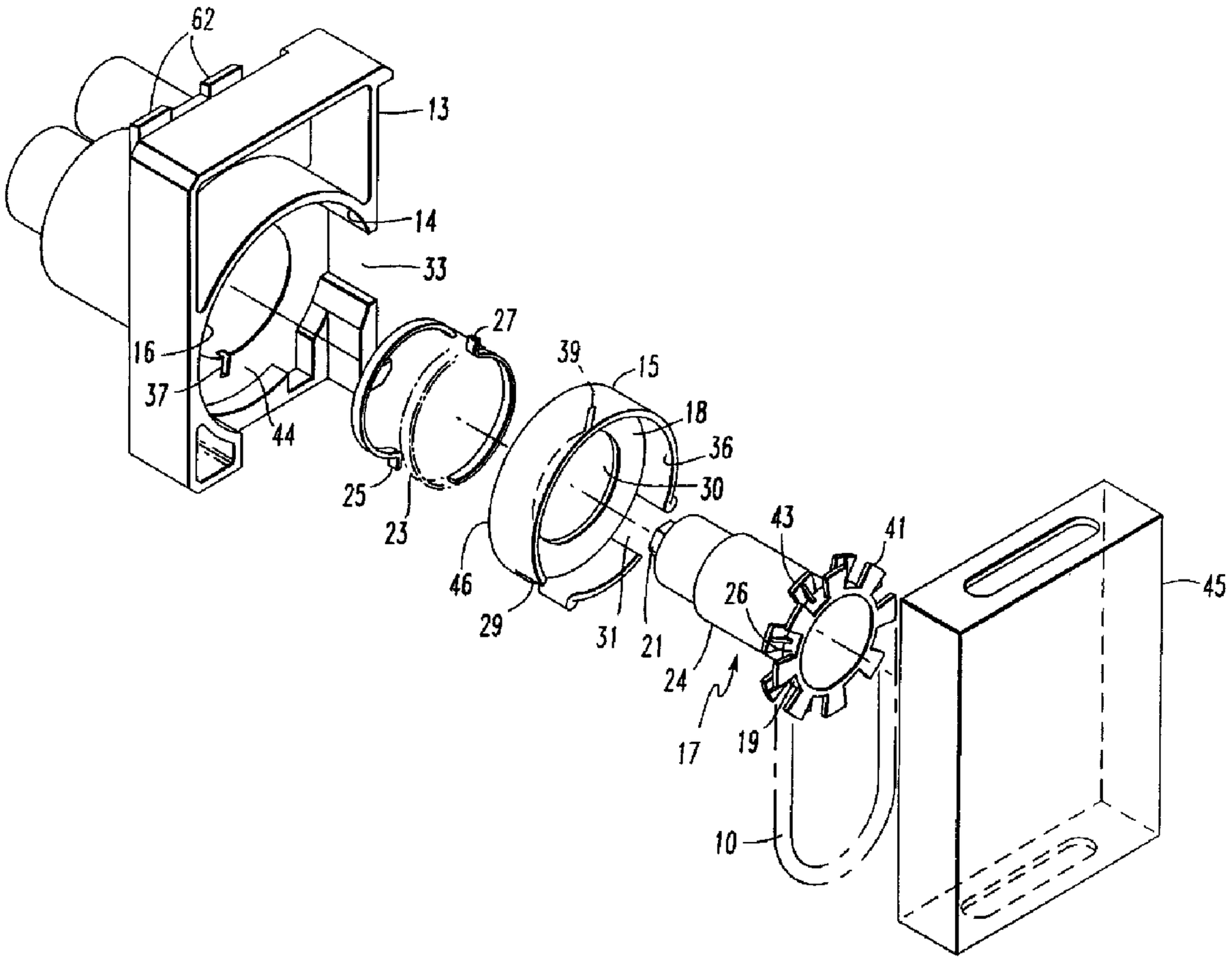
(54) Titre : FREIN A DEBLOCAGE POUR STORES ET AUTRES COUVRE-FENETRES
(54) Title: RELEASE BRAKE FOR ROLLER SHADES AND OTHER WINDOW COVERINGS



(57) Abrégé/Abstract:
A release brake (1) for a window covering (4, 28) of the type having a roller (2) about which either a window covering material or lift cords (10, 12) are wound as a stationary member (20), a movable member in the shape of a drum (15), and a hub (17). In one embodiment particularly useful for a roller shade, the hub (17) is fixed and the surrounding movable member (15) can be restrained

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(57) Abrégé(suite)/Abstract(continued):
or released by a coil spring (23) encircling the hub (17). In another embodiment the member which surrounds the hub (17) is fixed and the hub (17) can be restrained or released by a coil spring (23) encircling the hub. The spring (23) is sized and positioned so that the spring (23) will press against the outside surface of the hub (17) when in a relaxed condition to restain the hub (17) or sized and positioned to press against the inside surface of the movable member when in a relaxed condition to restain that member. The tangs (25, 27) of the spring (23) are moved relative to one another to increase the diameter of the spring (23) which releases the hub (17) and allows it to rotate freely or to decrease the diameter of the spring (23) which releases the movable member (15) and allows it to rotate freely.

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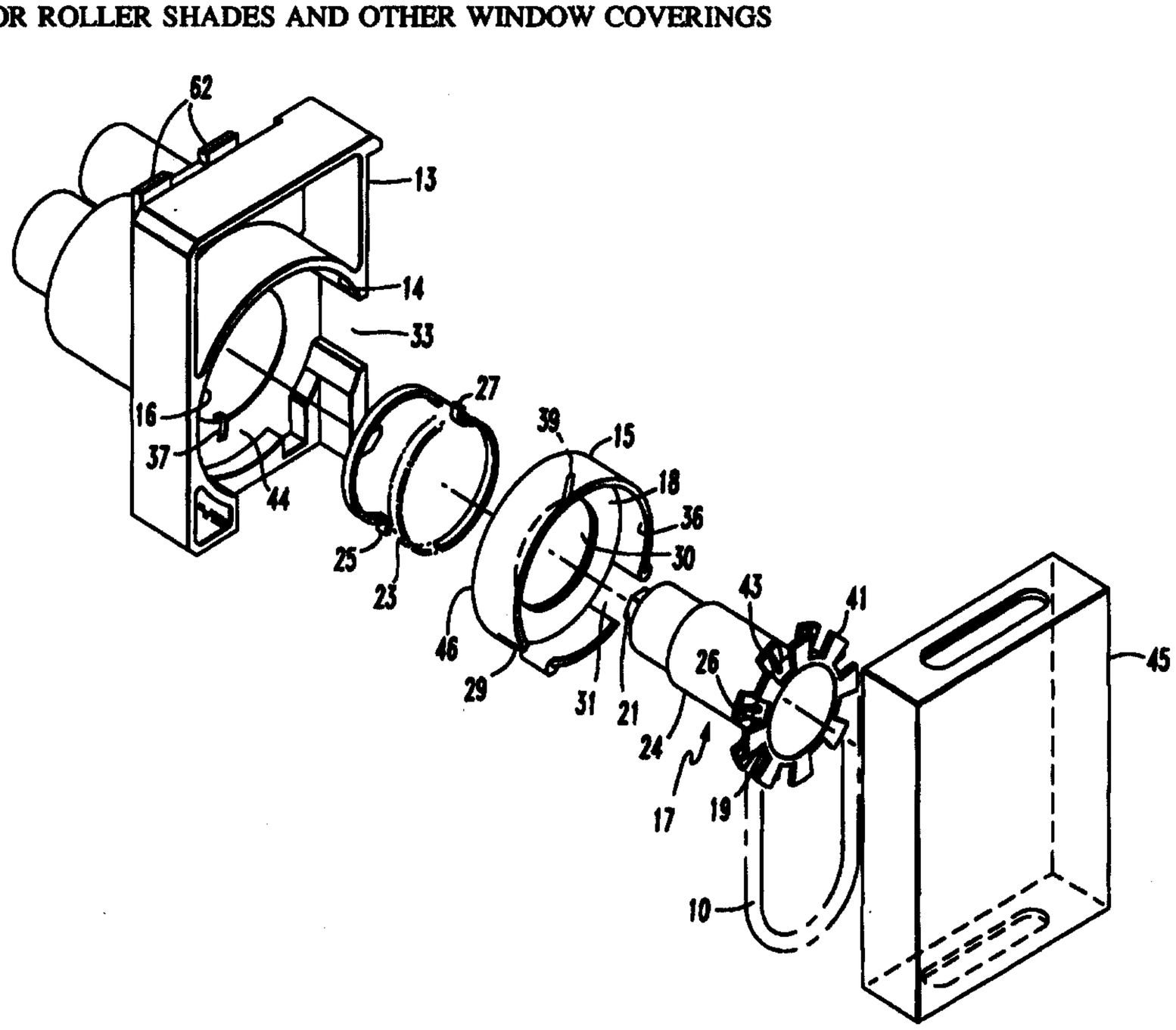
(54) Title: RELEASE BRAKE FOR ROLLER SHADES AND OTHER WINDOW COVERINGS

(57) Abstract

A release brake (1) for a window covering (4, 28) of the type having a roller (2) about which either a window covering material or lift cords (10, 12) are wound as a stationary member (20), a movable member in the shape of a drum (15), and a hub (17). In one embodiment particularly useful for a roller shade, the hub (17) is fixed and the surrounding movable member (15) can be restrained or released by a coil spring (23) encircling the hub (17). In another embodiment the member which surrounds the hub (17) is fixed and the hub (17) can be restrained or released by a coil spring (23) encircling the hub. The spring (23) is sized and positioned so that the spring (23) will press against the outside surface of the hub (17) when in a relaxed condition to restain the hub (17) or sized and positioned to press against the inside surface of the movable member when in a relaxed condition to restain that member. The tangs (25, 27) of the spring (23) are moved relative to one another to increase the diameter of the spring (23) which releases the hub (17) and allows it to rotate freely or to decrease the diameter of the spring (23) which releases the movable member (15) and allows it to rotate freely.



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TITLE

RELEASE BRAKE FOR ROLLER SHADES AND OTHER WINDOW COVERINGS

FIELD OF THE INVENTION

The present invention relates to a device for operating and positioning a window covering, particularly a covering that is raised and lowered like a roller shade, a pleated shade, or a venetian blind.

DESCRIPTION OF THE PRIOR ART

In a roller shade window covering material is rolled and unrolled around a tubular core hung on brackets. Conventionally, a spring is provided within the core to raise and counterbalance the lowering of the shade. In a pleated or cellular shade, lift cords are rolled or unrolled about take up spools carried on a central shaft. Conventionally, the shaft, take up spools, and the shade operating mechanism is enclosed within a headrail which is hung on brackets. Additionally, a bottom rail is usually provided for added weight at the bottom of the shade to assist in lowering the window covering when the lift cords are unrolled.

The prior art most commonly used for controlling the vertical position of a roller window shade is the ratchet and pawl mechanism. Examples of this mechanism are shown in United States Patent Nos. 203,414 and 2,140,049. The ratchet and pawl mechanism has been in use for many years, but it is notoriously unpopular among users. Criticisms include the necessity of handling the shade material in order to operate the shade, and unreliable operation. Ratchet and pawl mechanisms are often difficult to engage and can only be set at heights corresponding to the tooth spacing of

the ratchet. Many times the ratchet and pawl mechanism wears out before other components of the shade.

Another prior art device for controlling window shades is the friction brake. Examples of such brakes are disclosed in United States Patent Nos. 5,184,660 and 5,482,105. These devices have a coiled spring between a central core and a sleeve. These devices apply a fixed torque to resist rotation of the shade roller no matter which direction the roller is turned. These devices suffer from the disadvantage that a substantial force is needed to raise the shade.

The prior art also contains examples of clutch mechanisms that are adapted for the operation of roller shades. Among these are United States Patent Nos. 4,372,432 and 5,361,822. Prior art clutch mechanisms overcome some of the disadvantages of ratchet and pawl devices, but they have some disadvantages of their own. The clutch based devices are operated by a cord loop that hangs from one end of the shade roller. The cord loop eliminates the need for handling of the shade material or a protective shield attached thereto, and the clutch mechanism allows the height of the shade to be precisely set. It also permits the shade to be operated from one end rather than from the center which can be difficult to reach if the window is behind a piece of furniture. Also, clutch devices tend to be somewhat more expensive than the ratchet and pawl devices, and they require some amount of lost motion to insure proper operation. This lost motion is apparent when beginning to raise the shade. When the cord is first pulled, some motion is required before the shade begins to move. Also, the lost motion can contribute to an oscillating, or surging motion while the shade is lowered.

Clutches and friction brakes have also been used in pleated shades and venetian blinds where the lift cords are wound around a take-up roll located within the headrail. The take-up roll is driven by a loop cord or motor. The loop cord is the subject of child safety concerns and the motorized system is significantly more expensive.

Consequently, there is a need for a reliable release brake that allows an operator to easily raise and lower shades to any desired position. Preferably, the release brake should be easy and inexpensive to manufacture and not have any protruding components which could be broken off.

SUMMARY OF THE INVENTION

I provide a release brake for a window covering of the type having a roller about which either a window covering material or lift cords are wound. There is a stationary member, a movable member, in the shape of a drum and a hub. In one embodiment particularly useful for a roller shade the hub is fixed and the surrounding movable member can be restrained or released by a coil spring encircling the hub. In another embodiment the member which surrounds the hub is fixed and the hub can be restrained or released by a coil spring encircling the hub.

In the latter embodiment the movable member is a tube and the hub is a tube or solid cylinder sized to rotate relative to the movable member and the stationary member. A spring having a selected diameter is fitted laterally between the stationary member and the movable member and lightly rubs on the exterior surface of the cylindrical hub. A first tang at one end of the spring is attached to the stationary member. The second tang at an opposite end of the spring is attached to the movable member so that one tang can be moved relative to the other tang to change the diameter

of the spring. The spring is sized and positioned so that the spring will encircle and lightly press against the outside surface of the hub when in a relaxed condition. When the hub is turned in the direction to lower the shade the spring quickly changes diameter to bind the hub, but when the hub turns in the opposite direction the spring changes diameter in the opposite direction and releases the hub. When the tangs of the spring are moved relative to one another to increase the diameter of the spring, the spring does not restrain movement of the hub. This allows a shaft or roller attached to the hub to turn freely. Then the lift cords on the shaft or the shade wound around a roller may unwind or be wound by the operator. A counter balance spring is attached to the shaft or roller.

In a similar preferred embodiment that has lift cords there is a spool attached to the hub at one end and a square or hex shaped projection at an opposite end. The hub and movable member fit within a recess in the stationary member. Additionally, the spool fits within a cylindrical recess in the face of the movable member. The hub drives the shaft via the hex shaped projection. Preferably the hub is offset from the central shaft towards the front of the headrail using an arrangement of two offset gears. Also, a slip clutch is preferably interposed between the central shaft and the offset gear which drives it.

Other details, objects and advantages of my invention will become apparent from the following description and the accompanying drawings of certain presently preferred embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawing figures, certain preferred embodiments of the invention are illustrate in which:

Figure 1 is a front view of a roller shade containing a present preferred release brake release brake in a fully lowered position.

Figure 2 is a front view similar to Figure 1 showing the roller shade in a partially lowered position.

Figure 3 is a perspective view of an end portion of a pleated shade in a fully raised position which shade contains a present preferred release brake that utilizes a release cord.

Figure 4 is a perspective view of a pleated shade similar to the pleated shade of Figure 3 shown in a lowered position and with the headrail partially cut away to show the central shaft and take up spools for the lift cords.

Figure 5 is an end view partially cut away of a roller shade showing a counterbalance spring within the shade.

Figure 6 is an exploded view of the present preferred release brake.

Figure 7 is a top view partially in section of the present preferred release brake.

Figure 8 is a perspective view of a present preferred alternative spring that can be used in the present preferred release brake.

Figure 9 is a sectional view taken along the line IX-IX in Figure 4.

Figure 10 is a perspective view partially in section of a present preferred offset gear drive for the present preferred release brake.

Figure 11 is a perspective view of a gear spacer and cover for the gear drive shown in Figure 10.

Figure 12 is a top plan view of a right portion of a headrail containing my release brake and a present preferred travel limiting mechanism.

Figure 13 is a side view partially in section of the travel limiting mechanism shown in Figure 12.

Figure 14 is a perspective view of the end portion of a pleated shade similar to the pleated shade of Figure 3 in a fully lowered position.

Figure 15 is an end view of another present preferred release brake.

Figure 16 is an exploded view of the release brake shown in Figure 15.

Figure 17 is an end view of the preferred release brake of Figure 15 with the linkage in a gripping position.

Figure 18 is an end view similar to Figure 17 showing the linkage in a release position.

Figure 19 is an end view of the release brake of Figure 15 having a loop cord attached thereto with the linkage in a locked position.

Figure 20 is an end view similar to Figure 19 with the linkage is a release position.

Figure 21 is a sectional view showing a present preferred cord gripping device on the operating cord.

Figure 22 is a perspective view of a second present preferred spring that can be used in the embodiment of Figures 15 thru 21.

Figure 23 is a side view of yet another present preferred release brake partially in section.

Figure 24 is a sectional view taken along the line XXIV-XXIV of Figure 23.

Figure 25 is an end view of a another present preferred release brake in a gripping position.

Figure 26 is an end view of the release brake of Figure 25 in a release position.

Figure 27 is an end view of another present preferred release brake in a gripping position;

Figure 28 is an end view of the release brake of Figure 27 is a release position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

I provide a release brake which may also be called a shade operator that may be used in conjunction with a roller shade 4 such as shown in Figures 1 and 2 or a pleated or cellular shade 28 such as shown in Figures 3 and 4. When used in a roller shade, the release brake 1 is provided at one end of the roller shade. This shade is mounted on window frame 6 by bracket 7. As can be seen most clearly in Figure 5 there is a roller axle 20 which fits within a slot in the bracket 7. This connection keeps the roller axle 20 stationary while the roller 2 may rotate around stationary roller axle 20. An optional counteracting spring 22 is provided within the roller at the end opposite my release brake. One end of the counteracting spring is attached to roller 2 while the opposite end is attached to a stationary axle 20. The spring is in a relaxed position when the shade is somewhere in between the fully raised and fully lowered position. This may be higher or lower than shown in Figure 2. One way to accomplish

this is to disengage the axle 20 from the bracket when the window covering is at the desired position. The spring unwinds to a relaxed state and the axle 20 is replaced onto the mounting bracket after the spring has unwound. The spring 22 winds when the shade is moved up or down from the neutral position. The spring is not intended to lift the shade, but simply to slow the descent speed and partially counter-balance the load. When the shade is moved up from the neutral position, the spring 22 winds and encourages the shade to descend. This is helpful when the shade is completely raised and wrapped on the roller and the edge of the shade is rubbing against the bracket or spool. In this case, the weight of the shade is insufficient to overcome the friction in the system and lower the shade. The tension in spring 22 can overcome the friction and ensure that the shade descends.

I prefer to provide a looped cord 10 shown in Figure 4 to operate those blinds having lift cords. For those shades having a roller, I prefer to use tape or cord 40 wound around the spool as shown in Figure 3. As the shade is lowered the tape 40 is rolled onto the spool. Conversely, when the shade is raised the tape 40 is unrolled from the spool. A release cord 12 is provided to release the release brake.

In the pleated or cellular shade 28 shown in Figures 3 and 4, the headrail is mounted to the window frame in a conventional manner. The lift cords 8 of the pleated or cellular shade are wound about take-up spools 9 within headrail 3 as shown in Figure 4.

Referring now to Figures 6 and 7, one present preferred embodiment of my release brake 1 has a fixed housing 13 with a cylindrical recess 14 in the front face and a stepped cylindrical bore 16 in the recessed portion 18 which extends entirely through the fixed housing 13. A movable member 15, in the shape of a cylindrical

drum, is rotatably disposed in the cylindrical recess 14 and a hub 17 having a cylindrical body 24 which is rotatably disposed through a cylindrical bore 30 in the movable member 15 and also extends through the cylindrical bore 16 in the fixed housing 13. The movable member 15 also has a cylindrical recessed face 18 sized to rotatably enclose a spool 19 which is rigidly attached to one end of the cylindrical body 24 of the hub 17. The hub 17 also has a square or hex shaped projection 21 extending longitudinally from the end of the hub 17 opposite the spool 19. The projection 21 extends through the bore 16 in the fixed housing 13. A spring 23 is provided around the cylindrical body 24 of the hub 17 and is positioned between a step in the fixed housing 13 and the movable member 15. The spring 23 is preferably a coil spring, but a spring 67 formed from a flat coil, as shown in Figure 8, could also be satisfactorily employed. The bore 16 in the fixed housing 13 and the rear face of the movable member 15 each have a notch 37, 39 provided therein for retaining one of two tangs 25, 27 provided at opposite ends of the spring 23. The opposite faces of the tangs 25, 27 which press against the adjacent side, or bearing surface, of the slots when a face acts on the spring or movable member. The inside of the diameter of the spring 23, or 67, is sized to lightly grip the outside surface of the cylindrical body 24 of the hub 17 in order to sense the direction of rotation and allow rotation in one direction and prevent rotation in the other direction. The movable member 15 is rotated to cause the tang 27 retained in the notch 39 in the movable member 15 to be moved with respect to the opposite tang 25, which is retained in the fixed housing 13. The spring 23 is positioned such that counter clockwise rotation of the movable member 15 causes the coils of the spring 23 to open up which allows the hub 15 to rotate freely inside the coil. Thus,

rotation of the movable member 15 counter clockwise releases the hub allowing the release brake or lift cord shaft to freely rotate. In that condition the window blind is free to fall to a fully lowered position or a kickoff and counterbalance spring attached to the roller will unwind turning the shaft or roller.

The cord 10 is preferably a looped cord and is positioned around the spool 19 in a channel 26. However, a separate release brake cord 12 combined with a spooled ribbon could be satisfactorily employed in place of the looped cord 10 as shown in Figure 3. The channel 26 is defined by a number of opposed, offset tabs 41 which project radially from the spool 19. Additionally, I prefer to provide triangular ribs 43 extending from each tab 41 into the channel 26. When the cord 10 is disposed in the channel 26 the ribs 43 help to grip the cord 10 to prevent slipping and provide positive shade movement. The diameter of the cord 10 is sized to fit snugly in the channel 26 in the spool 19 and is enclosed therein by the sidewalls 36 of the inside portion 18 of the movable member 15. Both ends of the cord loop 10 extend through the front of the headrail 3 through two openings 29, 31 provided in the sidewalls 36 of the recessed portion 18 of movable member 15. Preferably, one wide opening 33 is provided in the fixed housing 13 adjacent to the two openings 29, 31 in the movable member 15 which is large enough to permit both ends of the cord loop 10 to pass therethrough. Finally, a similar single opening in the cover permits the loop to descend to the person operating the shade.

Each opening 29, 31 in the movable member 15 has preferably a curved lip 32, 34, shown best in Figure 9 over which of the cord loop 10 travels. Pulling downward on either side of the cord 10 applies a downward force on one of the curved lips 32, 34. The downward force causes the movable member 15 to rotate. Even a

slight rotation of a few degrees is all that is required to expand the spring 23 and release the hub 17 to permit the spool 19 to rotate freely. Since both ends of the cord loop 10 exit the spool 19 on the front side of the headrail 3, the movable member 15 is rotated counter clockwise regardless of which direction the spool 19 is rotated. When the cord 10 is released the spring 23 returns to its undeflected state and regains its light grip on the hub 17. The weight of the shade will turn the hub 17 in a clockwise direction which will cause the spring to grip progressively tighter to lock the shade in whatever position it is in when the cord 10 is released. Additionally, an end cap 45 may be provided to enclose the hub 15, spool 19, and movable member 15 within the recess 14 in the fixed housing 13. The assembly is placed within and attached to a headrail or for a roller shade hung on a mounting bracket as shown in Figure 1. An alignment cover 59 shown in Figure 11 fits over the opposite end of the assembly as shown in Figure 7 and serves to align and contain the gears and the slip clutch.

One presently preferred embodiment of my release brake operator 1 employs a hub 17 which is offset from the take-up shaft 5 as can be seen in Figure 7. The offset is accomplished using gears 47 and 49 in the arrangement shown in Figure 10. Openings 56, 58 in the back face of the cover 59 provide proper spacing and alignment of first gear 47 and offset gear 49. The openings 56, 58 additionally provide bearing surfaces to support the end 48 of the first gear 47 and the shaft 5 or slip clutch 53, whichever is attached to the offset gear 49. The gear system offsets hub 17 towards the front of the headrail 3. This feature is advantageous because it reduces the path of the looped cord 10 within the headrail 3. Consequently, the cord 10 is nearer to the edge of the headrail 3 and thus is not dragged along the bottom of the headrail 3 as far as it would if shaft 5 was along a centerline through the headrail as occurs in nearly all

blinds. This both lowers the friction, which makes it easier to rotate the spool 19, and increases the life span of the cord 10 since it will not wear as quickly. Of course, one could connect shaft 5 directly or through a slip clutch to the hub 17. This gear system could be used in a motorized shade wherein a motor and gear box would be substituted for the clutch.

My present preferred offset gear drive mechanism is illustrated in Figure 10. A first gear 47 is connected to the square or hex projection 21 on the end of the hub 17 which projects through the fixed housing 13. Then, a square or hex bore 51 in the mating face of the first gear 47 is provided to connect it to the hub 17. Next, an offset gear 49 is positioned in meshed engagement with the first gear 47. Besides the advantage of having the spool 19 offset to the front of the headrail, the gears 47, 49 can be interchanged. Consequently, the drive mechanism is interchangeable between a 1.7:1 ratio and a 3:1 ratio by merely switching the two gears 47, 49. The 1.7:1 and 3:1 ratios are obtained using the presently preferred gear sizes. These ratios were selected because many in the industry use a 1.7:1 gear ratio for smaller, lighter shades and a 3:1 ratio for wider, heavier shades. Consequently, this operator can be used for either type by simply switching gears. If desired, different ratios can be obtained using a different combination of gear sizes.

The face of the offset gear 49 is also provided with a square or hex bore 51 which mates with the square or hex shaped shaft 5. Most lift cord shafts used in the industry are metal and hex shaped. However, a square bore provides a better coupling for plastic parts. I prefer to provide a slip clutch 53 interposed between the offset gear 49 and the shaft 5. The slip clutch 53, as shown in Figure 10, has a square or hex shaped end 55 which is sized to mate with a correspondingly square or hex shaped bore

51 in the offset gear 49. The opposite end of the slip clutch 53 has two or more prongs 57 separated by a slot 56 on either side. The prongs 57 define a square or hex shaped bore for receiving the shaft 5. The prongs 57 are sufficiently flexible such that if torque is applied to the shaft 5 by the hub 17 and the shaft 5 resists turning, the shaft 5 can slip within the prongs 57. The resistance of the slip clutch can be controlled by changing the length and width of slot 56 and by changing the dimensions of the ridges 54. This feature is advantageous as a safety mechanism to prevent breaking the lift cords 8, the gears or the loop. When the blind is raised completely up and the lift cords 8 are fully wound on the take up spools 6, the lift cords 8 may be broken if the spool 19 continues to be rotated causing the shaft 5 to rotate. If enough torque were applied to the shaft 5, the cord loop, spool teeth, gear teeth or lift cords 8 could break. However, with the slip clutch 53 in place, if torque is applied after the lift cords 8 are fully wound, the shaft 5 can slip within the prongs 57 of the slip clutch 53 to prevent breaking the lift cords 8. Another situation where the slip clutch is desirable is where the shade is somehow caught while being drawn up. If the spool 19 continued to be rotated the shaft 5 would slip and the lift cords 8 would not be in danger of breaking. The clutch 53 should slip prior to the breaking point of the lift cords, cord loop, spool teeth or gear teeth. Since the industry is moving toward smaller diameter lift cords, the slip clutch is an important feature in many window blinds.

I prefer to provide a travel limiting mechanism for my release brake 1 which is shown in Figures 12 and 13. The travel limiting rack described is an additional mechanism provided to prevent over winding of the lift cords 8 on the take up rollers or spools 9. The travel limiting mechanism is preferably a fixed housing or rack 61 which is attached to the headrail 3. The rack 61 is provided with stops 62, 64.

A shaft 5 extends from the slip clutch 53 of the release brake 1 through the headrail 3. Lift cord spools 9 are attached to the shaft 5. A nut 68 rides freely on the shaft which typically has a hexagonal cross section. I prefer to provide external threads on the nut which engage a threaded member 66 of the rack. As the shaft 5 rotates the nut 68 moves along the shaft 5 until the nut hits stop 62 or stop 64. The stops 62, 64 limit the travel of the nut 68 and thus prevent further rotation of the shaft 5. Tabs 70 and 71 are provided on the opposite faces of the nut 68 to engage a landing on the stops 62 or 64. Alternatively, the nut 68 can be affixed to the shaft and the entire rack 61 can move along the threaded portion 65 of the shaft 5 as it is rotated. Travel of the rack 61 within the headrail 3 can be limited by stops provided at certain positions in the headrail 3. Those stops could be cradles which hold shaft 5 and spool assembly 9. Both the nut and the rack slide freely on the shaft and in the headrail respectively. The travel of the rack is limited by stops such as cradles. The nut is limited by the rack and the rotation of the shaft is limited by the nut and finally the length of the shade is limited by the shaft.

In another preferred embodiment of my release brake shown in Figure 14 a spool tape or cord 40 is wound around the spool 11. As the shade is lowered the tape 40 is rolled onto the spool. Conversely, when the shade is raised the tape 40 is unrolled from the spool. A release cord 12 is attached to linkage 114. Pulling the release cord causes the linkage 14 to move downward allowing the take-up speed or roller 131 to turn freely.

In the pleated or cellular shade 128 shown in Figure 14, tang 150 extends from the operator through end plate 135 to the headrail. The headrail is mounted to the window frame in a conventional manner. The lift cords 130 extend

from the bottomrail 127 through the pleated or cellular shade material and are wound about a take-up spool 131 within headrail 126 as shown in Figure 14. For this embodiment I provide a tape cord 40 which is wider than release cord 12. As shown in Figure 15, the release cord 12 terminates at the release handle 113 while the spool tape 40 passes through the handle 113 and terminates at the tassel 115.

Referring now to Figures 16, 17 and 18, the present first preferred embodiment of my release brake has a generally cylindrical hub 118 with central cavity 117. Spool 111 is attached at one end of hub 118. The hub is sized so that the roller of the roller shade or take-up spool or tube of a pleated or cellular shade will snugly fit over the hub 118. Thus, when hub 118 turns the roller or tube will also turn. Coil spring 142 has two tangs 145 and 147 that are turned inwardly toward a center line through the spring. Spring 142 fits over core 144 so that tang 145 is retained in hole 146a and tang 147 is retained in slot 146. This assembly then fits within cavity 117 of hub 118. Spring 142 is sized so that in a relaxed state the spring will press lightly against the inner surface of cavity 117. When blade 150 is held in a bracket, core 144 is restrained from movement. Thus, when the hub 118 rotates in one direction, the friction with the spring will tend to expand the spring diameter which will press against the interior surface of hub 118 increasing the friction until the hub can no longer turn under normal operating loads since the spring is held fast by tang 147. That tang 147 is contained in hole 146a in core 144. The core 144 is restrained by the blade 150 that is held in a bracket which is fastened to the wall or window frame. Consequently, hub 118 and attached roller or spool will not move. When the hub 118 is turned in the other direction, the friction tends to reduce the spring diameter which in turn reduces the diameter of the spring allowing the hub and attached roller or spool to rotate. A bore

143 is provided for receipt of stub shaft 149. Tang 147 is fitted through slot 146 and into hole 148 provided in stub shaft 149. Linkage 114 is attached to shaft 149. When assembled the linkage will be positioned as shown in Figure 17 at a resting position between surfaces 153 and 154. Those surfaces act as stops limiting the movement of the linkage. A force acting on the distal end 155 of the linkage will cause the linkage to move through an arc to a position shown in Figure 18. Movement of linkage 114 turns shaft 149 moving inserted tang 147. This acts to reduce the diameter of spring 142 so that the spring no longer presses against the inner surface of the cavity 117. Consequently, hub 118 and the attached roller or spool are free to rotate in either direction. Generally this action allows gravity to pull the shade down. The weight of the shade is normally opposed by the spring expanding and binding the hub. This is automatic unless the action is disabled by the operator via the linkage. If the counterbalance spring is then in tension, the spring will retract causing the roll to move until the spring reaches its rest position. This is particularly useful in roller shades where the force of gravity is very small when the shade is all the way up.

Spool 111 may be sized to receive one cord, ribbon or tape which is wound about the spool. In that embodiment a release cord 114 would be attached to the distal end 155 of linkage 114. In an alternative arrangement shown in Figures 19 and 20 a cord or bead chain loop 151 is provided. This loop encircles spool 111 (which would have teeth or some other means to engage the loop) and is draped over a saddle 152 which extends transversely from linkage 114. Pulling on the rear half of the loop causes the linkage 114 to move backward contracting the spring 142 which allows free movement of the spool and the roller attached to hub 118.

When a single spool cord is used I prefer to provide a gripping device 160 shown in Figure 21. This gripping device has a generally oval main body 162. Holes 163 and 164 are provided at opposite ends of the body to allow passage of spool cord 110. Teeth 166 are provided on the interior surface of the body 162. When the body is squeezed together the teeth will engage and grip cord 110 allowing the cord to be easily pulled by the operator. For convenience I prefer to provide a finger loop 165 on the main body. Body 162 is made of a flexible, resilient material such that when squeezing pressure is released the body will return to its original position shown in Figure 21 allowing the gripping device to be easily slid along the cord. This gripping device is particularly useful for very thin cords. Thin cords allow longer lengths to be wound in a smaller space which means smaller edge clearance is possible.

Although the spring shown in Figure 16 has multiple coils, it should be understood that one could use a wider spring band. Such a wider spring 142a is shown in Figure 22. This spring can be substituted for spring 142 in the embodiment of Figure 16. As with spring 142 tang 147a fits in hole 148 on shaft 149 and tang 145a fits in hole 146 of core 144.

In another present preferred embodiment shown in Figures 23 and 24, I provide a sleeve 174 which fits between the core 170 and the hub 168 within cavity 167. As in the previous embodiment, the core has a blade 171 which extends through and is held in a bracket 172. Consequently, core 170 remains stationary. The bracket may have a flange 173 with a window that the spool cord or ribbon passes through. The sleeve 174 also has a flange 175 which extends upward between the bracket 172 and the spool 169 and wraps around the cord opening of the spool. The sleeve 174 is contained longitudinally between stops on the cord 170 and the hub 168. Sufficient

space is provided between the sleeve flange 175 and the spool 169 so that the hub and attached pulley may turn relative to the sleeve 174 and core 170 when not restrained by spring 176. Spring 176 has a first tang 177 that is attached to the sleeve and a second tang 178 that fits into stationary core 170. As can be seen from Figure 24 when one pulls either end of the loop cord 151 that will cause the sleeve 174 to rotate downward as indicated by the arrow in Figure 24. The loop cord normally fills the space between the spool and the sleeve. However, in the drawings the cord is shown smaller for better clarity. Since one tang 177 of spring 176 is affixed to that sleeve rotation of the sleeve will cause the spring to tighten to a smaller diameter. As a consequence, the spring will no longer rest against the inner surface of cavity 167 allowing the hub 168 and roller 190 to freely turn. The sleeve is oriented so that a downward force on either side of loop 151 will cause the sleeve to turn contracting the spring 176 and releasing hub 168.

In a third embodiment shown in Figures 25 and 26 a central hub 88 is provided which carries the roller or means for collecting cords to lift a shade. Housing 80 has a point 81 to which one end of a resilient member 82 is attached. The resilient member may be a strip of spring steel or plastic, or a leather strap. This member encircles hub 88 and is connected at its other end to a sleeve 81 which in turn is connected to a release cord 86. If a leather strap is used, a tension spring 83 is provided to lightly bias the leather strap against the hub 88. The combination of the leather strap 82 and spring 83 function in the same manner as a resilient metal or plastic strap. Release cord 86 is attached to one end of the strap directly or via a sleeve 82 which partially encloses the strap. When the lift cord is pulled and the hub is turned opposite the direction of the arrows, the strap is loosened because the friction pushes the strap towards the end fixed to the housing allowing the hub 88 to rotate freely relative to the

housing 80. When the load tries to turn the hub in the direction of the arrow the strap tightens around the hub and prevents it from turning further. The sleeve rotating opposite this arrow will put slack on the strap so that the hub can turn freely in either direction. The sleeve may be turned by a cord loop as in some of the embodiments already described or by a release cord connected to the sleeve and or the strap end that is not fixed to the housing.

A fourth embodiment shown in Figures 27 and 28 utilizes a pawl and ratchet arrangement. In this device, teeth 84 are provided about the exterior of hub 98 to which the shade roller is attached. Hub 98 fits through an opening in the stationary housing 90. A pawl 92 is carried on stationary housing which is spring biased by spring 93 to press the pawl against teeth 94 on the hub 98. A release cord 96 is attached to the pawl 92. When an operator pulls the release cord 96 the pawl is disengaged from hub 88 allowing it to turn.

While specific embodiments of my invention have been described in detail, it will be appreciated by those skilled in the art that various modifications to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular embodiments disclosed herein are intended to be illustrative only and not limiting to the scope of my invention which should be awarded the full breadth of the following claims and all embodiments thereof.

I claim:

1. A release brake for a window covering of the type having at least one roller about which one of a window covering material and lift cords are wound comprising:

a. a stationary member having a bore passing through the stationary member;

b. a movable member which is movable relative to the stationary member when not restrained, the movable member having a bore passing through the movable member which bore is aligned with the bore passing through the stationary member;

c. a hub disposed through the bore in the movable member and the bore in the stationary member, the hub having an outside surface; and

d. an elongated resilient member having opposite ends, the resilient member encircling the outside surface of the hub, the resilient member attached at one end to the stationary member such that relative movement between the movable member and the hub in one direction will cause the resilient member to move toward the hub and relative movement in an opposite direction will cause the resilient member to move away from the hub so that the movement of the hub of movement or the movable member can be restrained or permitted.

2. The release brake of claim 1 wherein the elongated resilient member is a spring having a selected diameter, a first tang at one end and a second tang at an opposite end, the first tang attached to the stationary member and the second tang

attached to the movable member the spring sized to press against the outside surface of the hub when in a relaxed condition, such that movement of the movable member will move one tang of the spring relative to the other tang to increase the diameter of the spring so that the spring does not restrain movement of the hub.

3. The release brake of claim 1 further comprising a first gear connected to a first end of the hub and an offset gear in meshed engagement with the first gear.

4. The release brake of claim 3 wherein the first end of the hub and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the hub and said roller such that the first gear and the offset gear are interchangeable.

5. The release brake of claim 3 further comprising a slip clutch interposed between the offset gear and the roller.

6. The release brake of claim 5 wherein the slip clutch comprises:

a. a first end connected to the offset gear; and

b. a second end connected to the roller, the second end having a plurality of prongs which have inside surfaces defining a bore having a certain cross section, the roller having a cross section corresponding to said certain cross section, the plurality of prongs being resiliently flexible such that a predetermined amount of torque will cause the prongs to deflect outwards allowing the roller to rotate within the bore,

and the prongs then returning to an undeflected state about when the torque is less than the predetermined amount.

7. The release brake of claim 6 wherein the first end of the slip clutch and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the slip clutch and the roller.

8. The release brake of claim 1 also comprising a spool attached to the hub.

9. The release brake of claim 8 also containing a cord connected to the spool.

10. The release brake of claim 9 wherein the cord is a looped cord.

11. The release brake of claim 9 wherein the cord is attached to the spool in a manner to be wound and unwound around the spool.

12. An improved roller shade of the type having a roller about which window covering material is rolled and unrolled wherein the improvement comprises a release brake comprised of:

a. a stationary member having a bore passing through the stationary member;

b. a movable member which is movable relative to the stationary member when not restrained, the movable member having a bore passing through the movable member which bore is aligned with the bore passing through the stationary member;

c. a hub rotatably disposed through the bore in the movable member and the bore in the stationary member, the hub having one end connected to the roller and having an outside surface; and

d. a spring having a selected diameter, a first tang at one end and a second tang at an opposite end, the first tang attached to the stationary member and the second tang attached to the movable member the spring sized to press against the outside surface of the hub when in a relaxed condition, such that the movement of the movable member will move one tang of the spring relative to the other tang to increase the diameter of the spring so that the spring does not restrain movement of the hub.

13. The improved roller shade of claim 12 also comprising a counterbalance spring attached to the roller.

14. The improved roller shade of claim 12 further comprising a first gear connected to the first end of the hub and an offset gear in meshed engagement with the first gear and connected to the roller.

15. The improved roller shade of claim 14 wherein the first end of the hub and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive

therein one of said first end of the hub and said roller such that the first gear and the offset gear are interchangeable.

16. The improved roller shade of claim 14 further comprising a slip clutch interposed between the offset gear and the roller.

17. The improved roller shade of claim 16 wherein the slip clutch comprises:

a. a first end connected to the offset gear; and

b. a second end connected to the roller, the second end having a plurality of prongs which have inside surfaces defining a bore having a certain cross section, the roller having a cross section corresponding to said certain cross section, the plurality of prongs being resiliently flexible such that a predetermined amount of torque will cause the prongs to deflect outwards allowing the roller to rotate within the bore, and the prongs then returning to an undeflected state about the roller when the torque is less than the predetermined amount.

18. The improved roller shade of claim 17 wherein the first end of the slip clutch and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the slip clutch and the roller such that the first gear and the offset gear are interchangeably connectable to the first end of the slip clutch.

19. The improved roller shade of claim 12 also comprising a spool attached to a hub and a cord connected to the spool.

20. The improved roller shade of claim 19 wherein the cord is a looped cord.

21. The improved roller shade of claim 19 wherein the cord is attached to the spool in a manner to be wound and unwound around the spool.

22. An improved blind of the type having a roller about which lift cords are rolled and unrolled wherein the improvement comprises a release brake comprised of:

a. a stationary member having a bore passing through the stationary member;

b. a movable member which is movable relative to the stationary member when not restrained, the movable member having a bore passing through the movable member which bore is aligned with the bore passing through the stationary member;

c. a hub rotatably disposed through the bore in the movable member and the bore in the stationary member, the hub having one end connected to the roller and having an outside surface; and

d. a spring having a selected diameter, a first tang at one end and a second tang at an opposite end, the first tang attached to the stationary member and the

second tang attached to the movable member the spring sized to press against the outside surface of the hub when in a relaxed condition, such that movement of the movable member will move one tang of the spring relative to the other tang to increase the diameter of the spring so that the spring does not restrain movement of the hub.

23. The improved blind of claim 22 further comprising a first gear connected to the first end of the hub and an offset gear in meshed engagement with the first gear and connected to the roller.

24. The improved blind of claim 23 wherein the first end of the hub and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the hub and said roller such that the first gear and the offset gear are interchangeable.

25. The improved blind of claim 23 further comprising a slip clutch interposed between the offset gear and the roller.

26. The improved blind of claim 25 wherein the slip clutch comprises:

a. a first end connected to the offset gear; and

b. a second end connected to the roller, the second end having a plurality of prongs which have inside surfaces defining a bore having a certain cross section, the roller having a cross section corresponding to said certain cross section, the plurality of prongs being resiliently flexible such that a predetermined amount of torque

will cause the prongs to deflect outwards allowing the roller to rotate within the bore, and the prongs then returning to an undeflected state about the roller when the torque is less than the predetermined amount.

27. The improved blind of claim 26 wherein the first end of the slip clutch and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the slip clutch and the roller such that the first gear and the offset gear are interchangeably connectable to the first end of the slip clutch.

28. The improved blind of claim 22 wherein the roller is enclosed within a headrail and further comprising a rotation limiting mechanism connected to the roller which prevents the roller from rotating when the blind is in one of a fully raised position and a fully lowered position.

29. The improved blind of claim 28 wherein the rotation limiting mechanism comprises:

a. a thread portion on the roller;

b. a rack disposed within and attached to the headrail, having spaced apart stops the threaded portion; and

c. a nut having internal threads engaging the threaded portion of the roller and positioned for movement between the stops, the stops limiting the travel of the nut along the roller to stop the rotation of the roller.

30. The improved blind of claim 29 also comprising:

a. an externally threaded member connected to the rack; and

b. external threads on the nut which engage the externally threaded member such that as the roller rotates the external threads of the nut engage the threaded member causing the nut to move along the roller.

31. The improved blind of claim 22 also comprising a spool attached to the hub and a cord connected to the spool.

32. The improved blind of claim 31 wherein the cord is a looped cord.

33. The improved blind of claim 32 wherein the cord is attached to the spool in a manner to be wound and unwound around the spool.

34. A release brake for a window covering of the type having a roller about which one of a window covering material and lift cords are wound comprised of:

a. a stationary member having a first cylindrical recess, a first cylindrical bore therethrough and a notch extending from the recess;

b. a cylindrical movable member rotatably disposed in said first recess, the movable member having a second cylindrical recess, a second cylindrical bore therethrough and a face having a notch;

c. a cylindrical hub rotatably disposed in the first and second bores through the stationary member and the movable member, the hub having a first end

connected to the roller, and an outside surface;

d. a spring disposed about the outside surface of the hub, the spring having a selected diameter, a first tang at one end and a second tang at an opposite end, the first tang retained in the notch in the stationary member and the second tang retained in the notch in the movable member, the spring sized to press against the outside surface of the hub when in a relaxed condition to restrain rotation of the hub, and the tangs of the spring movable relative to each other to increase the diameter of the spring so that the spring does not restrain movement of the hub; and

e. a cylindrical spool attached to a second end of the hub and rotatably disposed in said second cylindrical recess in the movable member.

35. The release brake of claim 34 further comprising a first gear connected to the first end of the hub and an offset gear in meshed engagement with the first gear and connected to the roller.

36. The release brake of claim 35 wherein the first end of the hub and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the hub and said roller such that the first gear and the offset gear are interchangeable.

37. The release brake of claim 35 further comprising a slip clutch interposed between the offset gear and the roller.

38. The release brake of claim 37 wherein the slip clutch comprises:

a. a first end connected to the offset gear; and

b. a second end connected to the roller, the second end having a plurality of prongs which have inside surfaces defining a bore having a certain cross section, the roller having a cross section corresponding to said certain cross section, the plurality of prongs being resiliently flexible such that a predetermined amount of torque will cause the prongs to deflect outwards allowing the roller to rotate within the bore, and the prongs then returning to an undeflected state when the torque is less than the predetermined amount.

39. The release brake of claim 38 wherein the first end of the slip clutch and the roller have a like cross section and the first gear and the offset gear each have a bore defining a cross section corresponding to said like cross section to receive therein one of said first end of the slip clutch and the roller.

40. The release brake of claim 34 also containing a cord connected to the spool.

41. The release brake of claim 40 wherein the cord is a looped cord.

42. The release brake of claim 40 wherein the cord is attached to the spool in a manner to be wound and unwound around the spool.

43. A release brake for a window covering of the type having at least one roller about which one of a window covering material and lift cords are wound comprising:

a. a stationary member having a bore passing through the stationary member;

b. a movable member which is movable relative to the stationary member when not restrained, the movable member having a bore passing through the movable member which bore is aligned with the bore passing through the stationary member;

c. a hub rotatably disposed through the bore in the movable member and the bore in the stationary member, the hub having one end connected to the roller and having an outside surface; and

d. a spring having a first tang at one end and a second tang at an opposite end, the first tang attached to the stationary member and the second tang attached to the movable member, such that movement of the movable member in a first direction will move said second tang of the spring relative to said first tang to decrease the diameter of the springs so that the spring retrains movement of the hub, and such that movement of the movable member in a second direction will move said tang of the spring relative to the first tang to increase the diameter of the spring so that the spring does not restrain movement of the hub.

44. The release brake of claim 43 wherein said stationary member and said movable member having bearing surfaces adapted to contact each other and wherein the second tang is attached to the movable member by means of said contact.

45. The release brake of claim 44 wherein the bearing surface of said movable member has a notch adapted to receive said second tang.

46. A release brake for a window covering of the type having a roller about which one of a window covering material and lift cords are wound comprising:

a. a stationary member;

b. a moveable member which is moveable relative to the stationary member when not restrained:

c. a spring having a selected diameter, a first tang at one end and a second tang at an opposite end the first tang attached to the stationary member and the second tang attached to the moveable member;

d. a hub having a cavity which has an inside surface and in which the spring is positioned the spring and cavity being sized so that the spring will press against the inside surface of the cavity when in a relaxed condition and the tangs of the spring can be moved relative to one another to reduce the diameter of the spring so that the spring does not restrain movement of the hub, and the hub sized and shaped for attachment of the roller; and

e. a spool attached to the hub.

47. The release brake of claim 46 also comprising a tang attached to the stationary member for engagement with a mounting bracket.

48. The release brake of claim 46 also containing a lift cord connected to the spool.

49. The release brake of claim 48 wherein the lift cord is a looped cord.

50. The release brake of claim 1 also comprising lift cord attached to the spool in a manner to be wound and unwound around the spool.

51. An improved roller shade of the type having a roller about which window covering material is rolled and unrolled wherein the improvement comprises a release brake comprised of:

a. a stationary member;

b. a moveable member which is moveable relative to the stationary member when not restrained:

c. a spring having a selected diameter, a first tang at one end and a second tang at an opposite end the first tang attached to the stationary member and the second tang attached to the moveable member;

d. a hub attached to the roller and having a cavity which has an inside surface and in which the spring is positioned the spring and cavity being sized so that the spring will press against the inside surface of the cavity when in a relaxed condition and the tangs of the spring can be moved relative to one another to reduce the diameter of the spring so that the spring does not restrain movement of the hub; and

e. a spool attached to the hub.

52. The improved roller shade of claim 51 also comprising a counterbalance spring attached to the roller.

53. The improved roller shade of claim 51 also comprising a tang attached to the stationary member for engagement with a mounting bracket.

54. The improved roller shade of claim 51 also containing a lift cord connected to the spool.

55. The improved roller shade of claim 51 wherein the lift cord is a looped cord.

56. The improved roller shade of claim 51 also comprising lift cord attached to the spool in a manner to be wound and unwound around the spool.

57. An improved blind of the type having a roller about which lift cords are rolled and unrolled wherein the improvement comprises a release brake comprised of:

a. a stationary member;

b. a moveable member which is moveable relative to the stationary member when not restrained:

c. a spring having a selected diameter, a first tang at one end and a second tang at an opposite end the first tang attached to the stationary member and the second tang attached to the moveable member;

d. a hub attached to the roller and having a cavity which has an inside surface and in which the spring is positioned the spring and cavity being sized so that the spring will press against the inside surface of the cavity when in a relaxed condition and the tangs of the spring can be moved relative to one another to reduce the diameter of the spring so that the spring does not restrain movement of the hub; and

e. a spool attached to the hub.

58. The improved blind of claim 57 also comprising a tang attached to the stationary member for engagement with a mounting bracket.

59. The improved blind of claim 58 also containing a lift cord connected to the spool.

60. The improved blind of claim 59 wherein the lift cord is a looped cord.

61. The improved blind of claim 57 also comprising lift cord attached to the spool in a manner to be wound and unwound around the spool.

62. A release brake for a window covering of the type having a roller about which one of a window covering material and lift cords are wound comprised of:

a. a hub sized so that a first end will fit into one end of the roller and having an interior cylindrical cavity open at a second end of the hub opposite the first end;

end;

b. a coil spring having an inner tang at one end and an outer tang at an opposite end both tangs extending toward a centerline through the coil spring, the coil spring positioned within the interior cylindrical cavity of the hub;

c. a core positioned within the coil spring, the core having an exterior slot into which the inner tang of the coil spring extends and an eccentric bore open at an outer end of the core;

d. a stub shaft partially inserted into the eccentric bore and having a transverse slot into which the outer tang of the coil spring is fitted;

e. a lever attached to an outer end of the stub shaft;

f. a stop attached to the outer end of the core and being sized and positioned to limit movement of the lever through an arc so that when the lever is at one end of the arc the coil spring will engage an inner surface of the interior cylindrical cavity restraining movement of the hub and when the lever is at an opposite end of the arc the coil spring will not restrain movement of the hub; and

g. a shade mounting bracket tang extending from a center of the outer end of the core.

63. The release brake of claim 62 also comprising a spool attached to the hub adjacent to the second end of the hub.

64. The release brake of claim 63 also comprising lift cord attached to the spool in a manner to be wound and unwound around the spool.

65. The release brake of claim 63 also comprising a pulley attached to the lever and wherein the lift cord passes over the pulley.

66. The release brake of claim 62 also comprising a release cord attached to the lever for moving the lever through the arc.

67. The release brake of claim 66 also comprising a ball attached to a distal end of the release cord and having a passageway through which the lift cord passes.

68. The release brake of claim 62 also comprising a release wand attached to the lever for moving the lever through the arc.

69. The release brake of claim 62 also comprising a lift cord attached to the hub in a manner to be wound and unwound about the hub.

70. The release brake of claim 69 also comprising a lift cord gripping device through which the lift cord passes, the lift cord gripping device comprised of :

a. a flexible oval body having opposite inside surfaces and a hole at each opposite end through which the lift cord may freely pass when the inside surfaces are spaced apart; and

b. a plurality of resilient teeth attached to each of the opposite inside surfaces at least some of the teeth engaging a lift cord passing through the body when the oval body is squeezed to cause the opposite inside surfaces to move toward one

another.

71. The release brake of claim 70 wherein the resilient teeth are sized and positioned so that at least some of the teeth will mate and releaseably lock when the opposite inside surface are moved a given distance toward one another.

72. A release brake for a window covering of the type having at least one roller about which one of a window covering material and lift cords are wound comprising:

a. a stationary member having a bore passing through the stationary member;

b. a movable member which is movable relative to the stationary member when not restrained, the movable member having a bore passing through the movable member which bore is aligned with the bore passing through the stationary member;

c. a hub rotatably disposed through the bore in the movable member and the bore in the stationary member, the hub having one end connected to the roller and an outside surface about which the spring is positioned; and

d. an elongated resilient member having opposite ends, the resilient member encircling and lightly pressing against the outside surface of the hub, the resilient member attached at one end to the stationary member such that when the hub turns in one direction the resilient member is loosened and when the hub turns in an opposite direction the resilient member tightens around the hub and prevents the hub from turning.

73. The release brake of claim 72 wherein the resilient member is comprised of a strip of material selected from the group consisting of spring steel, plastic and leather.

74. The release brake of claim 73 wherein the resilient member is also comprised of a coil spring attached between the strip of material and the stationary member.

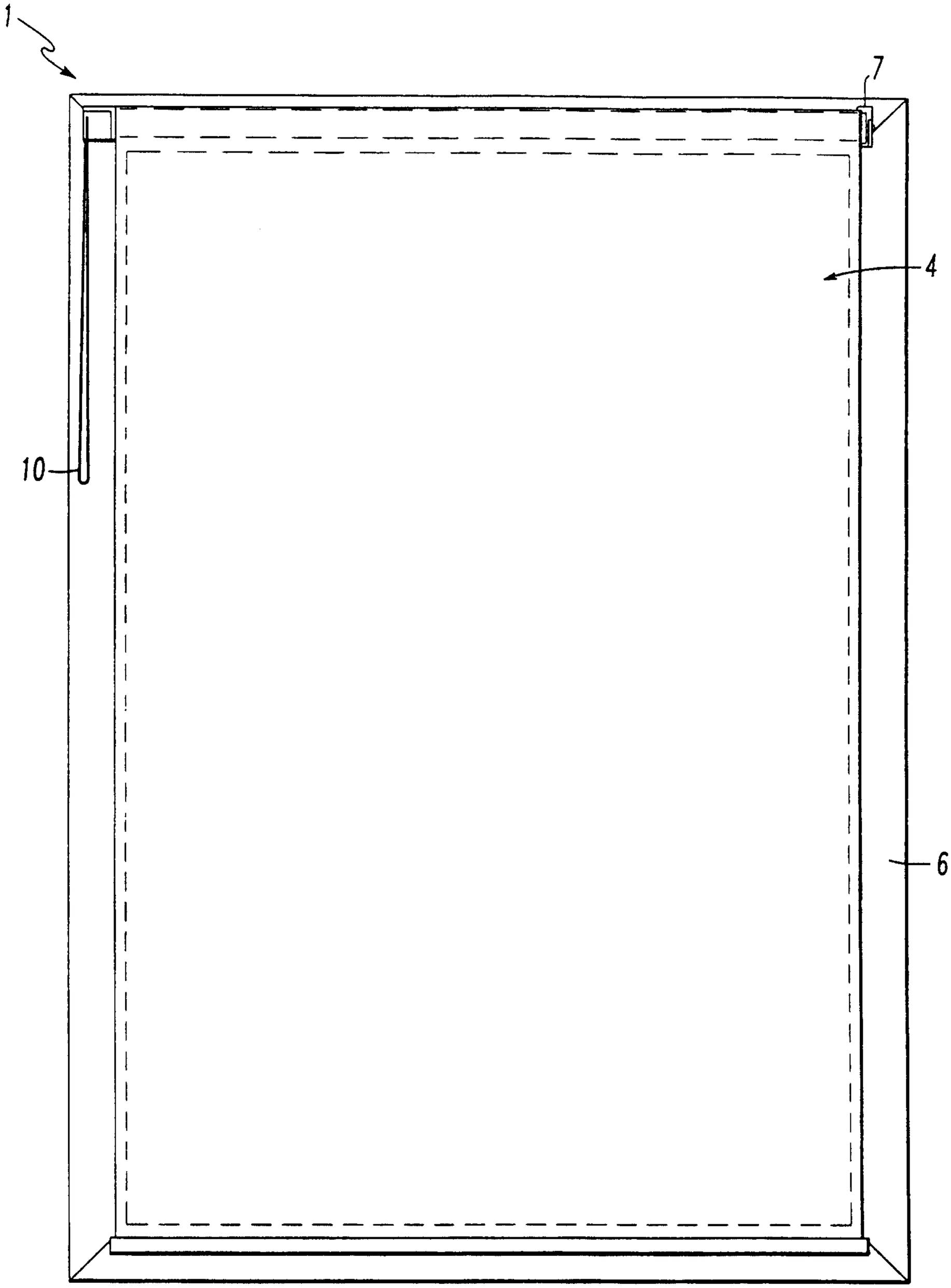


FIG. 1

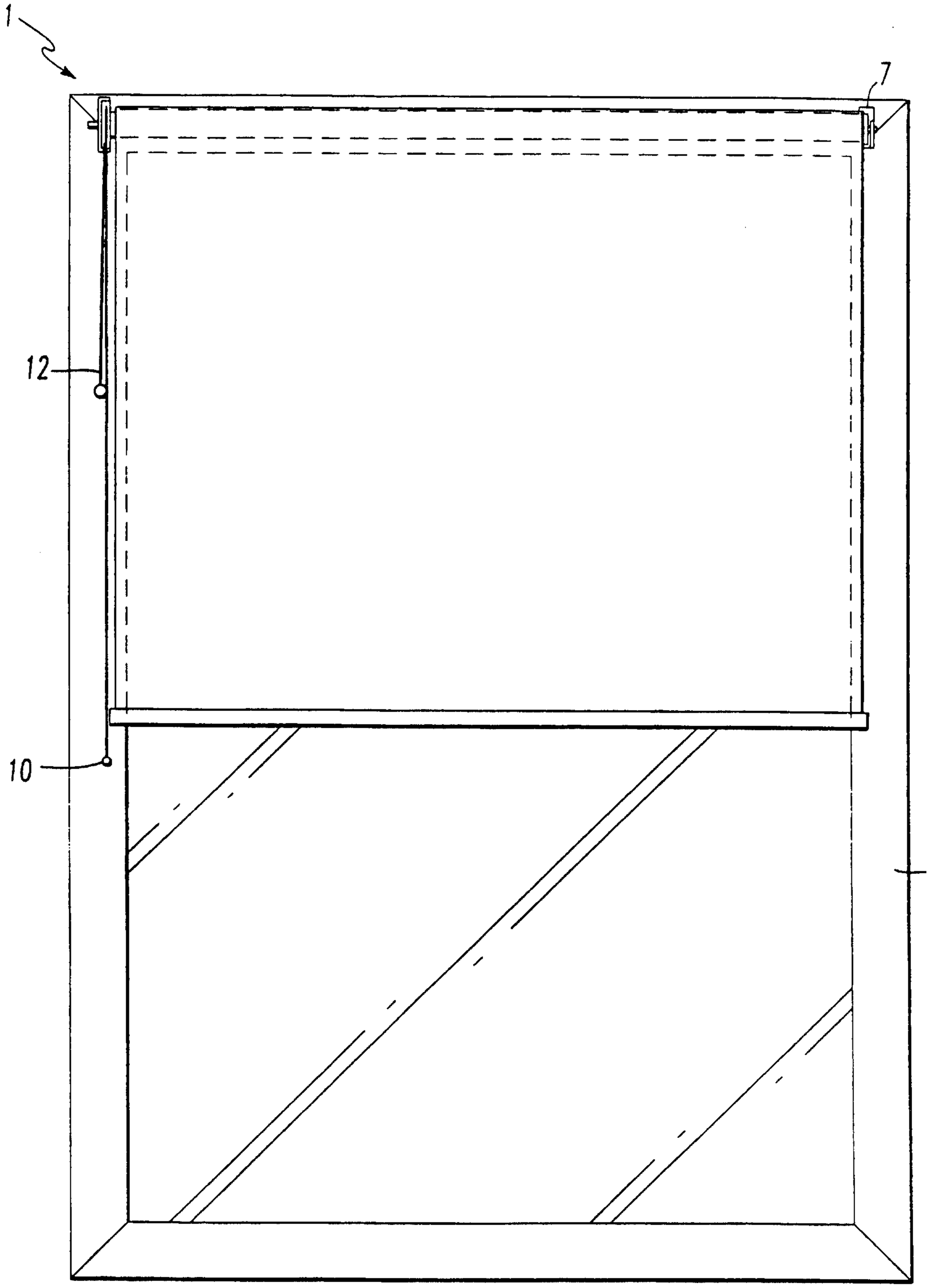
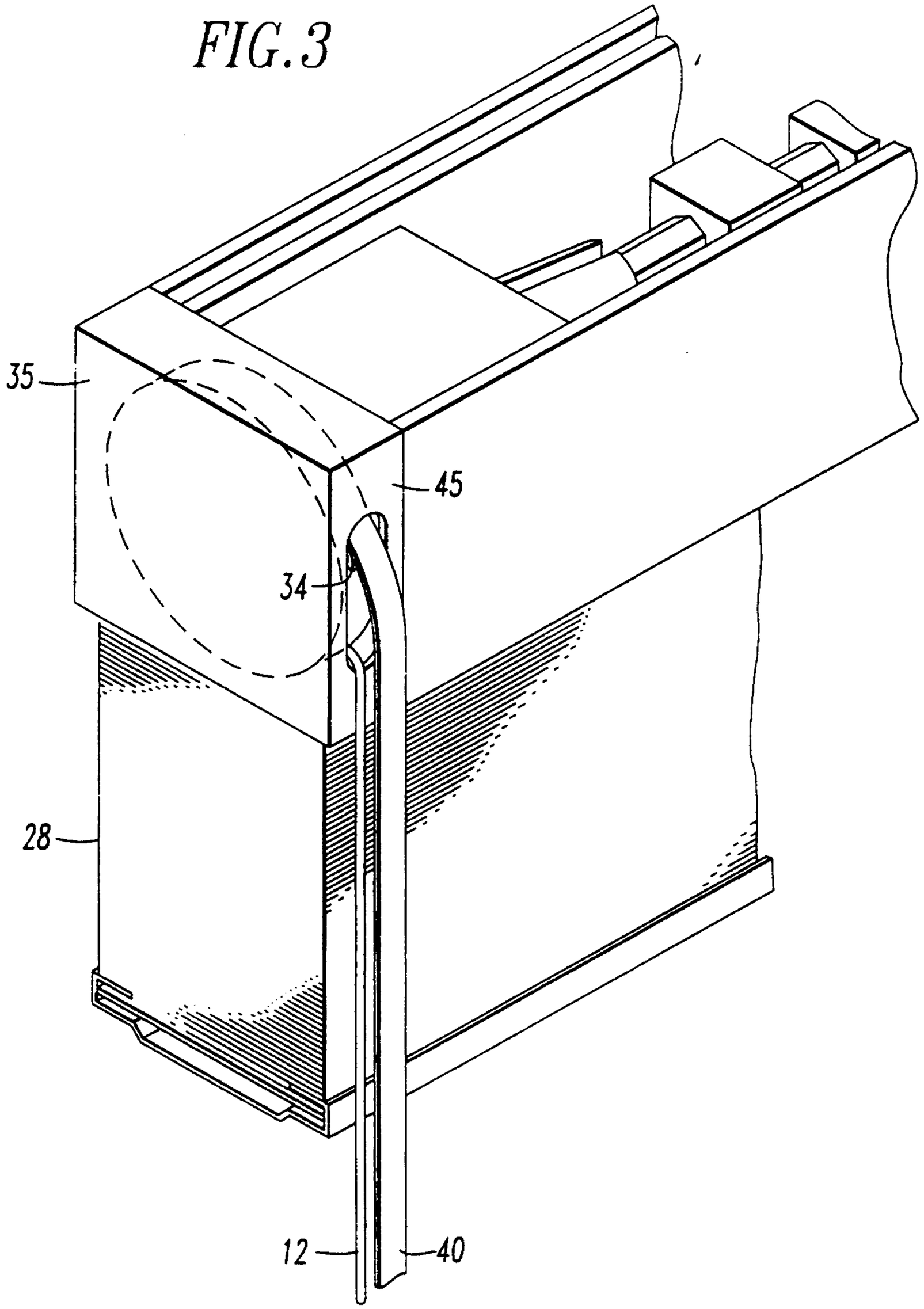


FIG.2

FIG.3



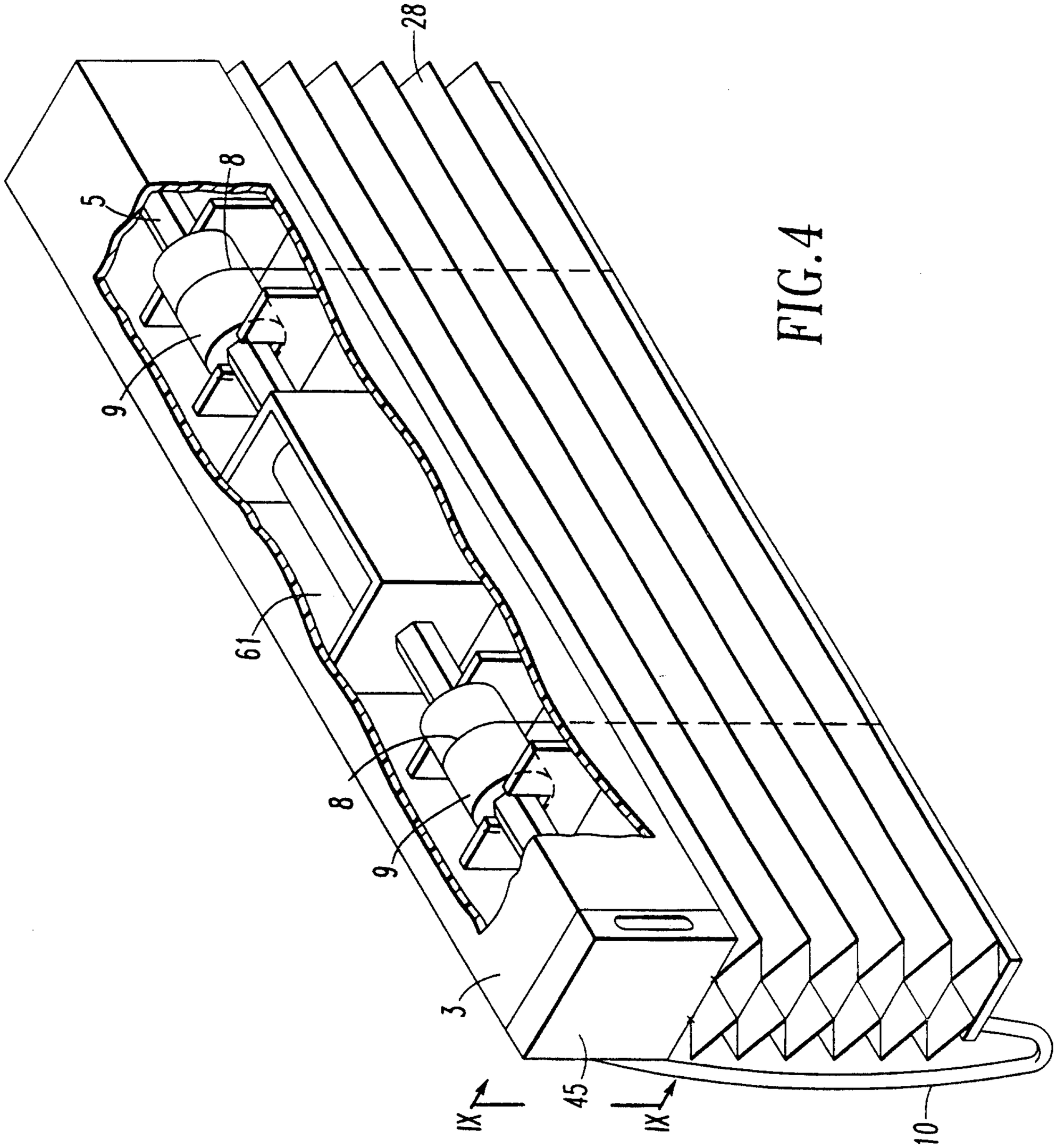


FIG. 4

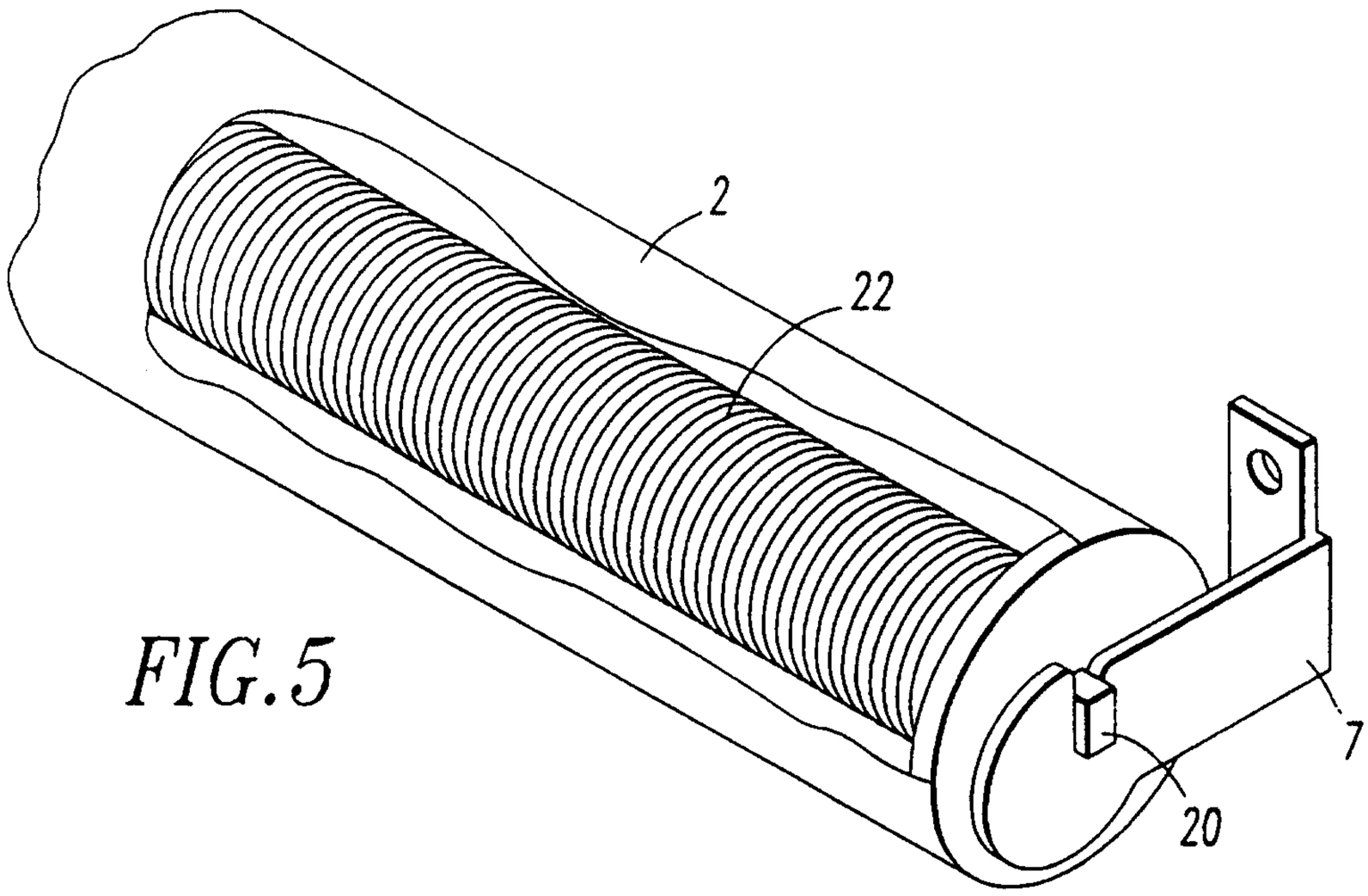


FIG.5

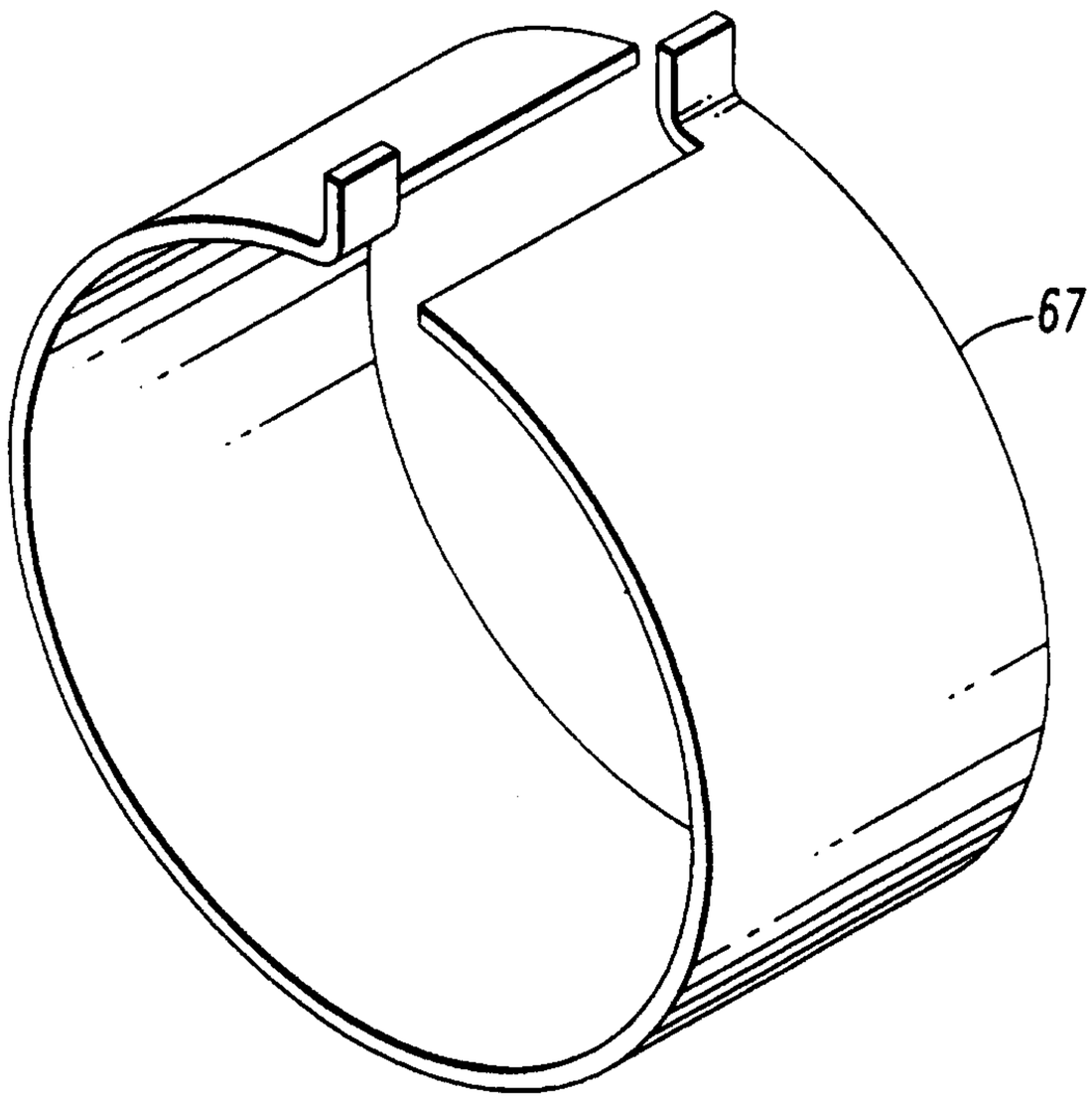


FIG.8

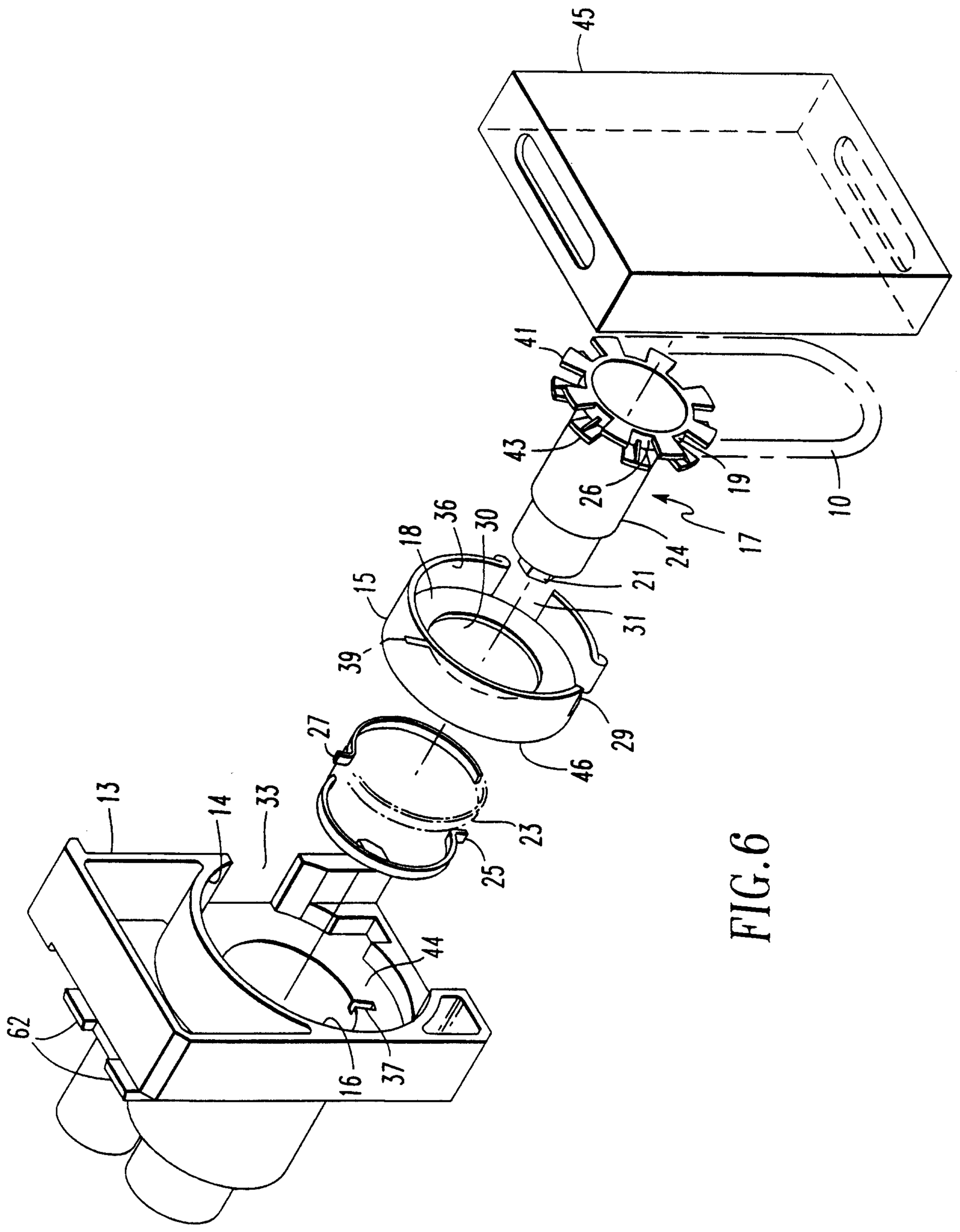

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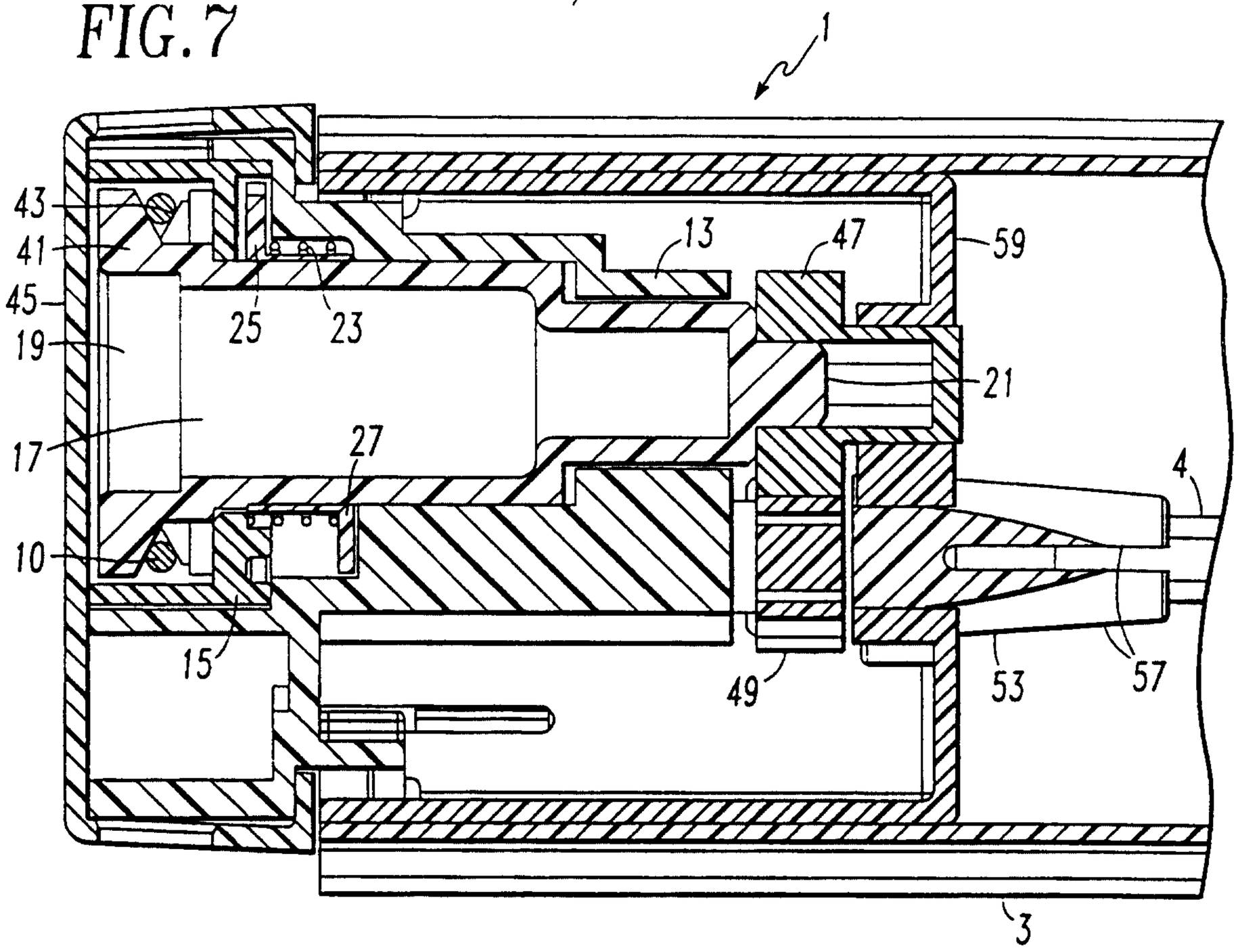
FIG.6

FIG.7



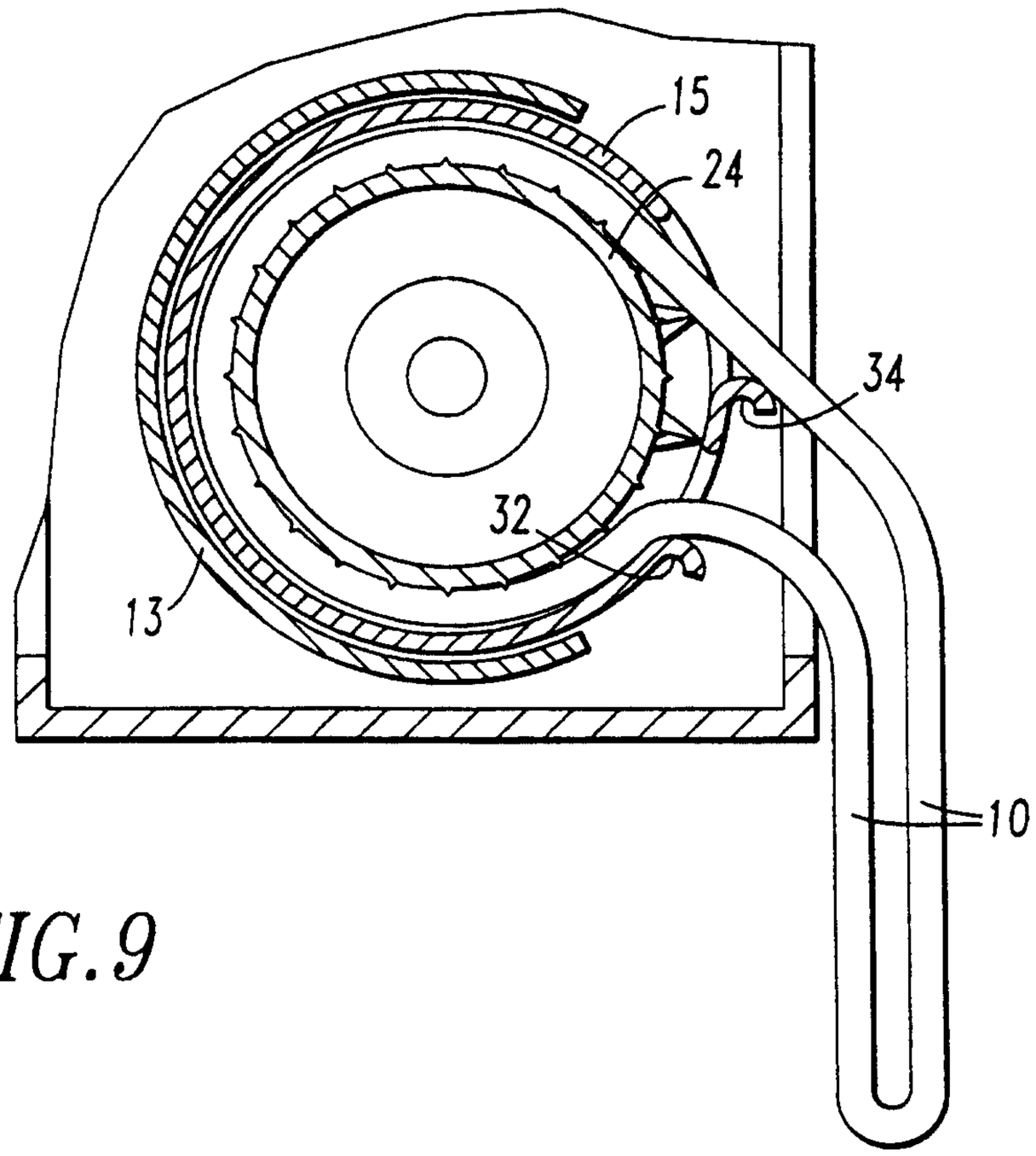


FIG.9

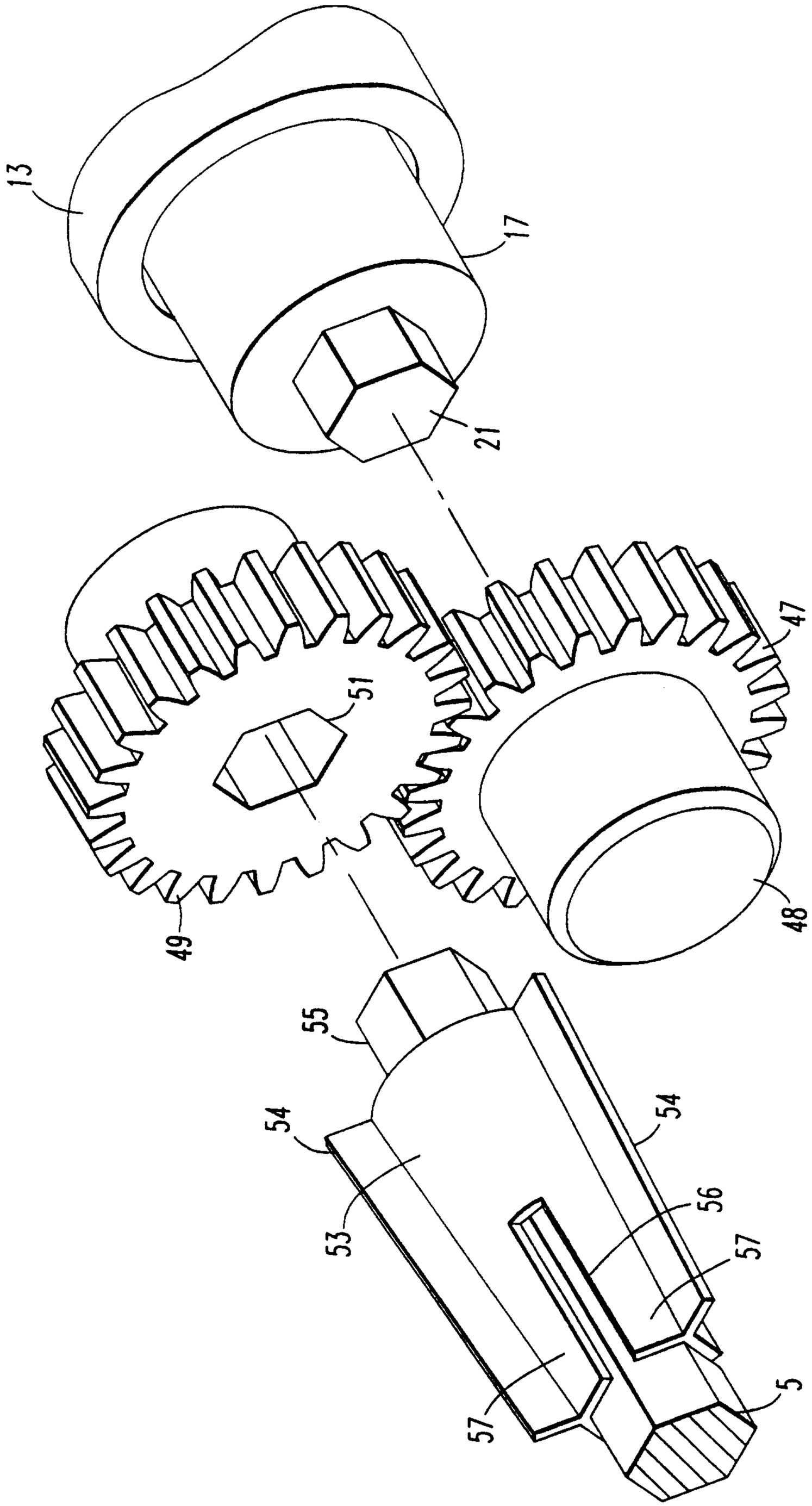


FIG. 10

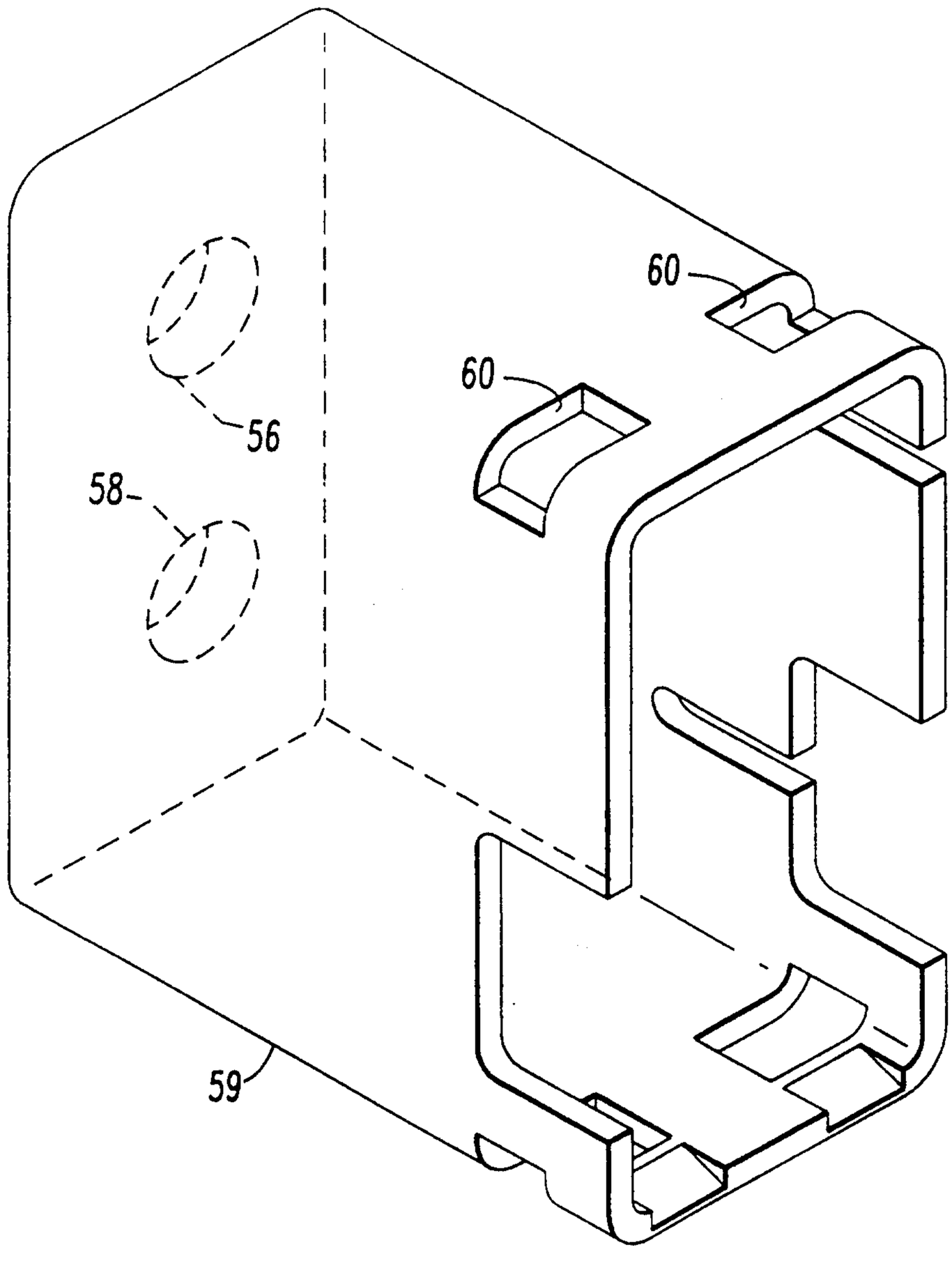


FIG. 11

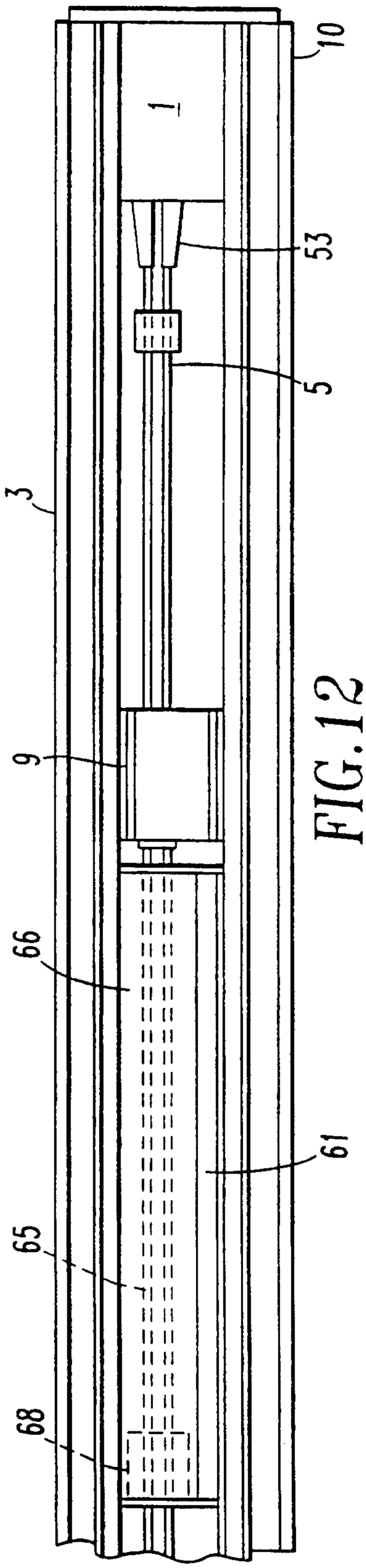


FIG. 12

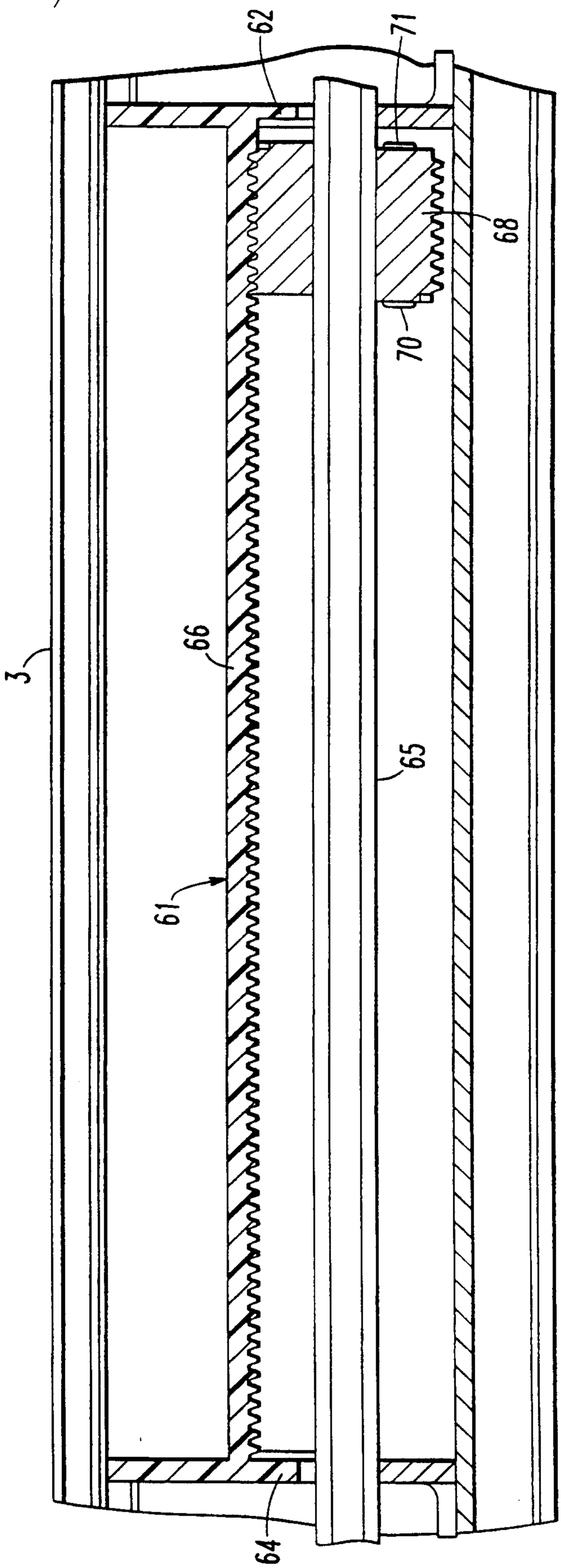


FIG. 13

FIG. 14

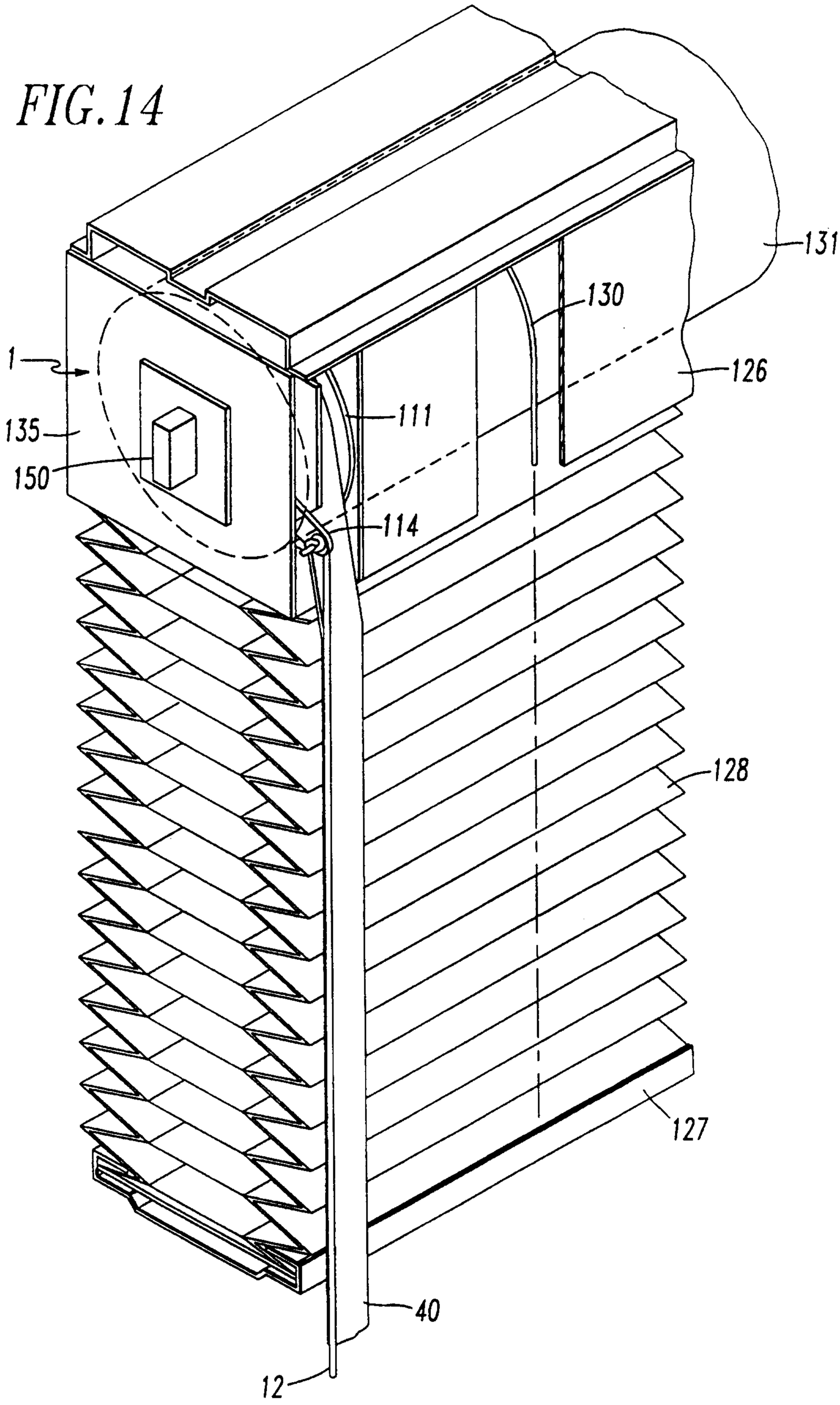
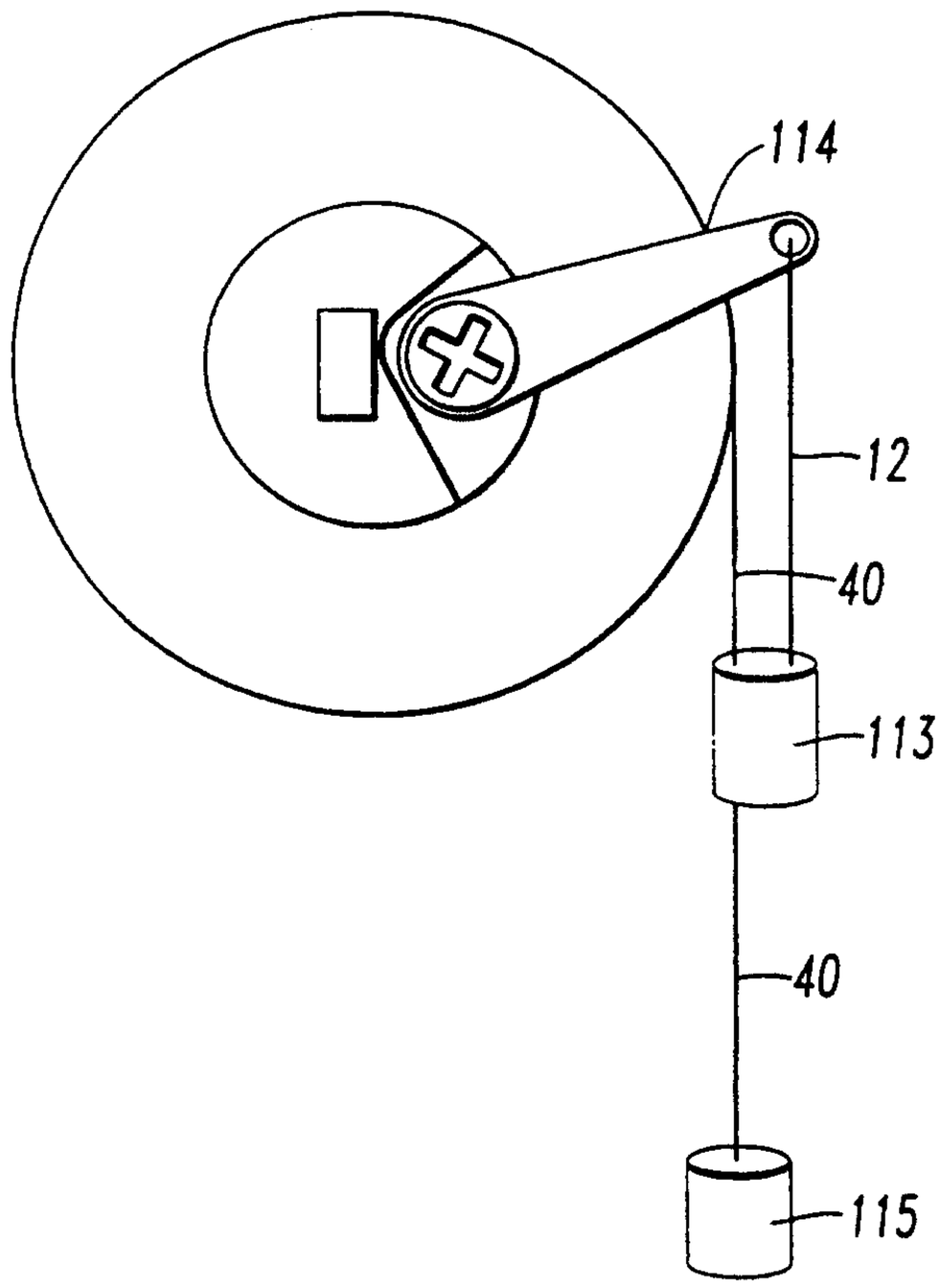


FIG. 15



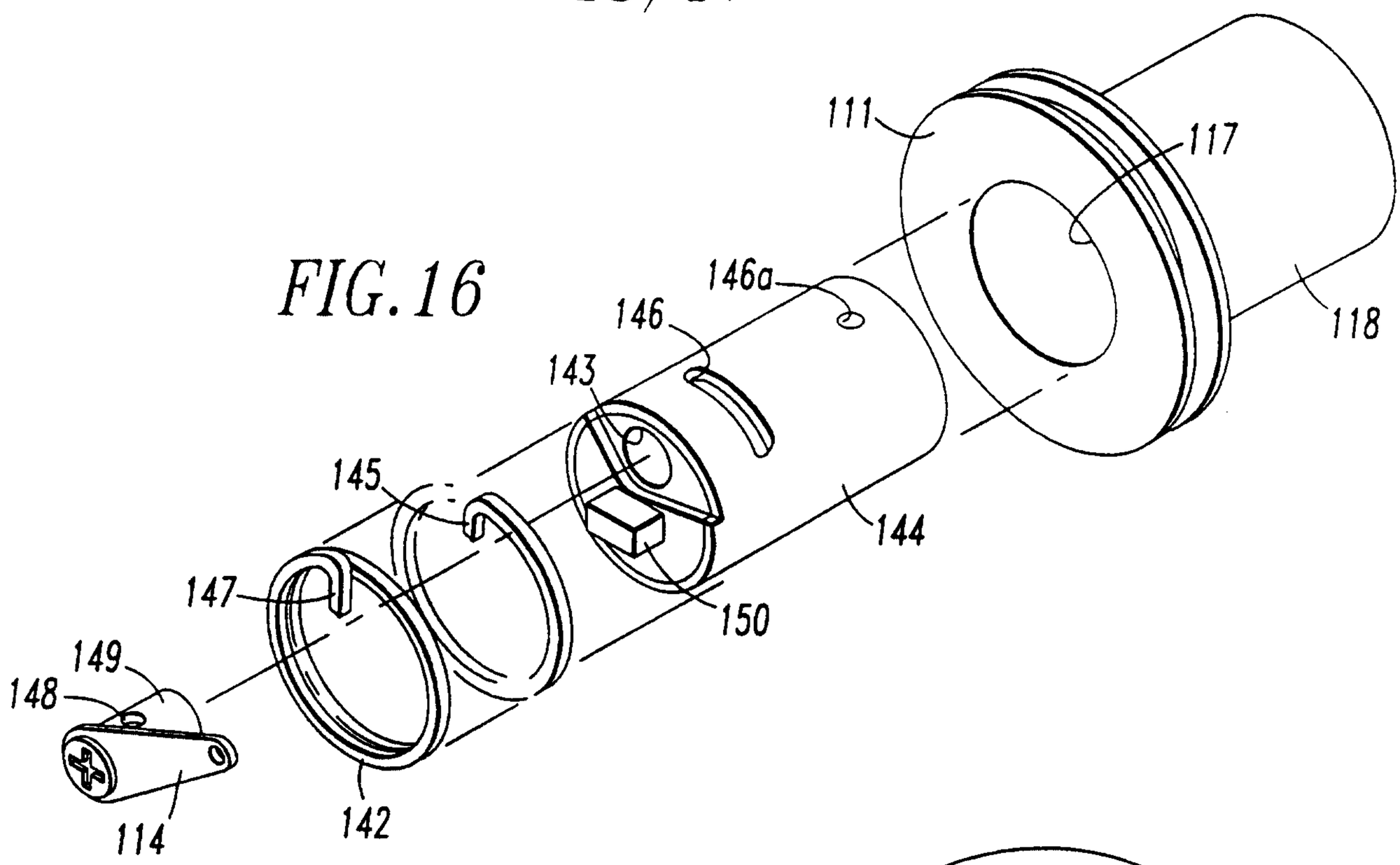


FIG. 16

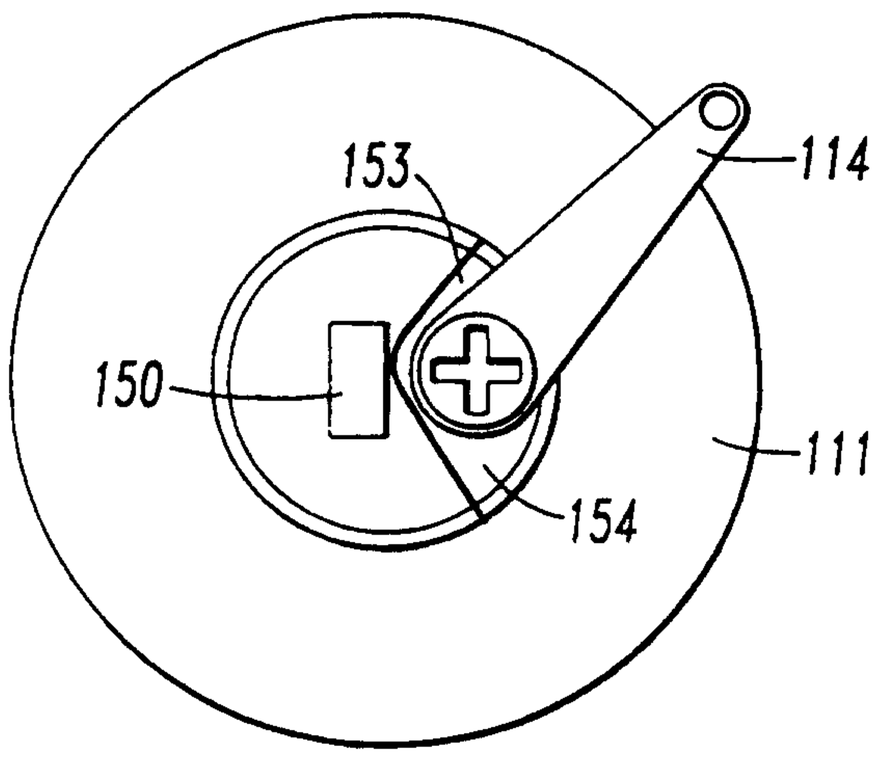


FIG. 17

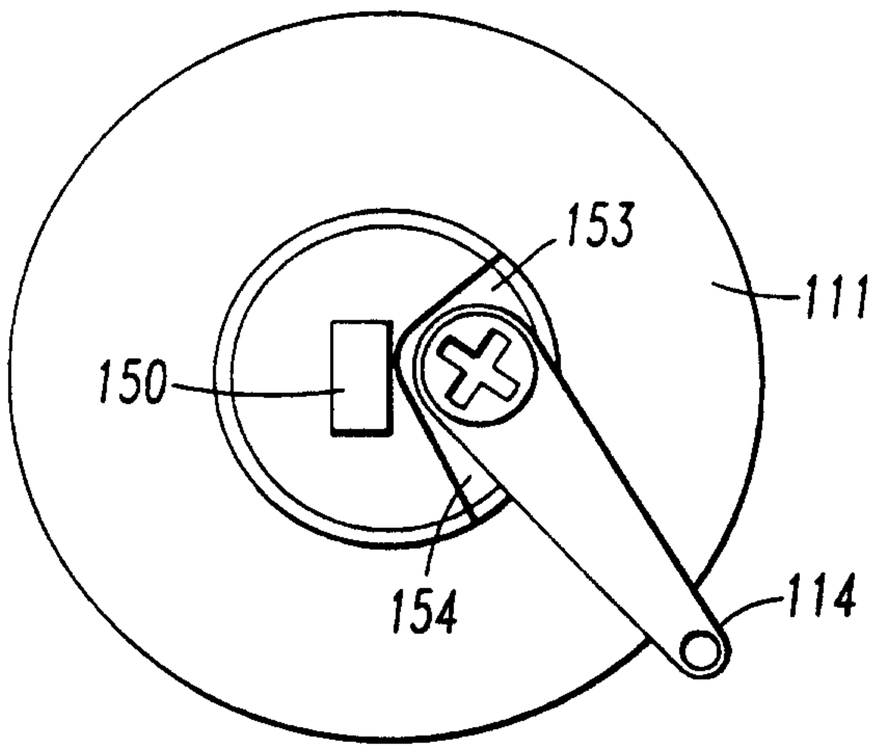


FIG. 18

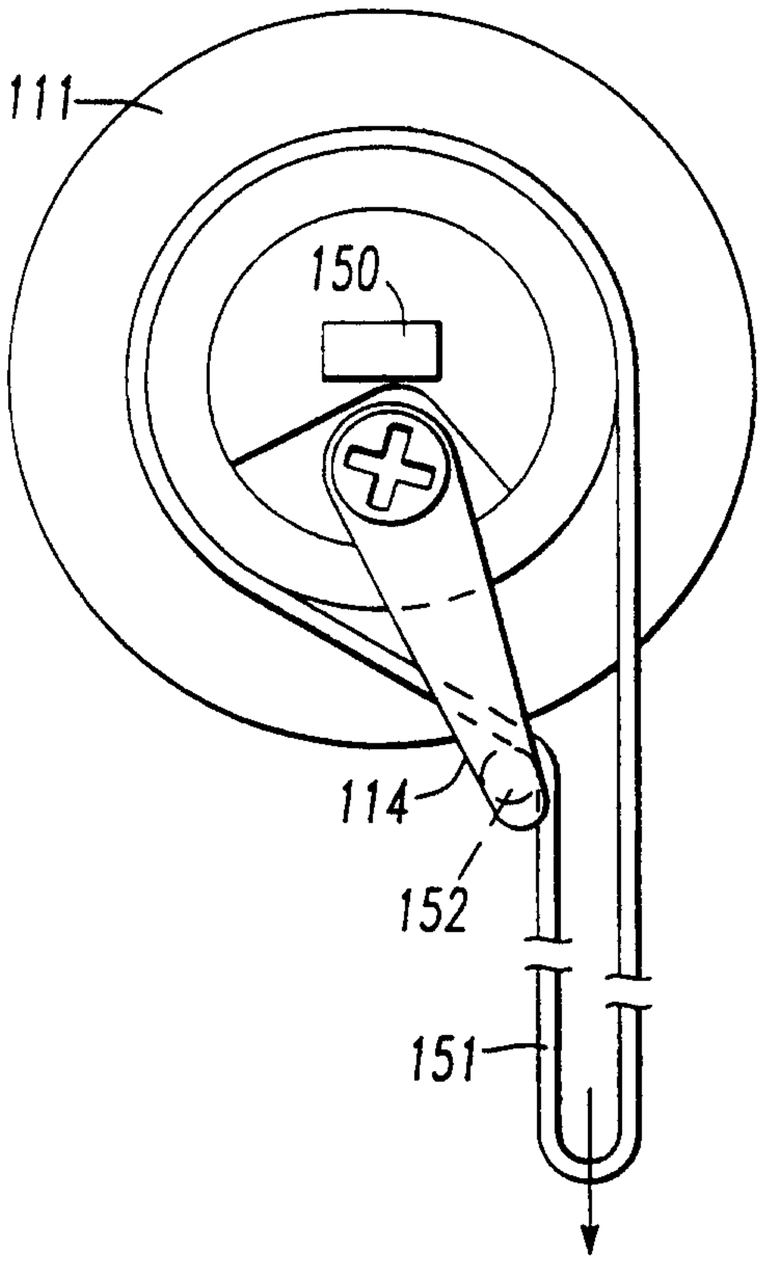


FIG.19

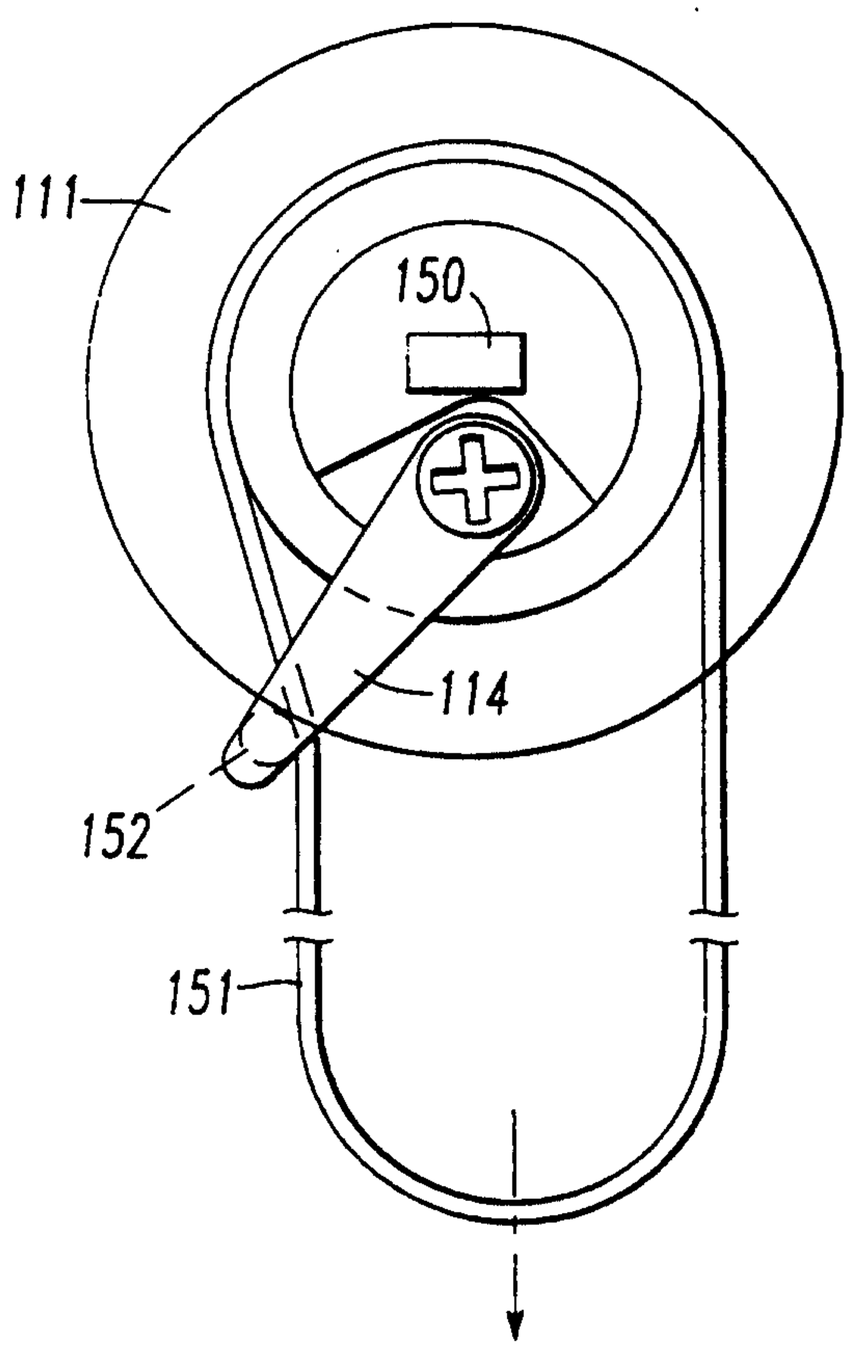


FIG.20

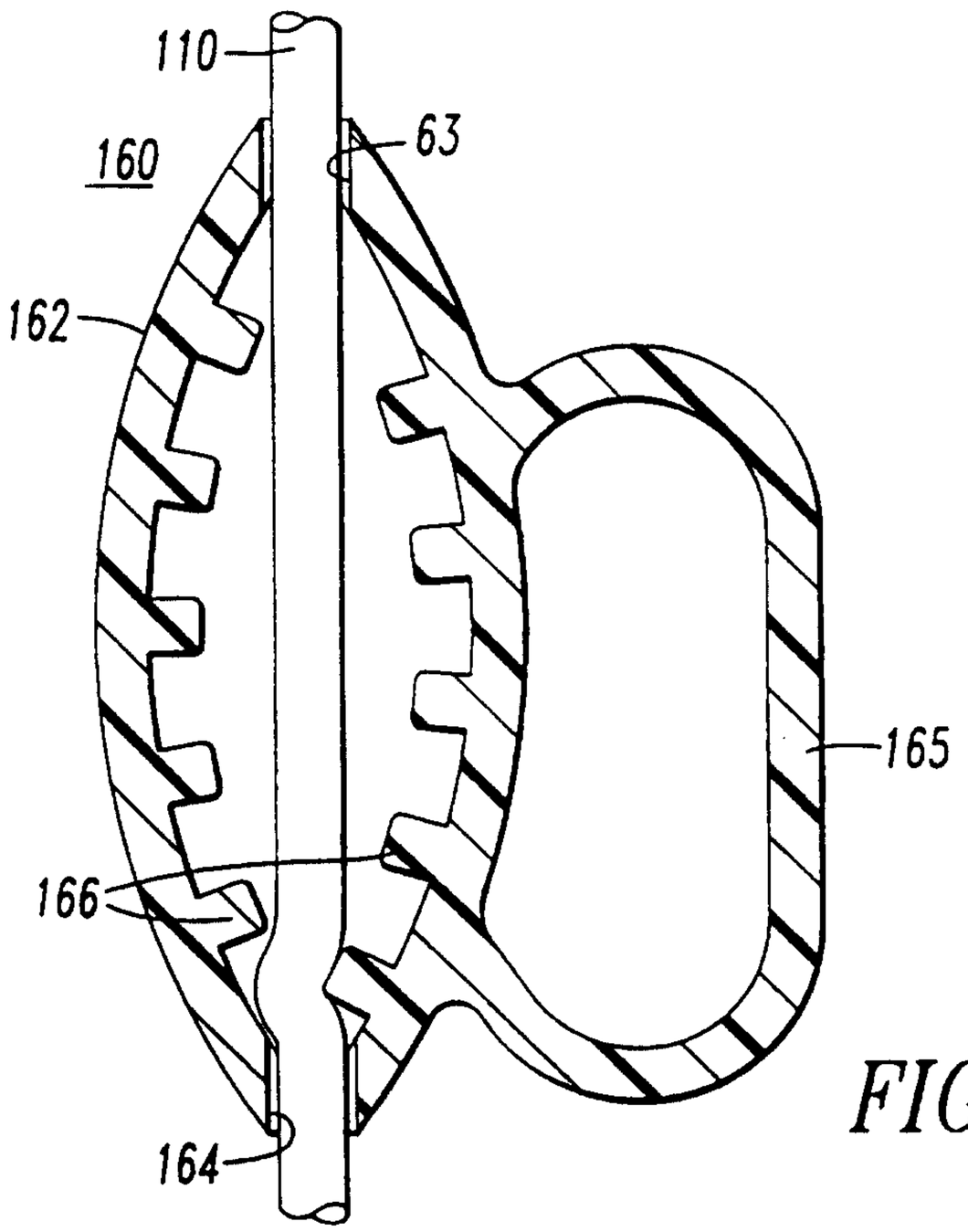
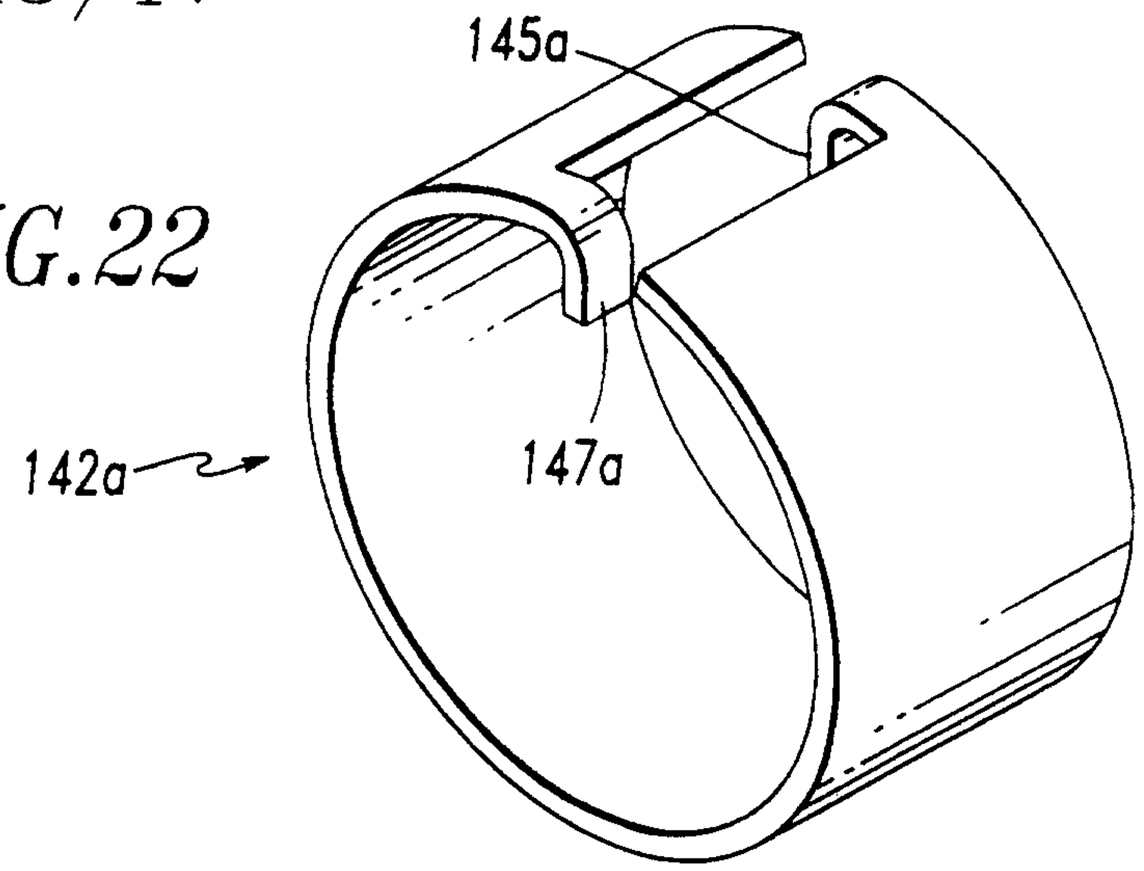


FIG.21

FIG.22



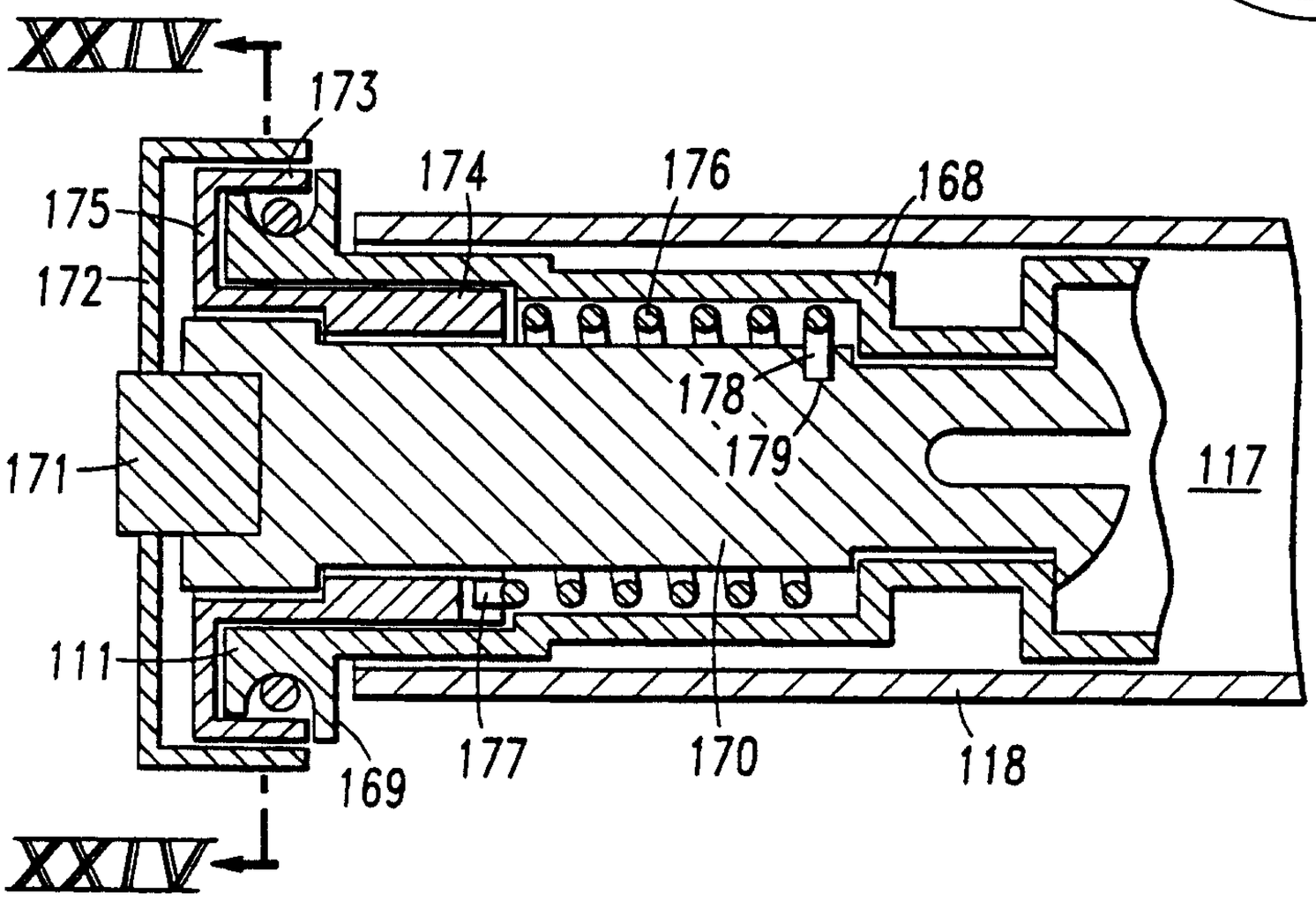


FIG.23

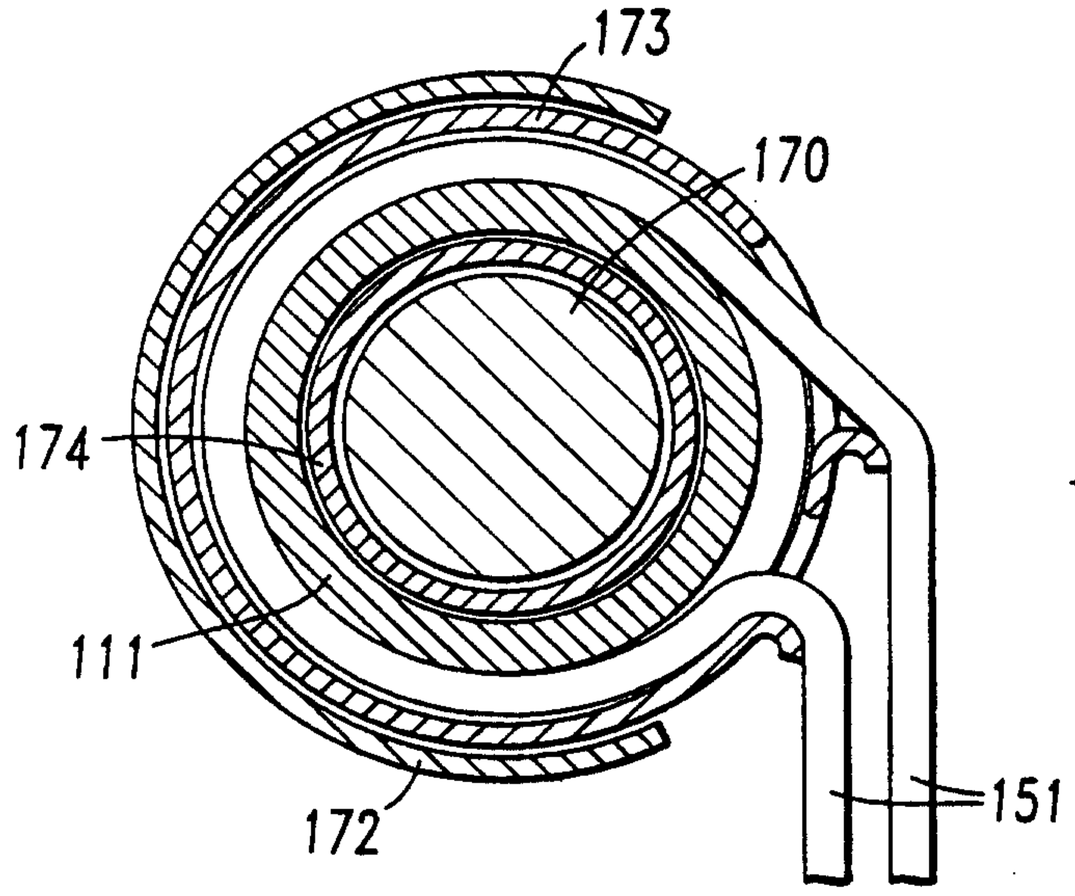


FIG.24

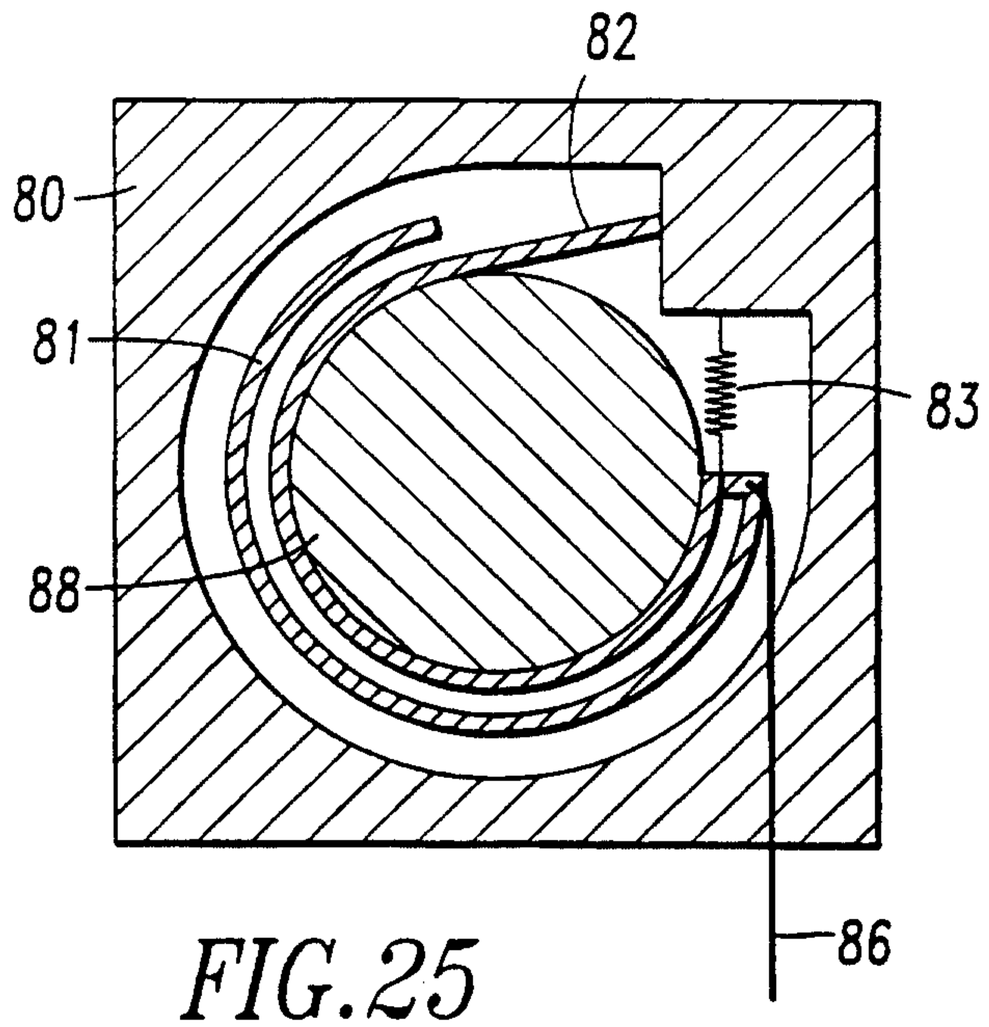


FIG.25

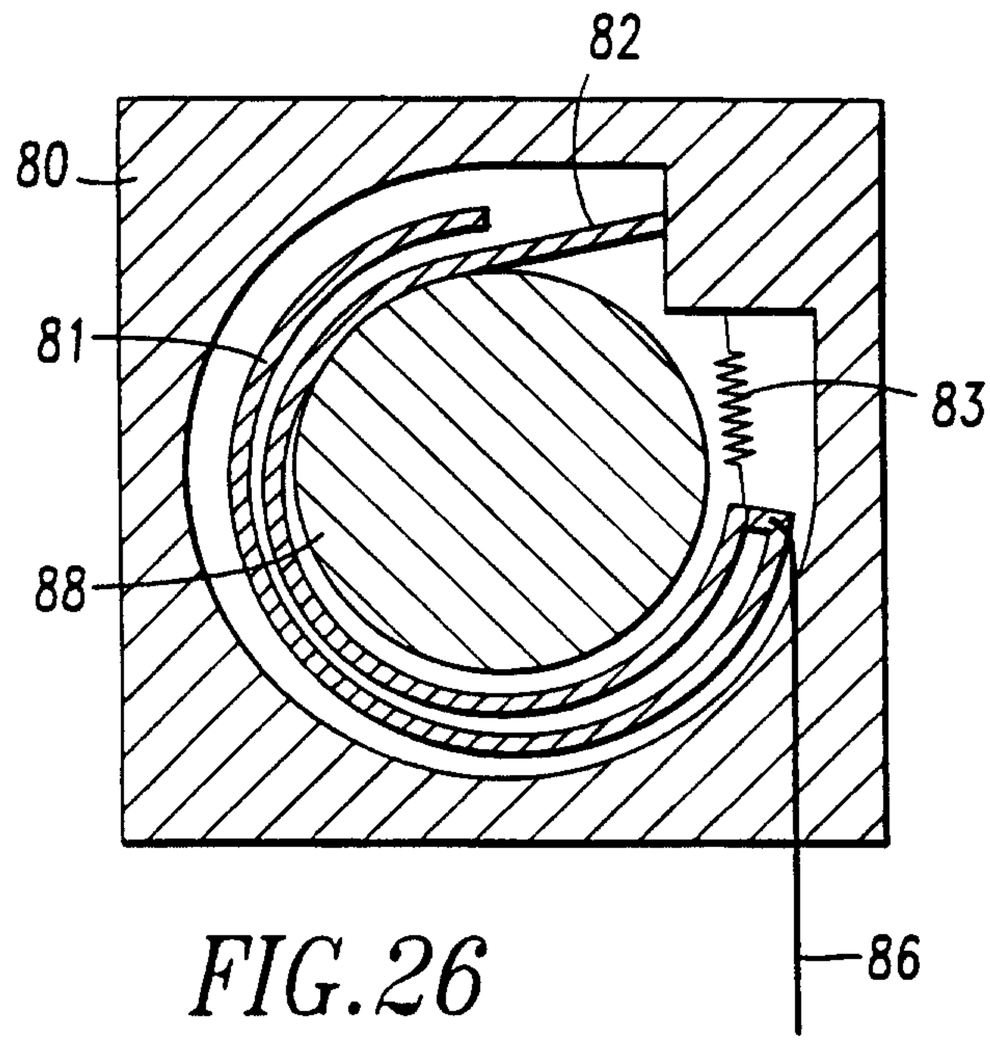


FIG.26

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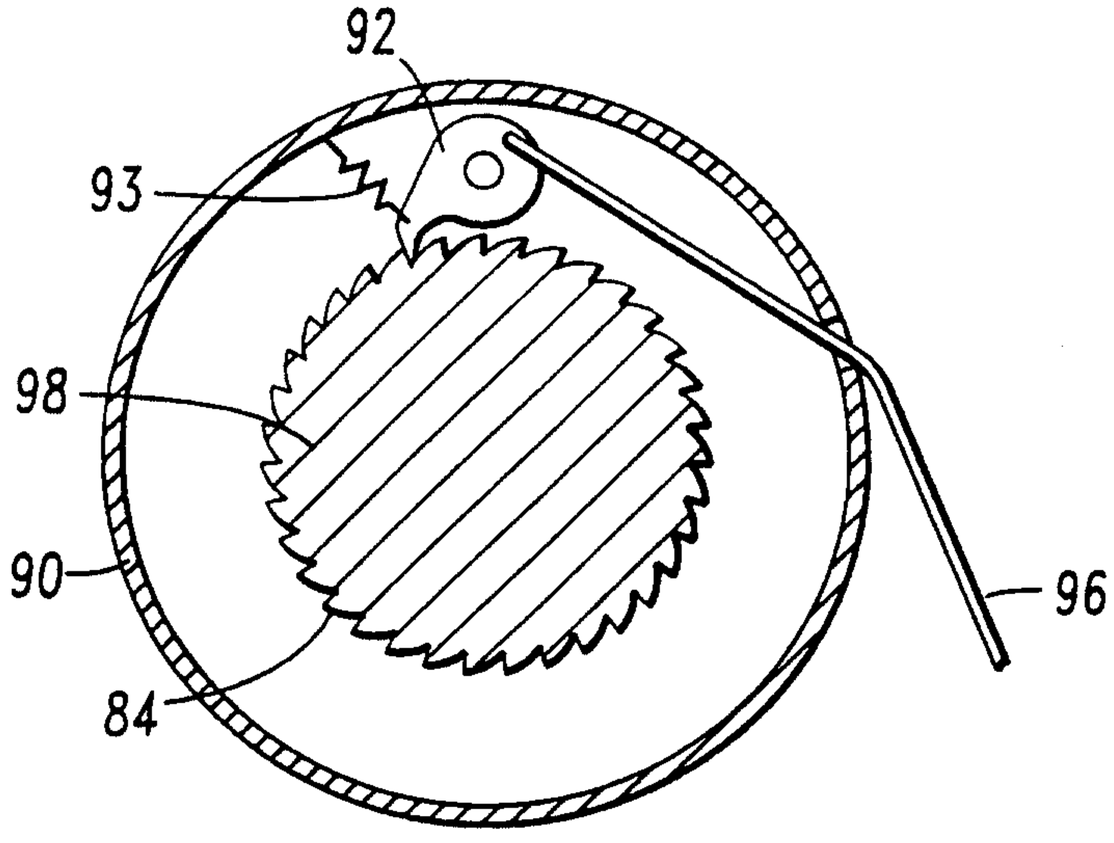


FIG.27

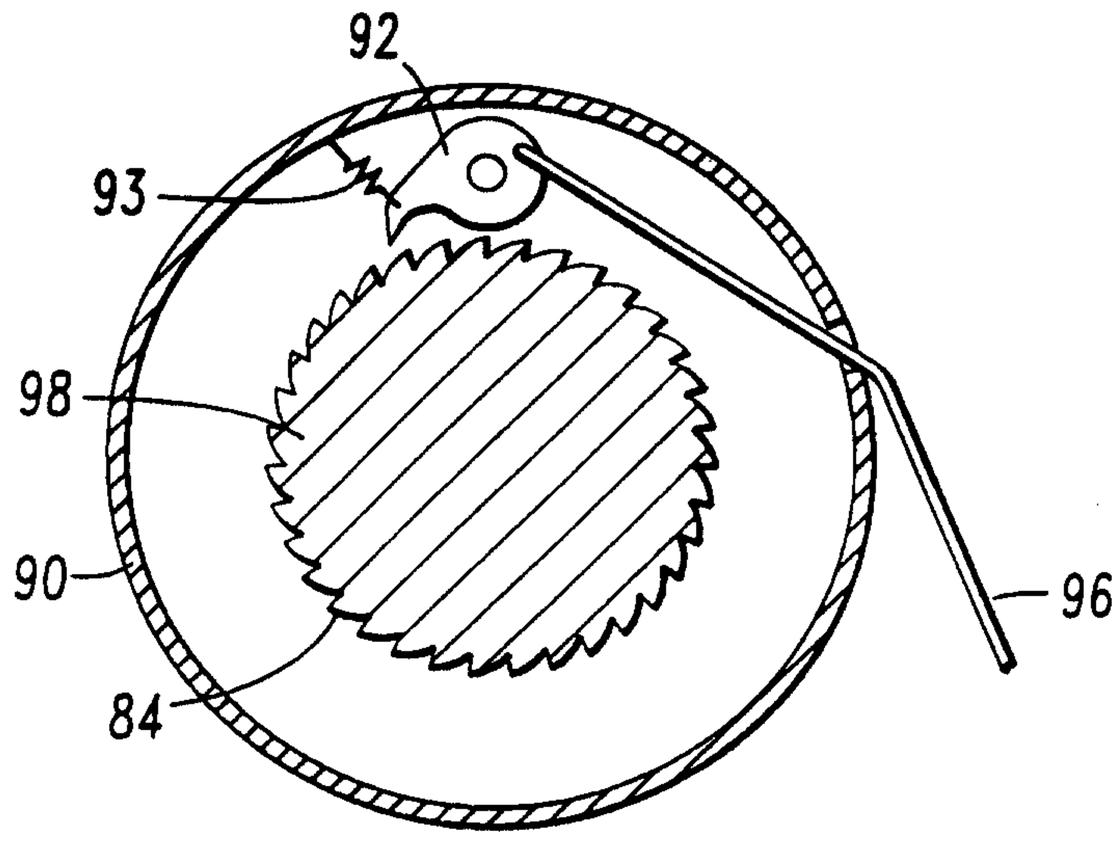
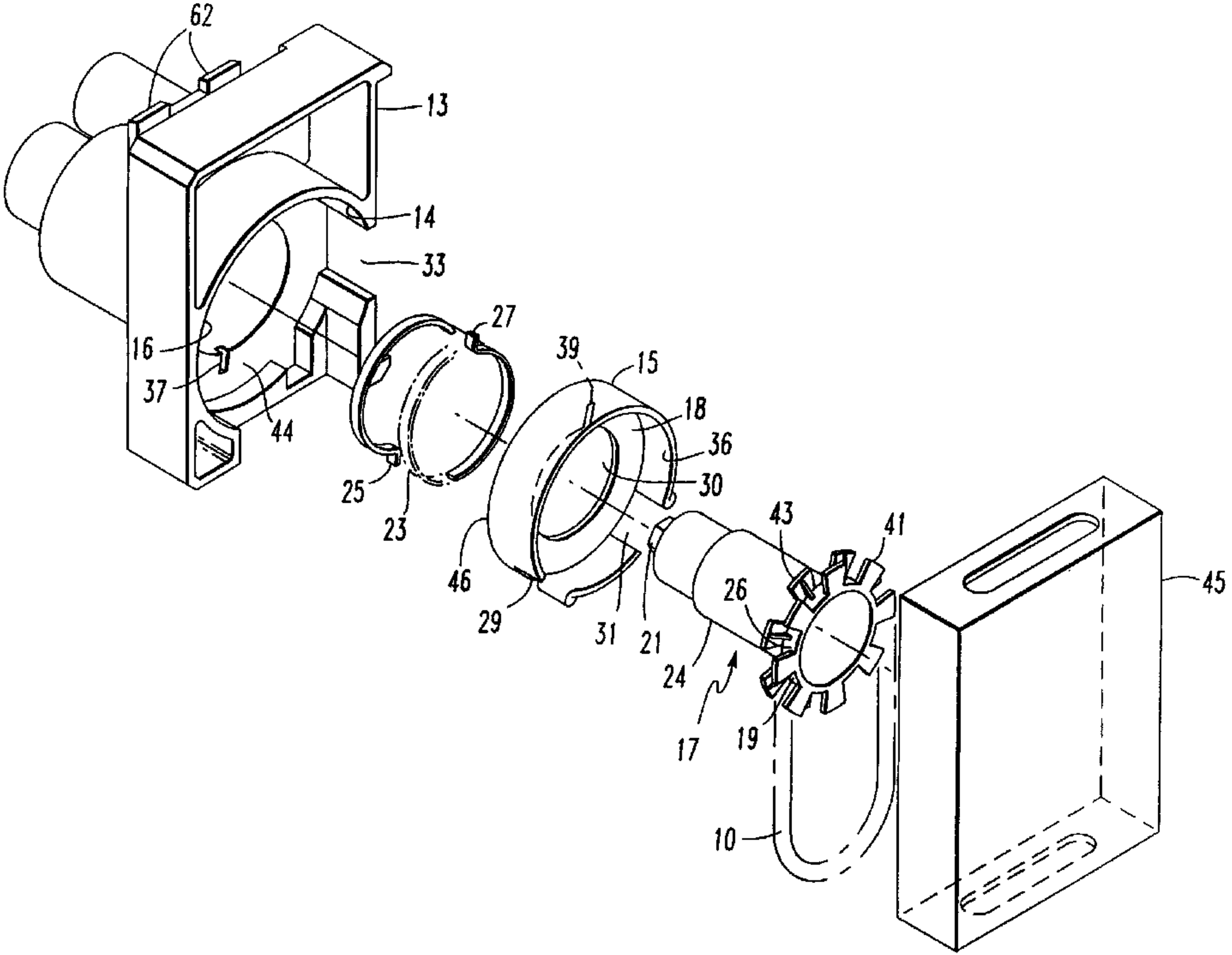


FIG.28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