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(56) Documents Cited:
EP 1387027 A2 **EP 0267423 A2**
US 6102454 A **US 5603537 A**

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INT CL[7] **E05B**
Other: **WPI, EPODOC, JAPIO**

(54) Abstract Title: **An actuator assembly for use in conjunction with a latch assembly**

(57) An actuator assembly 10 including a gear wheel in the form of a worm wheel 12, an energy storage means in the form of a spiral spring 14, a detent in the form of a pawl 16, an actuator in the form of a motor 18 and an actuator assembly body 20. Motor 18 is mounted on body 20 and includes a motor shaft 22 drivingly coupled to a pinion 24. Pinion 24 drivingly engages teeth 26 of the worm wheel 12. The motor 18 is operable to apply a force in a first direction to drive the pawl 16 in the first direction from a rest condition of the actuator assembly 10 to an actuated condition, and is also operable to apply a force in a second direction to drive the pawl 16 in the second direction from the actuated condition to the rest condition. The motor acts to provide stored energy in the spiral spring 14, the release of which assists the movement of the pawl 16 in the first direction with the actuator assembly 10 in the rest condition.

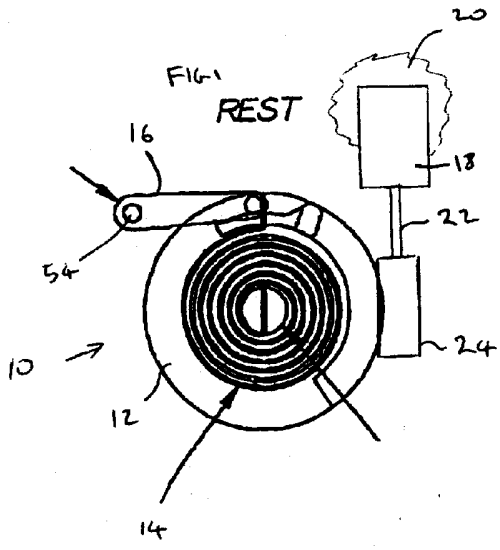

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FIG 1

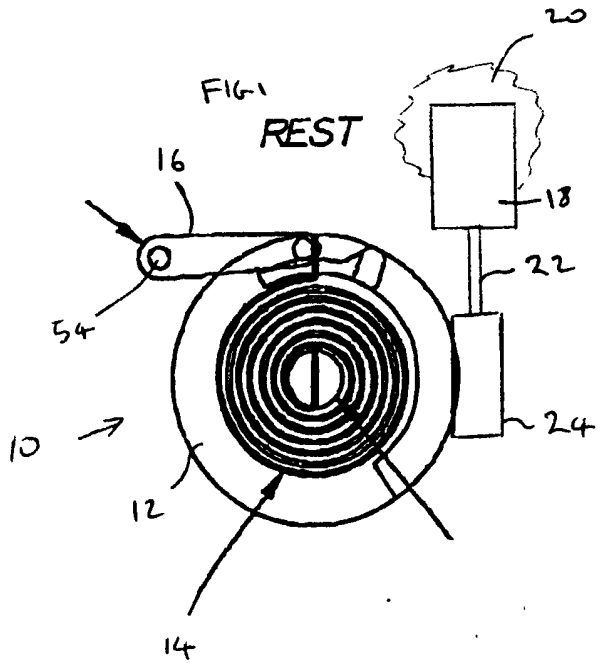
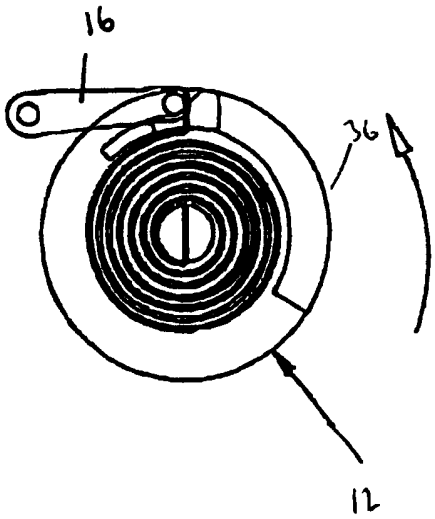


FIG 2



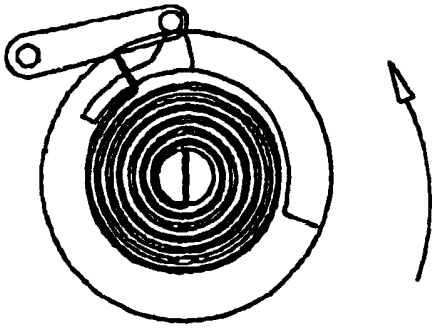


FIG 3

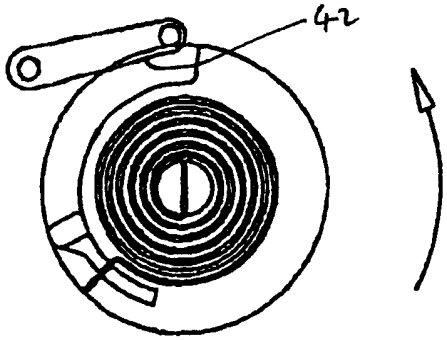


FIG 4

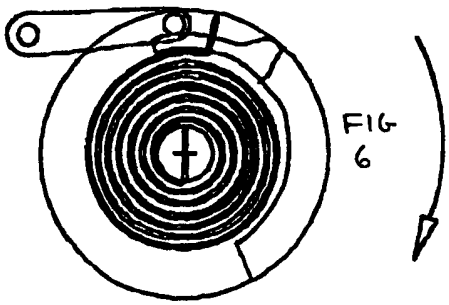


FIG 6

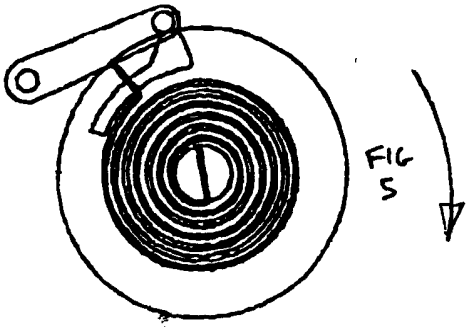


FIG 5

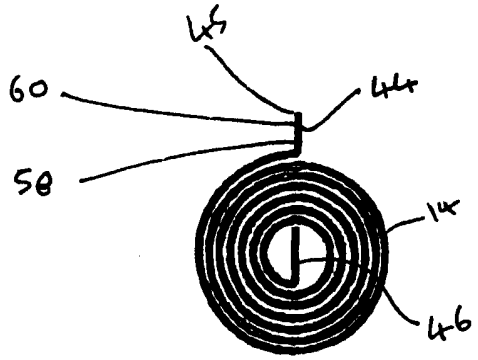


FIG 7

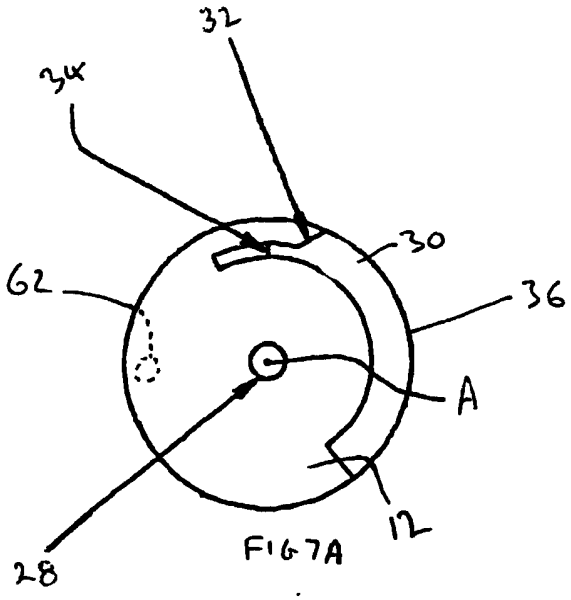


FIG 7A

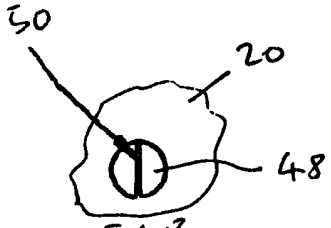


FIG 8

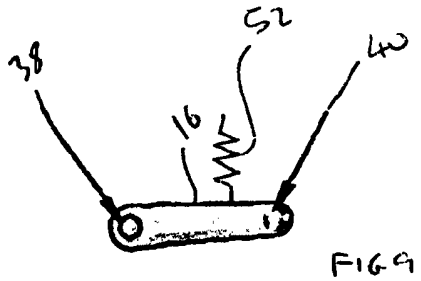


FIG 9

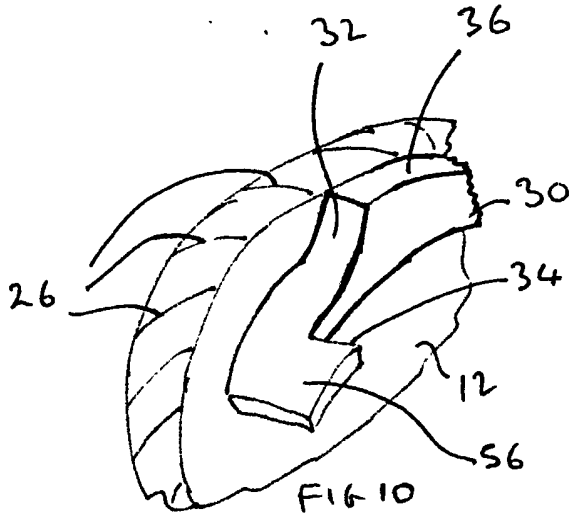


FIG 10

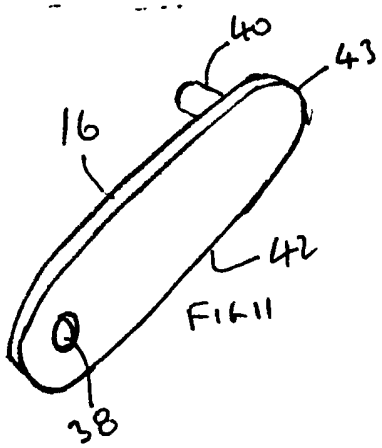


FIG 11

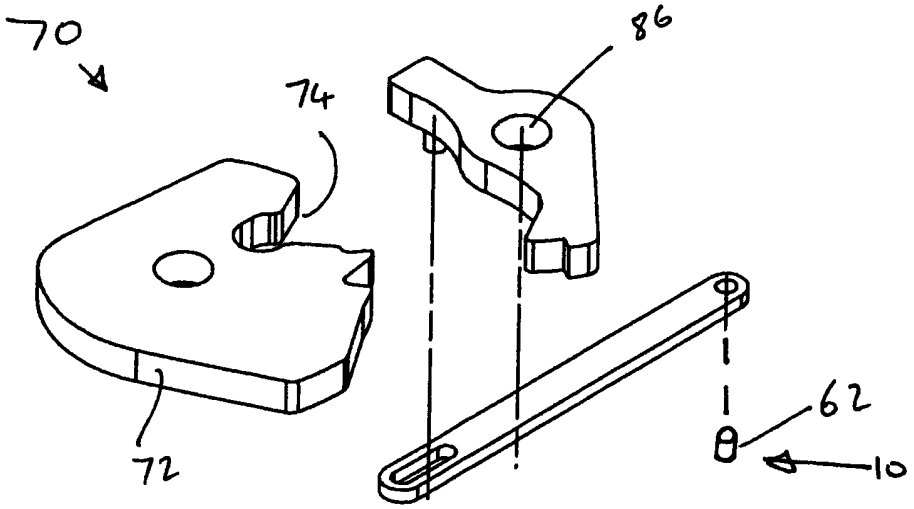


FIG 12

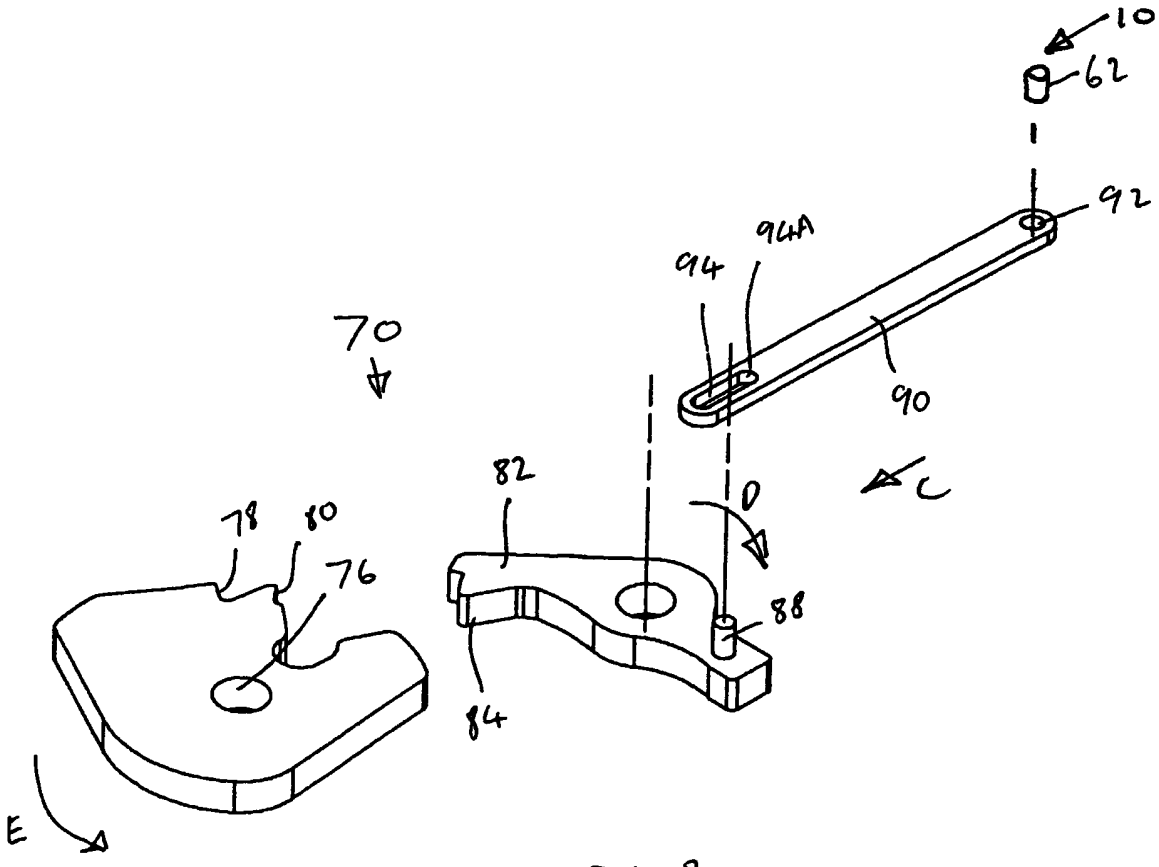
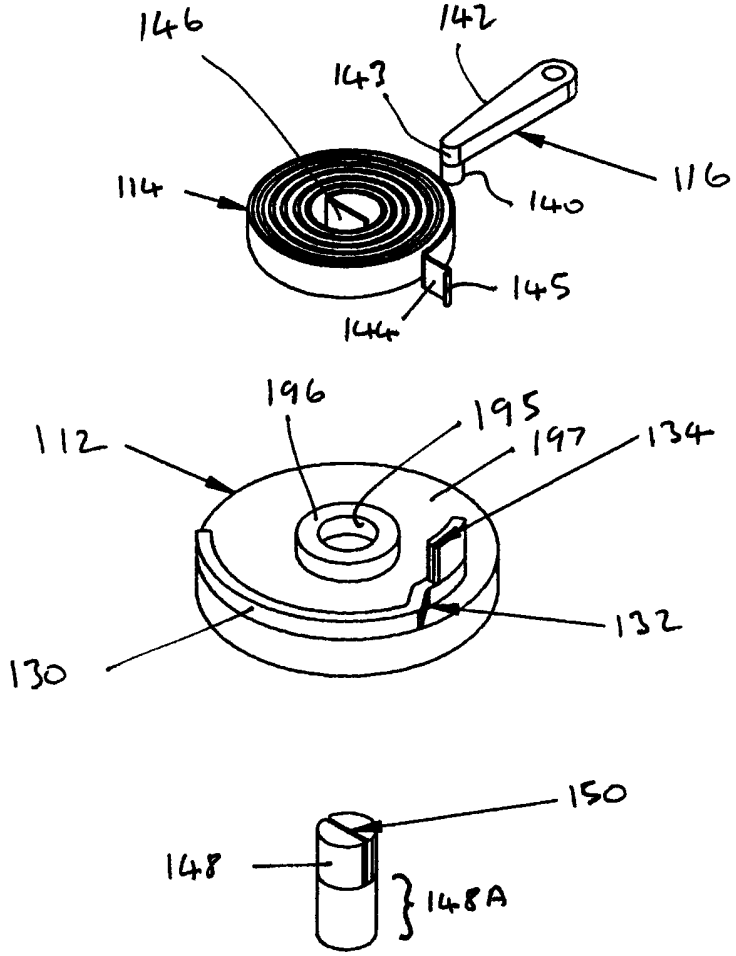


FIG 13


146
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148A

FIGURE 14.

An Actuator Assembly

The present invention relates to an actuator assembly, in particular an actuator assembly used in conjunction with a latch assembly, in particular a latch assembly of a vehicle door, such as a car door.

European Patent Application EP01300813 describes actuator assemblies in which a spring is used to assist the actuator motor when the actuator is actuated. Once actuated, the motor is then powered in a reverse direction to restore the assembly to a rest condition, and in particular to store energy in the spring in preparation for the next actuation operation.

In particular, figure 3 of EP01300813 shows a worm wheel that is driven by a motor and operates to drive a separate output lever. The output lever acts to store energy in the spring, and a stop pawl acts on an abutment of the output lever to ensure that the output lever remains in its at rest condition. The stop pawl is disengaged by a ramp surface of the worm wheel. In particular, the ramp surface is rotatable relative to the abutment of the output lever.

However, this arrangement is complicated in as much as it includes an output lever which is separate from the worm wheel. Furthermore the output lever is complicated to produce, having various abutments, slots and output pins. Furthermore, this arrangement is not particular compact, since in particular a space envelope is required for both the worm wheel and the output lever and a further space envelope is required for the spring and associated housing.

An object of the present invention is to provide an actuator assembly that is cheaper and/or easier to produce. Another object of the present invention is to provide an actuator assembly that has fewer components. Another object of the present invention is to provide an actuator assembly that is more compact.

Thus, according to the present invention there is provided an actuator assembly as defined in the accompanying independent claims.

The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figures 1 to 6 show the progressive operation of an actuator assembly according to the present invention,
Figures 7 to 11 show certain components of the actuator assembly of figure 1, or parts thereof, in isolation,
Figures 12 and 13 show parts of a latch assembly with which an actuator assembly according to the present invention can be used, and
Figure 14 shows an exploded view of certain components of a second embodiment of an actuator assembly according to the present invention.

Figure 1 shows an actuator assembly 10 including a gear wheel in the form of a worm wheel 12, an energy storage means in the form of a spiral spring 14, a detent in the form of a pawl 16, an actuator in the form of a motor 18 (shown schematically) and an actuator assembly body 20 (only part of which is shown). Motor 18 is mounted on body 20 and includes a motor shaft 22 drivingly coupled to a pinion 24. Pinion 24 drivingly engages teeth 26 (see figure 10) of the worm wheel 12.

Worm wheel 12 (best seen in figures 7A and 10) includes a pivot 28 and a boss 30 having a camming surface 32 proximate the worm wheel and an abutment 34 and a region 56 both of which are remote from the worm wheel. The boss further includes a peripheral surface 36 which extends through an arc of approximately 120 degrees. Worm wheel 12 is pivotally mounted via pivot 28 on body 20 about axis A which is substantially coincident with the axis of the spiral spring 14.

Pawl 16 is generally elongate and includes a pivot hole 38 at one end and a camming pin 40 at the other end. An edge 42 of the pawl serves to engage spiral spring 14 as will be further described below.

Pawl 16 is pivotally mounted on boss 54 which in turn is secured to body 20. A spring 52 (shown schematically in figure 9) biases pawl 16 in a clockwise direction about boss 54. Spiral spring 14 includes several (in this case six) turns and has a radially outer end 44 and a radially inner end 46. Both ends are radially orientated relative to an axis of the spring. A generally circular spring mount boss 48 is provided on the actuator assembly body. Spring mount boss 48 includes a radially orientated slit 50. The radially inner end 46 is positioned within slit 50 to secure the radially inner end of spring 14 rotationally fast with body 20 Radially outer end 44 includes a tip 45, a radially outer region 60 and a radially inner region 58

When assembled, camming pin 40 lies in the path of camming surface 32 and peripheral surface 36.

Edge 42 of pawl 16 lies in the path of the tip 45 of the radially outer end 44 of spring 14. Consideration of figure 1 shows the components in an assembled condition in a rest condition of the actuator. Spring 52 has biased edge 42 of pawl 16 into engagement with region 56 of boss 30. Abutment 34 is in engagement with the radially inner region 58 of radially outer end 44. End 43 of pawl 16 is in engagement with the radially outer region 60 of radially outer end 44.

Spring 14 is under load such that the spring is endeavouring to unwind, and hence the spring force is being applied to end 43 of pawl 16. However, because of the geometrical arrangement as shown in figure 1, pawl 16 remains in that position, and spring 14 cannot unwind. It will be appreciated that under these circumstances there is stored energy in spring 14

Operation of the actuator is as follows.

Starting from the position shown in figure 1, motor 18 is powered such that worm wheel 12 is caused to rotate about axis A in an anticlockwise direction. This causes abutment 34 to become disengaged from region 58 and simultaneously causes camming surface 32 to approach camming pin 40. This position is shown in figure 2, from which it will be

appreciated that pawl 16 and spring 14 are in the same position as shown in figure 1. Continued rotation of worm wheel 12 causes the camming surface 32 to engage camming pin 40 and thereby rotate pawl 16 in an anticlockwise direction about boss 54. In doing so, end 43 moves generally radially outwardly relative to axis A until such time as pawl 16 can no longer restrain spring 14 whereupon tip 45 can rotate underneath edge 42 and region 58 can re-engage abutment 34. This position is shown in figure 3. It can be seen that camming pin 40 now rests on peripheral surface 36 and this engagement ensures that as the worm wheel continues to rotate in an anticlockwise direction to the position shown in figure 4, pawl 16 remains in the position shown in figures 3 and 4. It will be appreciated that during movement of worm wheel from the figure 3 position to the figure 4 position the spring assists the motor, since even in the position shown in figure 4, the spring is still under load.

In order to return the actuator assembly to the rest position, the motor is powered in the opposite direction in order to rotate the worm wheel in a clockwise direction through the position shown in figure 5 to the position shown in figure 6. As this occurs, and as mentioned above, the peripheral surface 36 ensures that pawl 16 is not biased clockwise by spring 52. Figure 5 shows the position at which camming pin 40 is about to disengage peripheral surface 36. It will be appreciated that at this moment, tip 45 of spring 14 has just engaged edge 42 of pawl 16. Thus, continued clockwise rotation of worm wheel 12 from the position shown in figure 5 results in tip 45 being moved along edge 42 and hence reacting the spring force created by spring 52. Once tip 45 has moved past end 43 (as shown in figure 6) then spring 52 biases pawl 16 clockwise such that part of edge 42 engages region 56 as shown in figure 6.

Once power to the motor is cut, spring 14 returns the components to the rest position as shown in figure 1.

In use, worm wheel 12 is connected to an output member and the output member can be connected to components that require actuation.

In particular the output member can be of a particularly simple nature. An example of an output member would be a circular boss mounted on the side of the worm wheel opposite to boss 30 An example of such an output member boss is shown as item 62 on figure 7A. Alternatively the output member could be in the form of a simple lever connected to the worm wheel. Those skilled in the art will appreciate that other forms of output member could be used including an output shaft, or an output gear either mounted directly to worm wheel 12 or mounted on a shaft connected to worm wheel 12.

The actuator assembly is particularly applicable for use with a latch assembly of a vehicle, such as a car. Latch assemblies for passenger doors, boots, bonnets and other closures of cars are known wherein a latch bolt, typically in the form of a rotating claw is releasably securable in a closed position by a latch pawl. The claw includes a mouth for releasably receiving a striker, typically mounted on fixed structure of the vehicle. The pawl includes a pawl tooth which engages the claw, thereby latching the latch. Disengagement of the pawl tooth from the claw allows the claw to rotate to release the striker and thereby allow the door to open.

Figures 12 and 13 show isometric exploded top and bottom views of a latch assembly 70 (only part of which is shown) which includes an actuator assembly (only part of which is shown) according to the present invention. Latch assembly 70 includes a latch bolt in the form of a rotating claw 72 having a mouth 74 for releasably receiving a striker (not shown). Claw 72 is rotatably mounted via hole 76 on a pivot pin (not shown).

Claw 72 includes first safety abutment 78 and fully closed abutment 80 which are engageable by pawl tooth 84 of latch pawl 82. Pawl 82 is pivotally mounted via hole 86 on a pivot pin and includes a pawl release pin 88. A link 90 connects output member boss 62 of actuator assembly 10 (only boss 62 being shown for clarity) to the latch pawl 82. In particular output member boss 62 engages hole 92 of link 90 and pawl release pin 88 engages slotted hole 94 of link 90. It will be appreciated that slotted hole 94 provides a lost motion connection between link 90 and latch pawl 82, i.e. it allows link 90 to move linearly in a direction of arrow C to a limited extent without starting to move latch pawl 82. Those skilled in the art will readily appreciate that with the latch assembly in a latched

condition, operating the actuator assembly will cause output member boss 62 to rotate and thus cause link 90 to move generally linearly in the direction of arrow C whereupon end 94A of slotted hole 94 will engage and then displace pawl release pin 88 causing latch pawl 82 to rotate in the direction of arrow D thereby releasing pawl tooth 84 from the fully closed abutment 80 and allowing rotating claw 72 to rotate in the direction of arrow E thereby releasing the striker and allowing the associated closure to be opened.

There will clearly be a frictional force between pawl tooth 84 and abutment 80 as the latch starts to open, i.e. as the latch pawl 82 starts to rotate, and the actuator force required to overcome this friction is significantly greater than the actuator force required to move link 90 alone (i.e. when link 90 is being moved but end 94A has not yet engaged pawl release pin 88) Because of this, it is beneficial that the actuator assembly 10 reaches the position shown in figure 3 just as, or preferably just prior to end 94A engaging pawl release pin 88. Under these circumstances full spring assist is available as the latch starts to open, i.e. as latch pawl 82 starts to rotate and hence as pawl tooth 84 starts to slide across abutment 80.

Those skilled in the art will readily appreciate that there are many alternatives to providing a lost motion connection between an output member of an actuator assembly according to the present invention and a latch pawl of a latch used with an actuator assembly according to the present invention.

As mentioned above when the actuator assembly 10 is used with latch assembly 70, the motor 18 will be powered to release the latch. When the latch assembly 70 is used in a passenger door, typically the motor 18 might be powered for a set time such as half a second (or less). This time period is set to ensure that under all foreseeable conditions the latch pawl is disengaged from the latch claw. Typically under normal operating conditions it might take 0.1 or 0.2 seconds for the latch pawl to disengage from the latch claw. Under these circumstances the motor is stalled for the remainder of the timed period. Alternatively, the motor may be powered continuously until such time as sensors within the latch detect that the latch pawl has disengaged from the claw. Typically, microswitches might be used to detect the position of the latch pawl or the latch claw.

Once the latch has been opened, the motor can then be powered to re-wind the spring. Typically this might occur as soon as a sensor detects that the claw has been opened. Alternatively, a control system can provide a short time delay (such as 20 second or less, or 10 seconds or less) following which the motor is powered to rewind the spring.

A sequence might be:-

a) power the motor for half a second to open the latch,
b) detect an open position of the latch claw via a sensor (such as a microswitch or the like),
c) power the motor in a reverse direction for half a second to rewind the spring.

Alternatively, the motor could be powered to rewind the spring only upon closing of the door. Thus, typically sensors would be provided to detect an open position and a closed position of the claw. When the door is opened, the open position of the claw will be detected. The control system would then recognise that the spring needs rewinding. Once the door was closed, the sensor detecting the closed position of the claw would send a signal to the control system thereby prompting the motor to rewind the spring.

Figure 14 shows an actuator assembly 110 in which components which fulfil the same function as those of actuator assembly 10 are labelled 100 greater.

The actuator assembly 110 is provided by taking the components shown in figure 14 and substituting them for the equivalent components shown in figure 1 to provide the actuator assembly 110.

Worm wheel 112 includes an output member boss (not shown but similar to output member boss 62) or an equivalent feature to enable actuator assembly 110 to be used with a latch assembly in a manner similar to actuator assembly 10.

The tip 145 of spiral spring 114 has been bent over to provide a smooth, non sharp, surface against which edge 142 of pawl 116 acts in use.

Camming pin 140 of pawl 116 has a radius equivalent to end 143.

Worm wheel 112 includes a central hole 195 through which spring mount boss 148 projects It will be appreciated that a lower portion 148A of spring mount boss acts together with central hole 195 to allow worm wheel 112 to pivot relative to the actuator assembly body (not shown).

Worm wheel 112 includes an annular boss 196 which projects above a surface 197 by an amount equivalent to the amount by which the main circumferential region of boss 130 projects above surface 197. In this manner, radially inner end 146 can be supported such that radially outer end 144 is presented in the correct plane relative to abutment 134.

Claims

1 An actuator assembly including an actuator drivingly connected to a gear wheel, the gear wheel including an abutment secured rotationally fast with a camming surface, and being operable to drive an output member, a detent, the actuator being operable to apply a force in a first direction to drive the output member in the first direction from a rest condition of the actuator assembly to an actuated condition, and also being operable to apply a force in a second direction to drive the output member in the second direction from the actuated condition to the rest condition, the actuator assembly further including an energy storing means, in which movement of the output member in the second direction by the actuator acts to provide stored energy in the energy storing means and movement of the output member by the actuator in the first direction is assisted by the energy storing means by the release of said stored energy

in which the energy storage means acts on said abutment to assist movement of the output member in the first direction and with the actuator assembly in the rest condition:

i) the detent engages the energy storage means to releasably retain the energy storage means in a rest position and

ii) actuation of the actuator causes the camming surface to disengage the detent from the energy storage means thereby allowing the energy storage means to assist movement of the output member in the first direction.

2. An actuator assembly as defined in claim 1 in which the energy storage means is a spiral spring.

3 An actuator assembly as defined in claim 2 in which a radially outer end of the spiral spring engages the abutment.

4 An actuator assembly as defined in claim 3 in which the radially outer end is engaged by the detent.

5 An actuator assembly as defined in any preceding claim in which the abutment and the camming surface are provided on a common projection of the gear wheel.

6 An actuator assembly as defined in claim 5 in which the camming surface is proximate the gear wheel and the abutment is remote from the gear wheel.

7 An actuator assembly including an actuator drivingly connected to an output member, the actuator being operable to apply a force in a first direction to drive the output member in the first direction from a rest condition of the actuator assembly to an actuated condition, and also being operable to apply a force in a second direction to drive the output member in the second direction from the actuated condition to the rest condition, the actuator assembly further including an energy storing means, in which movement of the output member in the second direction by the actuator acts to provide stored energy in the energy storing means and movement of the output member by the actuator in the first direction is assisted by the energy storing means by the release of said stored energy, in which the energy storage means is a spiral spring.

8. A latch assembly including a latch bolt releasably securable in a closed position by a latch pawl and an actuator assembly as defined in any preceding claim in which the output member is connected to the latch pawl and operation of the actuator causes the latch pawl to release the latch bolt.

9 A latch assembly as defined in claim 8 when dependent on anyone of claims 1 to 6 in which there is a lost motion connection between the gear wheel and the latch pawl that enables the camming surface to disengage the detent from the energy storage means prior to the latch pawl starting to release the latch bolt.

INVESTOR IN PEOPLE

Application No: GB0405153.8 -11- **Examiner:** Kevin Hewitt

Claims searched: 1 to 9 **Date of search:** 6 August 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1,2,7	EP 1387027 A2 (ARVINMERITOR) See especially Figs. 3 & 3A; and paragraphs [0041] to [0052].
X	1,2,7	EP 0267423 A2 (AISIN SEIKI) See especially Figs. 2, 7, 8 & 11; and column 3 line 45 to column 6 line 38
X	1,2,7	US 6102454 A (WEYERSTALL) See especially Figs. 1, 3 & 4.
X	1,2,7	US 5603537 A (AMANO et al.) See all Figs.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

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Worldwide search of patent documents classified in the following areas of the IPC[07]

E05B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, JAPIO