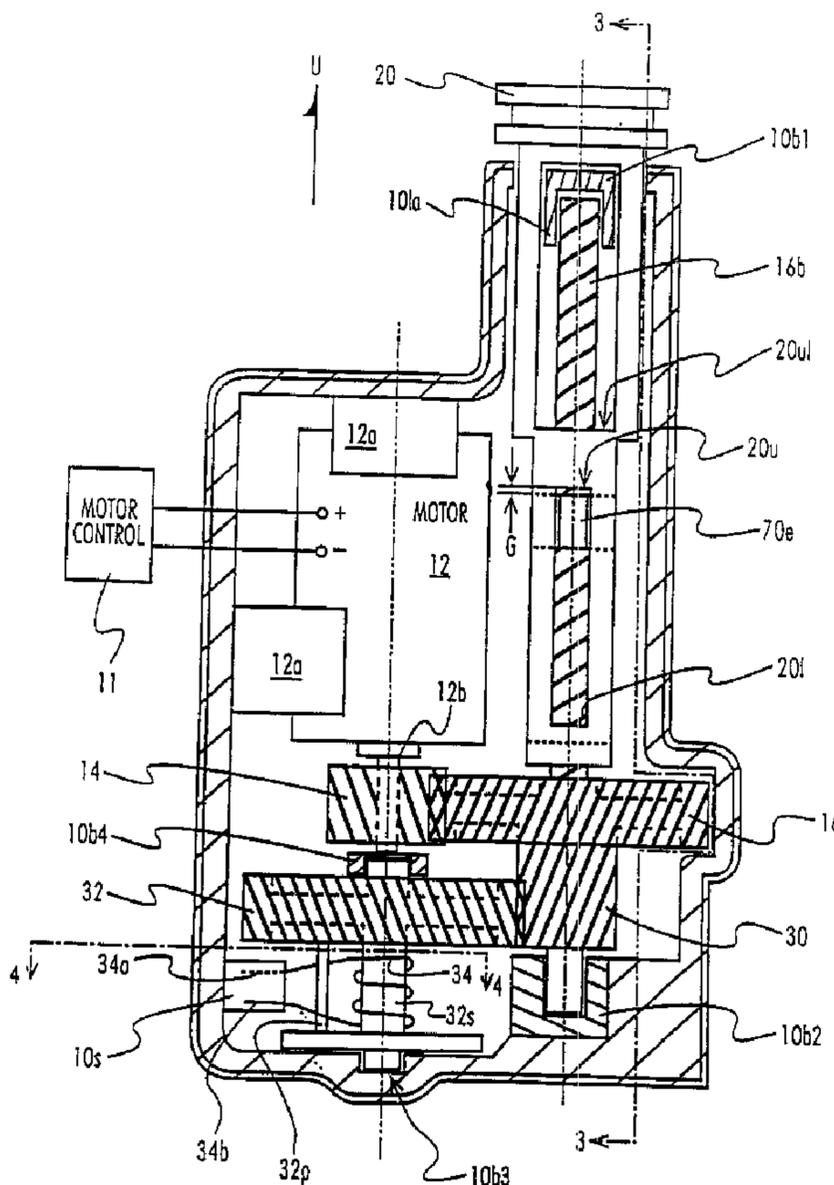




(86) Date de dépôt PCT/PCT Filing Date: 1994/02/10
 (87) Date publication PCT/PCT Publication Date: 1994/08/18
 (45) Date de délivrance/Issue Date: 2003/04/29
 (85) Entrée phase nationale/National Entry: 1995/08/08
 (86) N° demande PCT/PCT Application No.: CA 1994/000092
 (87) N° publication PCT/PCT Publication No.: 1994/018423
 (30) Priorité/Priority: 1993/02/10 (08/015,980) US

(51) Cl.Int.⁶/Int.Cl.⁶ E05B 47/00
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(54) Titre : DISPOSITIF DE COMMANDE DE MOUVEMENT DE TRANSLATION
 (54) Title: LINEAR MOTION DRIVE



(57) Abrégé/Abstract:

A linear drive, particularly useful for locking or unlocking a door lock mechanism or the like permits manual operation by providing an output shaft that can move freely regardless whether the output shaft is in extended or retracted positions without back driving the motor. The output shaft is coaxially slideably situated over a worm gear shaft which moves a nut that is

(57) Abrégé(suite)/Abstract(continued):

threadingly engaged therewith and moves inside the output shaft along the axial direction of the worm gear shaft. The output shaft is not threadingly engaged with the worm gear shaft. The output shaft thus is freely movable relative to the worm gear shaft, which results in essentially zero back drive of the worm gear shaft and the motor. To provide for manual operation, the nut is automatically moved back to its neutral position every time the output shaft is extended or retracted by a torsion spring or the like which can store energy therein. Whenever the motor is operated to drive the worm gear shaft, the spring gear is also rotated, which causes the spring to store energy therein. As soon as the motor is turned off, the energy stored in the spring causes the worm gear to rotate in the direction opposite to the last motor driven direction to move the nut to the neutral position it was in prior to energization of the motor.



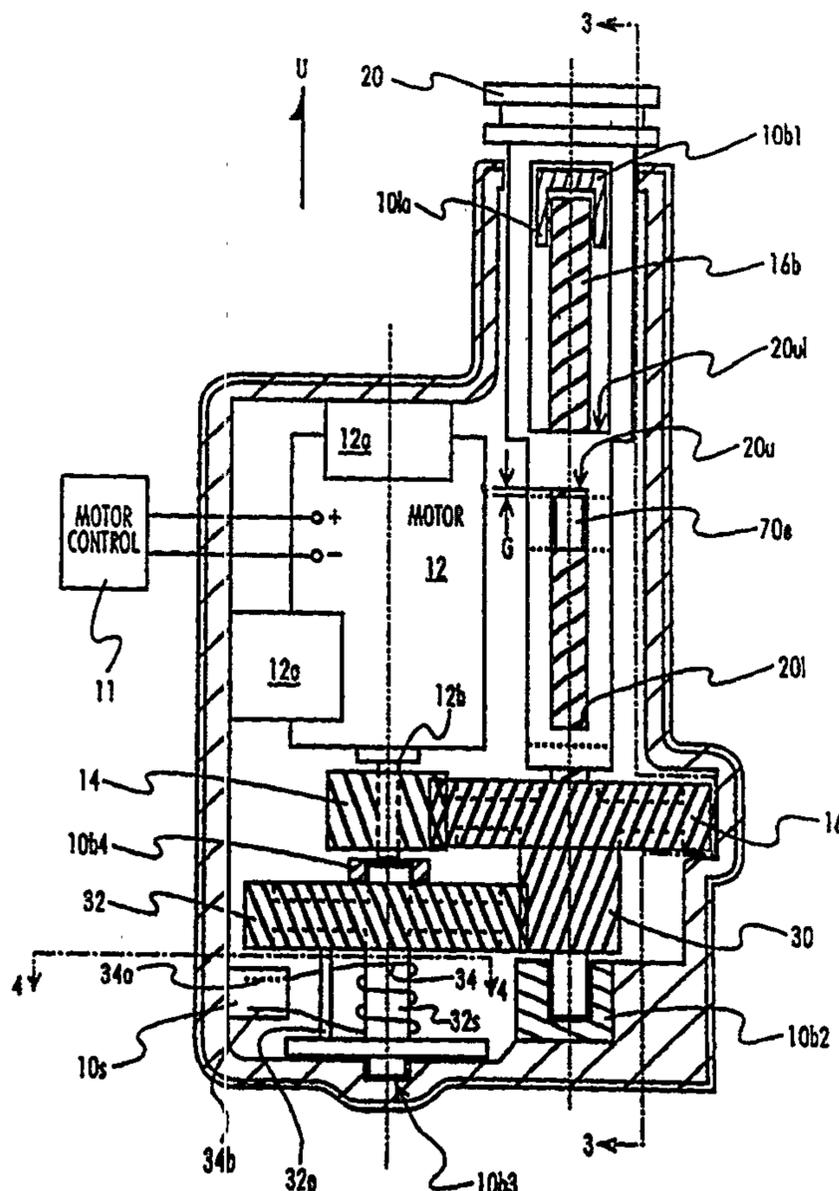
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification⁵ : E05B 47/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 94/18423 (43) International Publication Date: 18 August 1994 (18.08.94)</p>
<p>(21) International Application Number: PCT/CA94/00092 (22) International Filing Date: 10 February 1994 (10.02.94) (30) Priority Data: 08/015,980 10 February 1993 (10.02.93) US (71) Applicant: ATOMA INTERNATIONAL, INC. [CA/CA]; P.O. Box 354, 521 Newpark Boulevard, Newmarket, Ontario L3Y 4X7 (CA). (72) Inventor: VERGIN, William, E.; 2553 Farmdale Drive, Sterling Heights, MO 48314 (US). (74) Agent: AITKEN, David, W.; Osler, Hoskin & Harcourt, Suite 1500, 50 O'Connor Street, Ottawa, Ontario K1P 6LZ (CA).</p>		<p style="text-align: center; font-size: 2em;">2155657</p> <p>(81) Designated States: CA, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i></p>

(54) Title: LINEAR MOTION DRIVE

(57) Abstract

A linear drive, particularly useful for locking or unlocking a door lock mechanism or the like permits manual operation by providing an output shaft that can move freely regardless whether the output shaft is in extended or retracted positions without back driving the motor. The output shaft is coaxially slideably situated over a worm gear shaft which moves a nut that is threadingly engaged therewith and moves inside the output shaft along the axial direction of the worm gear shaft. The output shaft is not threadingly engaged with the worm gear shaft. The output shaft thus is freely movable relative to the worm gear shaft, which results in essentially zero back drive of the worm gear shaft and the motor. To provide for manual operation, the nut is automatically moved back to its neutral position every time the output shaft is extended or retracted by a torsion spring or the like which can store energy therein. Whenever the motor is operated to drive the worm gear shaft, the spring gear is also rotated, which causes the spring to store energy therein. As soon as the motor is turned off, the energy stored in the spring causes the worm gear to rotate in the direction opposite to the last motor driven direction to move the nut to the neutral position it was in prior to energization of the motor.



LINEAR MOTION DRIVE**BACKGROUND**

The present invention relates to a linear motion
5 drive, in particular for generating a linear motion from
a rotary motion while permitting independent manual
linear operation.

There are many uses for linear motion drive devices.
For instance, linear motion drive devices is particular
10 suitable for locking or unlocking a door locking
mechanism or the like. Power door locks, for example,
have been in use for locking and unlocking doors in
automobiles. There are many different types of actuators
for actuating a locking mechanism for doors or the like.

15 A typical power lock mechanism comprises an
electrical motor, and a rotary-to-linear transmission
mechanism which translates rotary motion from the motor
to a linear motion for actuating a door locking
mechanism. The rotary-to-linear mechanism typically
20 includes a reversibly rotatable lead-screw and a carriage
which linearly rides in the longitudinal direction of the
lead-screw as the lead-screw rotates or a rack and pinion
type where the motor drives a pinion (gear) and causes
the rack (carriage) to move linearly. The carriage or
25 rack is mechanically connected to the locking mechanism.

If the lead-screw/carriage or rack and pinion is
directly linked to the locking mechanism, manual
operation may be hindered or rendered difficult since the
motor has to be back driven. U.S. patent 4,723,454
30 issued to Periou et al, for instance, uses a carriage
which slides along the lead-screw to permit manual
operation. In particular, the lead-screw is permitted to
freely rotate in both directions when the motor is not
energized. The carriage is integral with a locking
35 mechanism attaching end. By manually pushing or pulling
the attaching end, the carriage can be moved linearly
relative to the lead-screw. A drawback of this type is
that manual operation causes back driving of the lead-

screw and the motor, which increases the manual force necessary to operate the locking mechanism. Moreover, because the carriage actually rides on the helical groove of the lead-screw, the carriage does not readily move in
5 the linear direction.

Many different devices have been contemplated in the past to prevent back driving of the motor and the lead-screws or the like during manual operation. U.S. Patents 4,290,634 issued to Gelhard; 4,821,521 to Schuler;
10 4,893,704 to Fry et al; 4,978,155 to Kobayashi, and French application FR-A-2 596 096, for instance, show various types of devices for preventing back driving of the motor during manual operation.

U.S. patent 4,978,155 uses a clutch mechanism
15 between a drive shaft and an output shaft to transmit power from the drive shaft to the output shaft. Specifically, the drive shaft is directly connected to the output of the motor and the output shaft is connected to a lock mechanism operating rod. The operating rod
20 moves linearly about the longitudinal axis of the output shaft via a helical thread formed on the output shaft. The clutch mechanism couples the drive shaft to the output shaft only when the motor is energized. At all other times, the output shaft freely rotates relative to
25 the drive shaft. Similar to U.S. patent 4,723,454, the operating rod may be manually depressed or extended, but such action causes the output shaft to rotate during manual operation, which increases the force necessary to move the operating rod. However, due to the clutch
30 mechanism, the motor is not back driven in this type of arrangement.

U.S. patent 4,893,704, on the other hand, uses complicated, coaxially arranged inner main and outer secondary shafts having opposed external threads that
35 cooperate to send a drive member to a neutral position without changing the direction of the motor during manual operation. Specifically, the drive member is connected

to the outer secondary shaft via a lost motion device to permit manual operation without back driving the motor. However, a drawback with this type of device is that the shaft needs to be further driven after the locking
5 mechanism has been already actuated to position the drive member in a neutral position.

U.S. patent 4,290,634 shows a use of a flywheel that is connected to a motor to store energy which is used to actuate the door lock mechanism. When the lock operation
10 is completed, the flywheel is uncoupled from the lock so that its residual energy is not absorbed by the lock to permit manual operation without turning the flywheel during manual operation. Specifically, one end of the rack has an abutment head which may be shifted into
15 engagement with a C-shaped connector, which is connected to the lock mechanism and a manual operating knob, by suitably turning the pinion to drive the rack. A spiral spring is operatively connected to a shaft of the pinion to rotate the pinion using the energy stored in the
20 spring to bring the abutment head in a neutral position to permit the manual knob to be depressed or extended without interference from the abutment head. In other words, a lost-motion type of connector is provided between the abutment head and the lock mechanism via the
25 C-connector.

U.S. patent 4,821,521, similar to U.S patent 4,290,634, uses the energy stored in a coil or helical spring to bring the positioning element, which is connected to a locking mechanism, to an initial position
30 when the motor is shut off. In this device, the positioning element is threadingly engaged with the gear spindle. The positioning element appears to be brought back to whatever position it was in prior to the actuation of the motor. It appears that there can be no
35 manual operation with this type of actuator, or, at the very least, manual operation will be rather difficult since the positioning element is threadingly engaged to

the gear spindle. Any type of manual operation disadvantageously requires the spindle and thus the motor to be back driven.

FR-A-2 596 096 also discloses an actuator using the energy stored in a spring to bring its positioning element to a neutral position after the motor is turned off. In one embodiment, the positioning element is threadingly engaged to a gear spindle with a torsional spring directly engaged therewith. The torsional spring acts directly on the positioning element itself to backdrive the gear spindle and the motor. In another embodiment, a pair of compressive springs are coaxially arranged with the gear spindle, with the positioning element sandwiched therebetween, which again act directly against the positioning element itself to backdrive the gear spindle. The present invention, on the other hand, uses a gear to backdrive the screw itself which in turn moves the positioning element to the neutral position. Due to this arrangement, less spring force is required to backdrive the screw using a gear than using the positioning element.

SUMMARY OF THE INVENTION

Accordingly, the primary object of the present invention is to provide an improved mechanism for returning a rotary-to-linear mechanism to a neutral position without using a power drive.

Another object of the invention is to provide manual operation without back driving the motor or the transmission means.

Another object of the invention is to provide a power actuator for a door locking mechanism, which is free of the above-mentioned drawbacks.

Another object of the invention is to provide a simple and efficient manual and power operations.

These and other objects of the invention are achieved in the present invention by providing an output

shaft that can move freely regardless of whether the
output shaft is in extended or retracted positions,
without back driving the motor or any of the driving
elements. Specifically, the present invention provides
5 an electrical motor with a gear, preferably helical for
noise reduction purposes, which mates with preferably a
worm gear. The worm gear is fixedly held collinearly
with an elongated screw. The screw is mated with a worm
nut which travels along the axis of the screw as the worm
10 gear rotates. The output shaft is coaxially situated
over the worm gear with no thread engagement
therebetween. The output shaft thus is freely movable
relative to the screw in the longitudinal or axial
direction of the screw, which results in essentially zero
15 back drive thereof when manually moving the output shaft.

The output shaft and the nut are fixedly held from
rotation so that rotation of the screw causes the nut to
move linearly along the axis of the screw, driving the
output shaft linearly as the nut abuts against either of
20 a pair of spaced apart abutments positioned within the
output shaft. The two abutments are spaced along the
axial direction of the output shaft. When the motor
rotates to cause the screw to rotate in one direction so
as to move the nut in the upward direction, the nut abuts
25 against the upper abutment, causing the output shaft to
move upward. When the motor rotates in the other
direction so as to cause the nut to move in the downward
direction, the nut abuts against the lower abutment,
causing the output shaft to move downward.

30 To provide for manual operation, the nut is brought
to a neutral position without driving the motor every
time the output shaft is extended or retracted. This is
achieved by providing a gear train engaging with the worm
gear to drive a torsion spring or the like which can
35 store energy therein. Specifically, in the present
invention, the worm gear is collinearly arranged relative
to another gear which is operatively engaged with the

spring gear. The spring gear winds the torsion spring or the like whenever the motor is energized to rotate the worm gear. Whenever the motor is operated to drive the worm gear, the spring gear is also rotated, which causes the spring to store energy therein. As soon as the motor is turned off, the energy stored in the spring causes the worm gear to rotate in the direction opposite to the last motor driven direction, which in turn brings the nut to the neutral position or the last position it was in prior to the energization of the motor. In the neutral position, the nut is preferably positioned adjacent to the upper abutment, when the output shaft is in its lowermost or retracted position or adjacent to the lower abutment when the output shaft is in its uppermost or extended position.

By positioning the nut in the neutral position which is adjacent to one of the abutments, manual operation can be readily realized, without back driving the screw nor the motor. The nut is preferably positioned adjacent to the output shaft's upper and lower abutments, in its neutral position, so that the nut can travel a small distance to build a momentum prior to contacting one of the abutments. This provides for higher initial force for breaking through ice which may build up, for instance, if used in an automotive door lock system in the winter time, and for breaking through debris which may build up over a period of use.

These and other objects of the invention will become more readily apparent in the ensuing specification when taken together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially broken front elevational view of a preferred embodiment of the present invention with the output shaft in the retracted position and the nut in the neutral position.

Fig. 2 is similar to Fig. 1, but partially shown, with the output shaft in the extended position and the nut in the neutral position.

Fig. 3 is a partially broken side elevational view taken along line 3-3 of Fig. 1

Fig. 4 is a cross-sectional view taken along line 4-4 of Fig. 1.

Fig. 5 is a cross-sectional view taken along line 5-5 of Fig. 3 to show the arrangement between the nut and the output shaft more clearly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments described herein have been contemplated for purposes of illustrating the principles of the present invention. Accordingly, the present invention is not to be limited solely to the exact configuration and construction illustrated and set forth herein.

The use of directional description such as upward, upper, downward, and down, has been contemplated only for purposes of describing the drawing figures. Therefore, as the directional description is merely relative, depending upon how the actual present linear drive is positioned or mounted, the present invention is not to be confined to the directional description set forth herein.

Figs. 1 and 2 show the present invention with the output shaft 20 in the retracted and extended positions, respectively. Fig. 1 schematically shows the overall arrangement of the elements that make up the linear drive 1, with a portion of the housing 10 being shown removed or broken away and the output shaft 20 in the retracted position. Although not shown, it is to be noted that the housing 10 substantially encloses the entire linear drive. Fig. 2 is identical to Fig. 1, but only partially shows the linear drive, with the output shaft 20 in the extended position.

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The linear drive 1 comprises an electrical motor 12 which is controlled by, for instance, a conventional motor control 11 driven by a D.C. power source, for instance, from the battery of an automobile. The motor 12 is stably held or attached to the housing 10 via conventional brackets or the like 12a. The motor control 11 controls the rotational direction of the motor and the time duration of the input voltage to the motor. Additionally, sensors and switches (not shown), which can be actuated by various moving elements of the linear drive such as the nut 70 as a positioning element, and the output shaft 20, may be located inside the housing to control the motor. The motor 12 has at its shaft 12b, a gear 14 which is engaged with a drive gear 16. The drive gear in turn is fixedly and collinearly attached to or integrally formed with a screw 16b. The screw 16b in turn is threadingly engaged with the nut 70 which is prevented from rotating, so that the rotation of the screw 16b causes the nut to displace linearly along the axis of the screw 16b. It is to be noted that any type of gear can be contemplated in the present invention such as spur gears. However, it is preferable to use gears 14, 16, 30, 32 which are helical for purposes of noise reduction. The screw 16b is journaled for rotation via bearing blocks or the like 10b1 and 10b2 formed with or attached to the housing 10.

Figs. 3 and 5 more clearly show the means for rotatably fixing the nut 70 relative to the output shaft 20 and the housing. Specifically, the nut 70 has a pair of diametrically opposed extensions 70e formed on the sides thereof, which extend through a pair of diametrically opposed slots 20s formed along the length of the output shaft 20 between a mid-upper abutment 20mu and a lower most abutment 20ml, and engage a pair of diametrically opposed grooves 10g formed on the housing 10. The groove/extension architecture permits the nut to substantially freely slide relative to the output shaft 20 and the housing 10 along the axial direction of the

AMENDED SHEET.

output shaft 20, but is prevented from rotating relative to the output shaft 20 and the housing 10. Moreover, the extension 70e of the nut 70 further prevents the output shaft 20 from rotating relative to the housing 10.

5 By rotating the screw 16b, the nut 70 travels along the axis of the screw 16b. The output shaft 20 is coaxially situated with the screw 16b with no thread engagement therebetween to permit the output shaft 20 to freely move relative to the screw 16b in the axial
10 direction thereof. Openings 20o with a sufficient clearance to permit the screw to rotate and the output shaft to move relative to the screw, without interference are formed in the mid-upper abutment 20mu and the lower most abutment 20ml to permit the output shaft to freely
15 move relative to the screw 16b.

The drive gear 16 also is collinearly formed with or attached to an output gear 30. The end of the output gear is rotatably journaled in a bearing block 10b2. The output gear 30 mates with a spring gear 32 which in turn
20 is rotatably journaled for rotation in bearing blocks 10b3, 10b4. The spring gear 32 is fixedly attached to a spring gear shaft 32s. A preloaded torsion or helical spring 34 is coaxially situated with the spring gear shaft 32s. A spring drive pin 32p extends parallel to
25 the spring gear shaft 32s and attached to the spring gear and the cover 36. The spring gear 32, the spring pin 32p and the cover 36 are fixed relative to each other so that they rotate in unison.

The arrangement of the spring 34 relative to the spring gear shaft 32s and the spring drive pin 32p is
30 better shown in Figs. 1 and 4. The ends 34a, 34b of the spring 34 extend generally laterally to the spring gear shaft 32s, with the spring gear pin 32p situated between the spring ends and a stop 10s formed inside the wall of
35 the housing 10. The spring 34 is arranged such that rotation of the spring gear 32 and thus the spring gear pin 32p in either direction by the motor causes the

spring to wind. More specifically, as shown in Fig. 4, if the motor is driven to rotate the spring gear 32 in the clock-wise direction CW, the pin 32p engages the upper end 34a of the spring and rotates the same in the
5 clock-wise direction CW, driving the same away from the stop 10s, while the lower end 34b of the spring 34 is urged toward and abuts the stop 10s. This causes the spring 34 to wind and store energy therein. As soon as the motor is turned off, the spring 34 unwinds in the
10 counter clock-wise direction CCW, in the direction opposite to the last motor driven direction. That is, the upper end 34a of the spring engages the pin 32p and rotates the spring gear 32 in the counter clock-wise direction, thus driving the screw 16b, which in turn
15 drives the nut 70 substantially back to the neutral position or the last position the nut was in prior to energization of the motor.

Similarly, if the motor is driven to rotate the spring gear in the counter clock-wise direction CCW, the
20 pin 32p engages the lower end 34b of the spring and rotates the same in the counter clock-wise direction CCW, driving the same away from the stop 10s, while the upper end 34a of the spring 34 is urged toward and abuts the stop 10s. This causes the spring 34 to wind and store
25 energy therein. As soon as the motor is turned off, the spring unwinds in the clock-wise direction CW, in the direction opposite to the last motor driven direction. That is, the lower end 34b of the spring engages the pin 32p and rotates the spring gear 32 in the clock-wise
30 direction, thus driving the screw 16b, which in turn drives the nut 70 substantially back to the neutral position or the last position the nut was in prior to energization of the motor.

The preloading of the spring 34 provides for a
35 predetermined return force sufficient to overcome any frictional losses between the gears.

The output shaft 20 and the nut 70 are fixedly held from rotating via the groove/extension architecture, for example, so that rotation of the screw 16b causes the nut to move linearly along the axis of the screw, driving the output shaft 20 linearly when the nut 70 abuts against either of the spaced apart abutments 20u and 20l formed by the ends of the slots 20s.

As shown in Fig. 1, the output shaft 20 is in the retracted position, at which the output shaft 20 is positioned such that the top portion 70t of the nut is adjacent to the upper abutment 20u. In operation, when the motor 12 is energized to rotate the screw 16b to move the nut 70 in the upward direction U, the top portion 70t of the nut 70 abuts against the upper abutment 20u and drives the output shaft upward to the extended position as shown in Fig. 2, until the upper-lower abutment 20ul of the output shaft 20 abuts against or is immediately adjacent to the lower abutment 10la formed by the bearing block 10b1.

When the motor stops, the stored energy from the spring 34 rotates the screw 16b in the direction opposite to the last motor driven direction, moving the nut 70 in the downward direction D, and bringing the nut 70 to its neutral position as shown in Fig. 2, all without moving the output shaft 20 since the nut 70 is slidably moveable relative to the output shaft 20. The lower portion 70b of the nut 70 is preferably adjacent the lower abutment 20l at its neutral position. At this point, the output shaft 20 can be manually moved in the downward direction D to the retracted position and moved back to the extended position with essentially zero backdriving of the screw 16b and the motor.

When the output shaft is in the extended position as shown in Fig. 2, as previously discussed, the lower portion 70b of the nut 70 abuts or is preferably adjacent the lower abutment 20l of the output shaft 20. A slight gap G between the nut and the upper and lower abutments

20u and 20l is present, which is generally caused by hysteresis in the gears and variations in component dimensions. However, this gap is preferable since it permits the motor/worm/nut to build momentum prior to contacting the output shaft, which provides for higher initial force for breaking through any ice and debris. The output shaft 20 is moved until the upper-upper abutment 20uu of the output shaft abuts against or is immediately adjacent to the upper abutment 10ua of the bearing block 10b1. Again, when the motor stops, the stored energy from the spring 34 rotates the screw 16b in the direction opposite to the last motor driven direction, moving the nut 70 in the upward direction U, and bringing the nut to its neutral position as shown in Fig. 1, all without moving the output shaft 20 since the nut 70 is slidably moveable relative to the output shaft 20. At this point, the output shaft 20 can be manually moved in the upward direction U to the extended position and moved back to the retracted position with essentially zero backdriving of the motor and the screw 16b.

Sensors or switches (not shown) may be used to stop the motor at the appropriate sensed positions. For instance, sensors may be placed along the length of the output shaft to detect the position of the output shaft and cause the motor to stop when the output shaft is at the extended position or retracted position. The particular arrangement of sensors and switches to control the motor is believed to be well known to one versed in the art, and thus need not be disclosed herein. U.S. patents 4,135,377 issued to Kleefeldt, et al. and U.S. patent 4,893,704, for instance, disclose sensors and switches for controlling a motor.

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What is claimed is:

1. A linear drive for actuating a door locking mechanism which permits manual locking and unlocking operation, using an electric motor (12) to drive an output shaft (20), which is operatively linked to said locking mechanism, between an extended position and a retracted position, relative to a housing (10) which substantially encloses elements of said linear drive, wherein said motor drives said output shaft using gears (14, 16, 16b) said output shaft (20) is coaxially and telescopingly situated over said screw (16b) and is freely movable relative to said screw in an axial direction of said screw between said extended position and said retracted position, and a positioning element (70) threadingly connected to a screw (16b) and positioned between upper and lower abutments (20u, 20l) formed on said output shaft, wherein said positioning element engages said upper abutment to move said output shaft upward to said extended position upon energization of said motor in one direction and engages said lower abutment to move said output shaft downward to said retracted position upon energization of said motor in a direction opposite to said one direction, and having an energy storing means (34) for automatically moving said positioning element to a neutral position after said motor has been deenergized so that said output shaft can be manually operated without back driving said screw and said motor, said neutral position being the position at which said positioning element (70) is adjacent said lower abutment (20l) when said output shaft is in said extended position and being the position at which said positioning element is adjacent said upper abutment (20u) when said output shaft is in said retracted position, characterized in that:

wherein said energy storing means for automatically moving said positioning element comprises a spring gear

(32) rotationally mated with said screw (16b) and a helical or torsion spring (34) coaxially positioned relative to said spring gear, said spring being energized by rotational movement of said spring gear imparted by said screw, wherein said spring rotates said spring gear in the opposite direction to the last driven direction, which rotates said screw to move said positioning element to said neutral position,

wherein by virtue of said neutral position of said positioning element being situated adjacent said upper abutment of said output shaft when said output shaft is in said retracted position, said output shaft is manually and repeatedly movable to said extended position and back to said retracted position without backdriving said screw and said motor and by virtue of said neutral position of said positioning element being situated adjacent said lower abutment when said output shaft is in said extended position, said output shaft is manually and repeatedly movable to said retracted position and back to said extended position without backdriving said screw and said motor.

2. A linear drive according to claim 1, further comprising a drive gear (16) collinearly attached to said screw (16b), and an output gear (14) attached to an output of said motor and which mates with said drive gear.

3. A linear drive according to claim 2, further comprising a spring drive gear (30) collinearly attached to said drive gear (16) and mating with said spring gear (32).

4. A linear drive according to claim 3, wherein said spring gear (32), drive gear (16), output gear (14) and spring drive gear (30) are helical gears.

5. A linear drive according to claim 1, further comprising a spring gear shaft (32s) coaxially connected to said spring gear (32), wherein said spring (34) is coaxially positioned with said spring gear shaft.

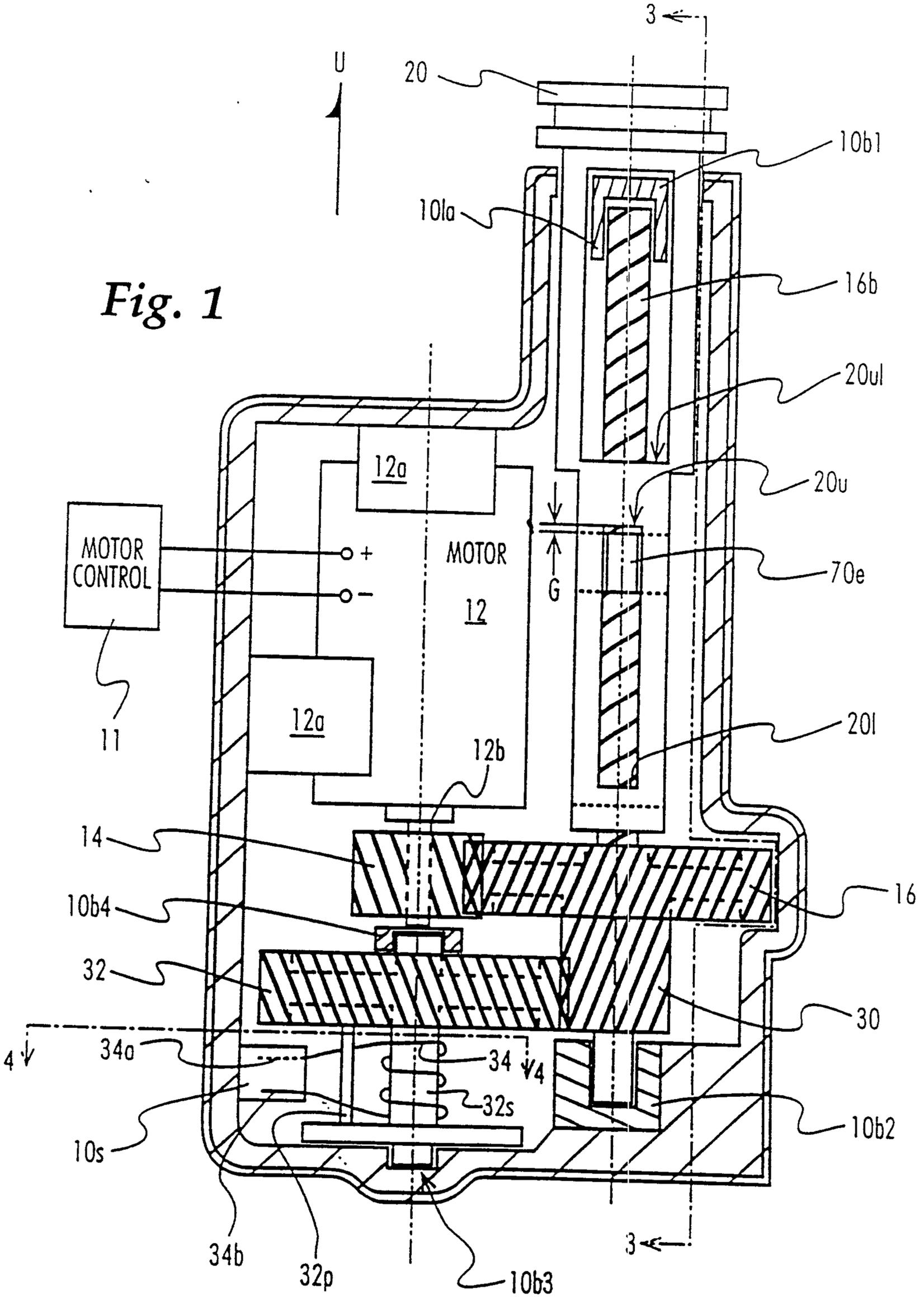
6. A linear drive according to claim 5, further including a pin (32p) extending from said spring gear (32), said pin extending substantially parallel to said spring gear shaft and radially spaced therefrom and wherein said housing includes a stop wall (10s), wherein one end (32a,32b) of said spring abuts against said pin and the other end (32b,32a) abuts against said stop when said spring gear is rotated to store energy therein.

7. A linear drive according to claim 1, wherein said upper and lower abutments each have an opening with sufficient clearance to permit said screw to freely pass therethrough and rotate without interference therefrom, wherein the distance between said upper and lower abutments being equal to or less than the distance of travel of said output shaft between said extended position and said retracted position.

8. A linear drive according to claim 7, wherein said output shaft (20) includes a pair of opposed slots (20s) formed inside a predetermined length of said output shaft between said upper and lower abutments and a corresponding pair of opposing extensions (70e) formed on said positioning element to slidably ride on said slots; wherein a pair of opposed parallel grooves (10g) are formed on inside walls of said housing and running parallel to said slots and engaging said extensions so as to prevent said positioning element and said output shaft from rotating.

9. A linear drive according to claim 1, wherein said neutral position remains substantially at a constant position adjacent one of said upper and lower abutments.

Fig. 1



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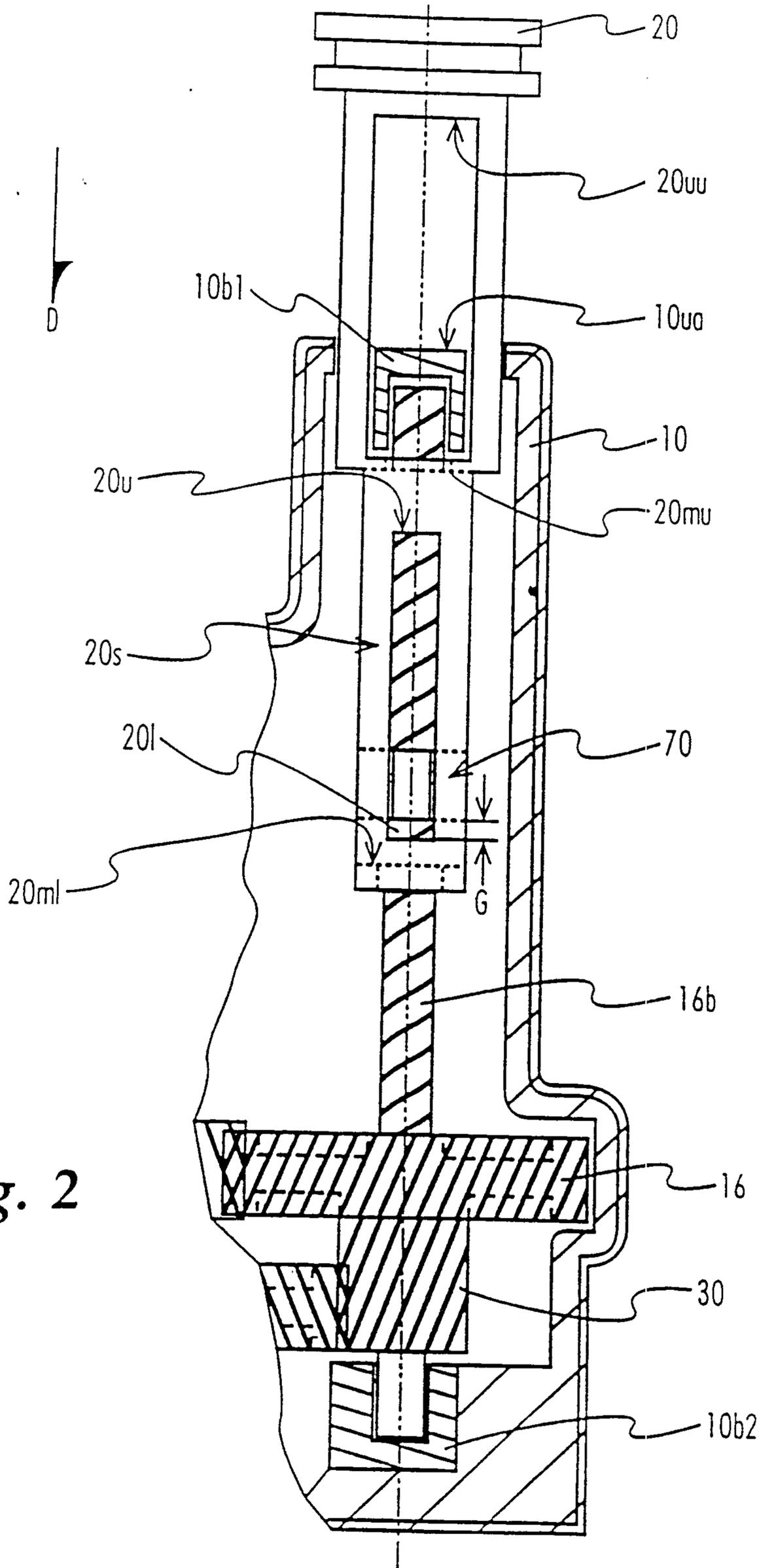


Fig. 2

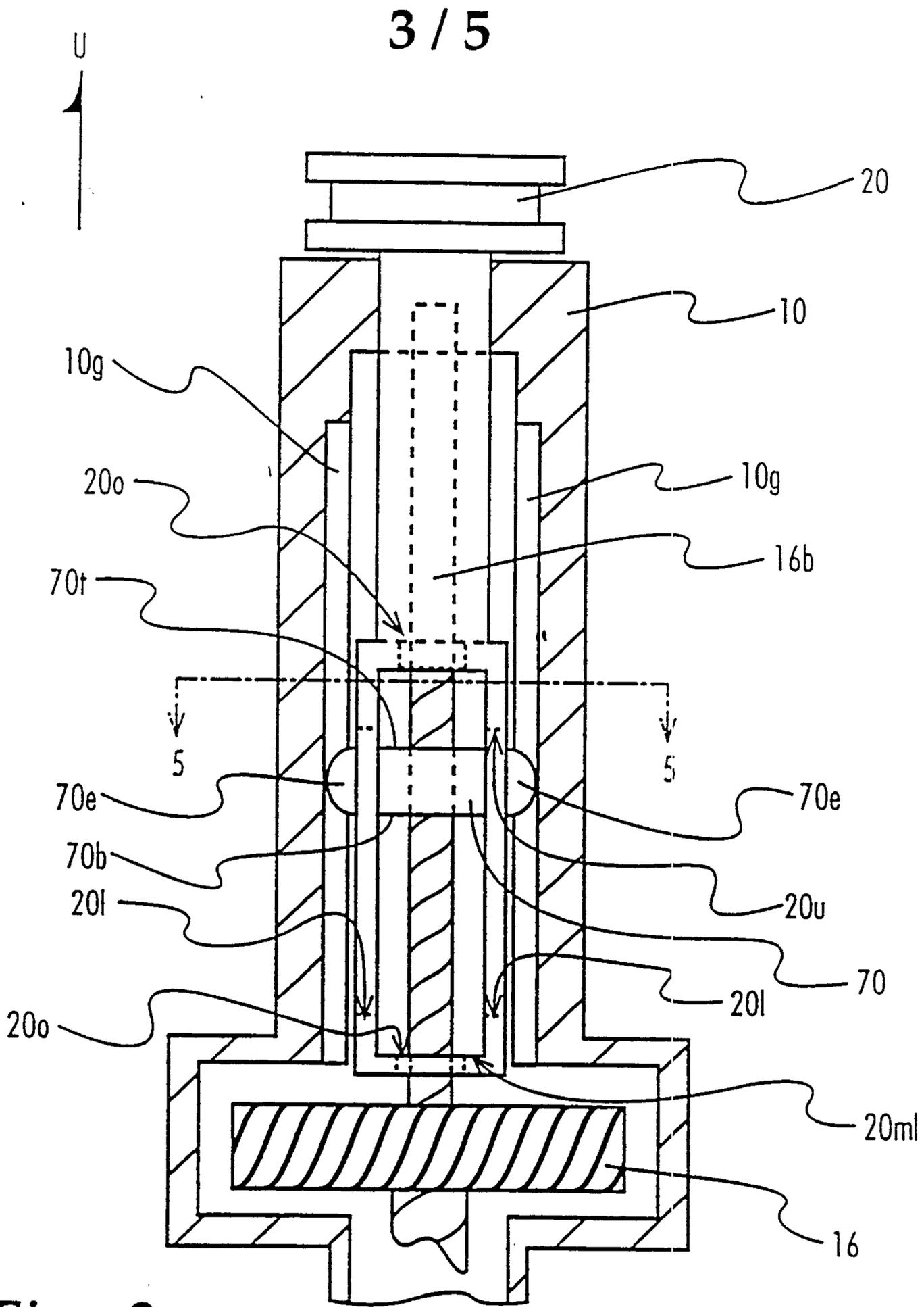


Fig. 3

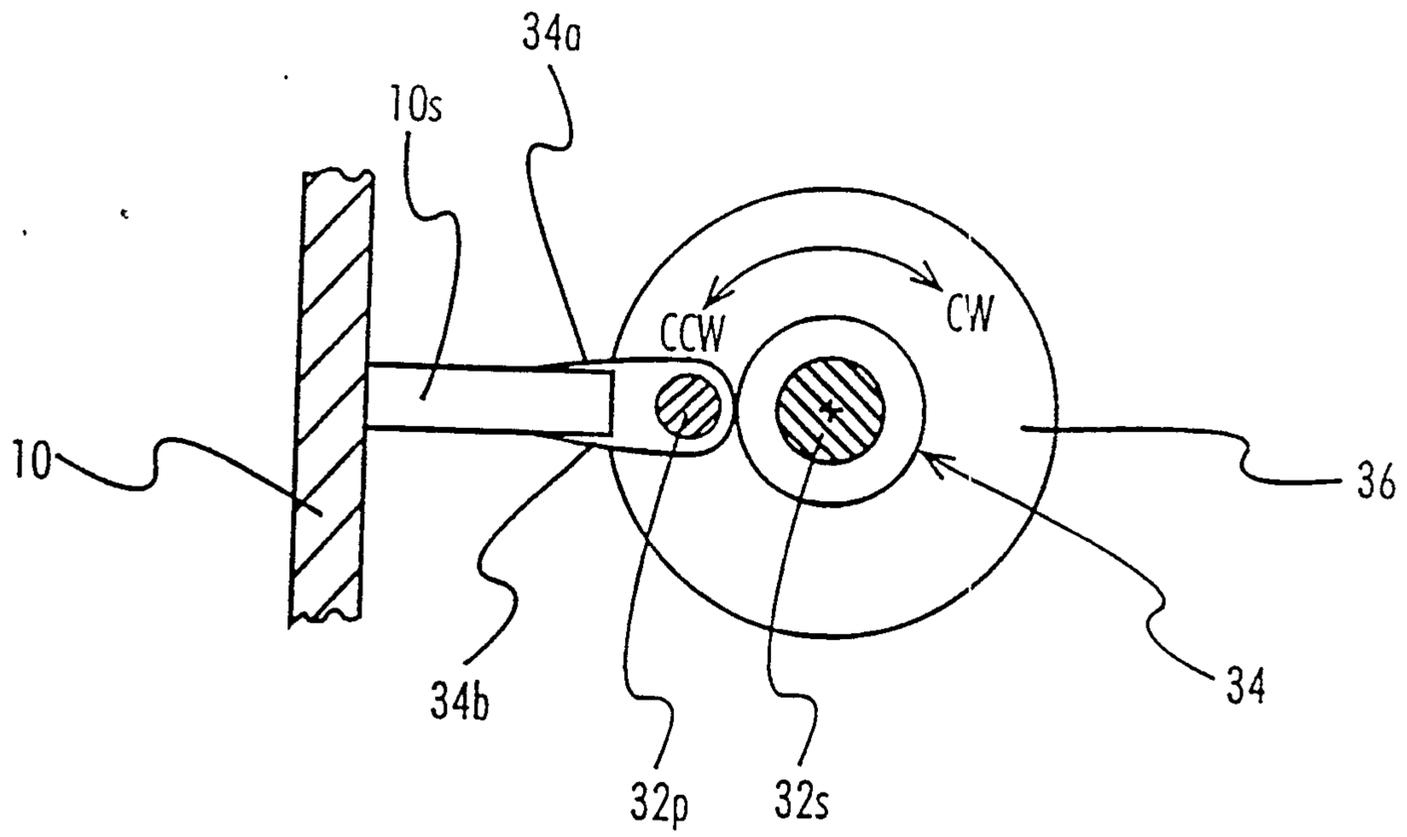


Fig. 4

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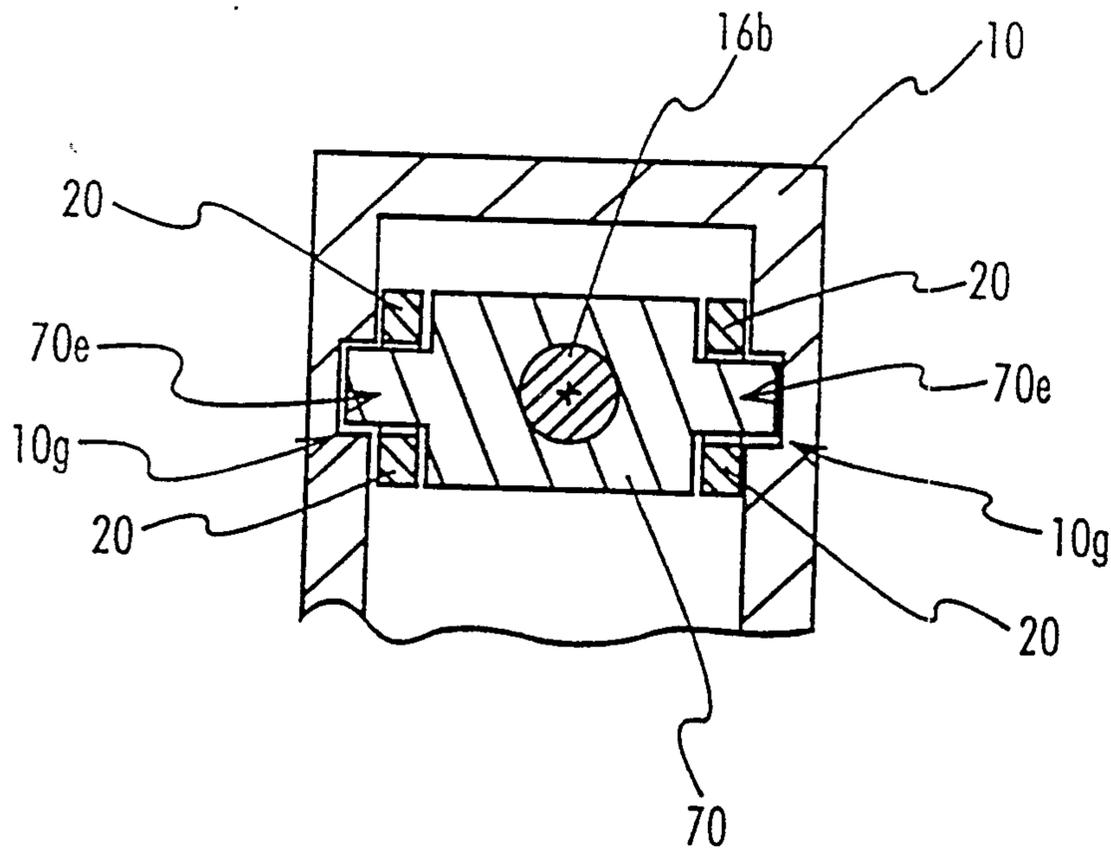


Fig. 5

