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(54) **VEHICLE DOOR HANDLE ASSEMBLY**

(57) The invention relates to a coupling device for a vehicle door handle (1), the door handle (1) having a handle lever (3) movable between a flush position in which it is flush with an exterior door panel (100) surface and a ready position in which it is protruding and graspable by a user by an electric motor (7), and between an inward clicking position in which a preloaded push-push unit (13) is released so as to bring the handle lever (3) in said ready position without actuation of the electric motor (7), comprising :

- a lever shaft (27), connected to the handle lever (3),
 - a push-push lever ring (29), rotatively coupled with the lever shaft (19), interacting via a push-push lever (30) with the push-push unit (13) when the handle lever (3) is pushed inwards in the clicking position so as to release the preloaded push-push unit (13) and push the lever (3) in ready position,
 - a coupling gear (31), rotatively coupled with the lever shaft (27), interacting with the electric motor (7) to move the handle lever (3) from the flush position to the ready position,
- wherein the lever shaft (27) is rotatively coupled to the coupling gear (31) via a coupling mechanism supported by the lever shaft (27) and rotatively linking the lever shaft (27) and the coupling gear (31), the coupling mechanism being configured to allow free rotational movement of the lever shaft (27) with respect to the coupling gear (31) within an angular range corresponding to the angular dis-

tance between the ready position and the clicking position of the handle lever (3).

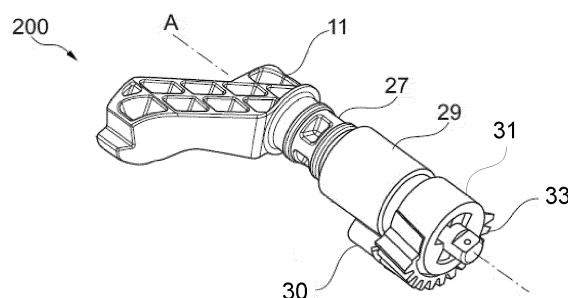


Fig. 3

Description

[0001] The present invention concerns a vehicle door assembly, in particular of the type with a flushing door handle lever.

[0002] Such vehicle door handle assemblies comprise an electric motor which, when actuated, moves the handle lever between a flush position and a ready position. In the flush position, the handle lever is flush with the exterior surface of the door body. In the ready position, the handle lever is protruding from said exterior surface, so as to be graspable by a user.

[0003] Once the user grasped the handle lever in its ready position, he can unlatch the door by pulling the lever in a further protruding unlocking position, in which the handle door lever interacts (via a Bowden cable, a rotating pin or a gear mechanism) with a latch mechanism and unlatches the door.

[0004] A handle lever spring brings the handle lever back in its ready position when the user releases the handle lever. The electric motor may also move the handle lever from the ready position to the flush position after opening or closing the door.

[0005] Such door handle assemblies also comprise a back-up mechanism, to enable the opening of the door in case of, for example, electric motor or car battery failure, that is when the electric motor cannot be actuated. This mechanism comprises for example a push-push mechanism, in which the user pushes the handle lever inwards from its flushing position until reaching a clicking position in which a preloaded spring is released. Said preloaded spring, when released, pushes the handle lever from the inward clicking position in the protruding ready position.

[0006] Once the user accesses the vehicle in back-up mode, the battery will generally be recharged, and/or the motor failure will be lifted and normal, electric, actuation can be resumed.

[0007] In normal functioning, the electric motor sets the handle lever in motion via a reduction mechanism, for example a worm and gear mechanism, which reduces the rotational speed of the motor actuation while increasing torque value. When the user pushes the lever from the flushing to the clicking position, said reduction mechanism is actuated in reverse.

[0008] Another problem arising from the irreversibility of the actuation is observed when a user opens the door with important speed. In particular, the user pulls on the lever, which is in open (extended) position, to cause opening of the door. Once the door panel reaches a sufficiently open position, the user will stop the motion by pushing on the handle lever to stop the door panel motion.

[0009] This reversal of forces causes the lever to be quickly driven back from open to ready or flush position. During this motion, the reduction mechanism may be actuated in reverse, potentially with high movement speed.

[0010] The resulting reverse actuation, in case of non-reversibility due to friction increased by temperature, may

cause the reduction mechanism to deteriorate or even break, thus potentially compromising the operating of the door handle as a whole, both in manual back-up and when resuming normal, electrical actuation (e.g. after recharging the battery or lifting the motor malfunction).

[0011] In order to overcome the aforementioned drawbacks, the present invention has for object a coupling device for a vehicle door handle, the door handle having a handle lever movable between a flush position in which it is flush with an exterior door panel surface and a ready position in which it is protruding and graspable by a user by an electric motor, and between an inward clicking position in which a preloaded push-push unit is released so as to bring the handle lever in said ready position without actuation of the electric motor, comprising :

- a lever shaft, connected to the handle lever,
- a push-push lever ring, rotatively coupled with the lever shaft, interacting via a push-push lever with the push-push unit when the handle lever is pushed inwards in the clicking position so as to release the preloaded push-push unit and push the lever in ready position,
- a coupling gear, rotatively coupled with the lever shaft, interacting with the electric motor to move the handle lever from the flush position to the ready position,

wherein the lever shaft is rotatively coupled to the coupling gear via a coupling mechanism supported by the lever shaft and rotatively linking the lever shaft and the coupling gear, the coupling mechanism being configured to allow free rotational movement of the lever shaft with respect to the coupling gear within an angular range corresponding to the angular distance between the ready position and the clicking position of the handle lever.

[0012] The relative free rotational movement allows to selectively uncouple the lever and the reduction stages when the user is pushing said lever in clicking position and when the push push unit pushes said lever in ready position.

[0013] The coupling device may present one or more of the following characteristics, taken separately or in combination.

[0014] The lever shaft comprises on an axial portion at least one radial rail, and the coupling gear comprises at least one circular arc shaped hole housing the radial rail, and the angular opening of the circular arc shaped hole corresponds to the angular distance between the ready position and the clicking position of the handle lever.

[0015] The lever shaft comprises on an axial portion two diametrically opposite radial rails, and the reduction gear comprises two radially opposite circular arc shaped holes in which the radial rails can move freely between

angular positions corresponding to the ready position and the clicking position of the handle lever.

[0016] The push-push lever is carried by a push-push lever ring form-fitted to a first axial portion of the lever shaft.

[0017] The lever shaft, the coupling gear and the push-push lever ring are made of moulded plastic.

[0018] The angular portion of the coupling gear bearing meshing teeth to interact with a reduction mechanism covers an angular portion of the coupling gear greater than the sum of the angle from clicking position to ready position and of the angle from flush position to ready position of the handle lever.

[0019] The angular portion of the coupling gear bearing meshing teeth to interact with a reduction mechanism covers an angular portion of the coupling gear greater than twice the angle from clicking position to ready position of the handle lever.

[0020] The invention also relates to the associated door handle, in particular for a vehicle door, having a handle lever movable between a flush position in which it is flush with an exterior door panel surface and a ready position in which it is protruding and graspable by a user by an electric motor, and between an inward clicking position in which a preloaded push-push unit is released so as to bring the handle lever in ready position without actuation of the electric motor, comprising :

- a lever shaft, connected to the handle lever,
- a push-push unit with at least one preloaded spring configured to bring a handle lever from a clicking position in which the preloaded spring is released in a ready position without actuation of an electric motor,
- an electric motor and a reduction mechanism to transmit rotational movement from the motor to the handle lever comprising a coupling gear the rotation of which causes the lever to rotate,

wherein the lever shaft is rotatively coupled to the coupling gear via a coupling mechanism supported by the lever shaft and rotatively linking the lever shaft and the coupling gear, the coupling mechanism being configured to allow free rotational movement of the lever shaft with respect to the coupling gear within an angular range corresponding to the angular distance between the ready position and the clicking position of the handle lever.

[0021] The push-push unit may comprise two preloaded springs pushing, when released, a slider interacting via a protruding finger with a push-push lever protruding radially from the handle lever shaft.

[0022] The reduction mechanism may comprise a worm drive interacting with the coupling gear to set the handle lever in motion when the electric motor is actuated.

[0023] Other characteristics and advantages of the invention will appear at the reading of the following description, given in an illustrative and not limiting fashion, of the following figures, among which :

- figure 1 is a schematic cut away of a vehicle door with a handle comprising a handle lever represented in different positions,
- figure 2 is a schematic view of a vehicle door handle,
- figure 3 is a schematic view of the coupling mechanism of the handle of figure 2,
- figure 4 is an exploded view of the coupling device of the handle according to figures 2 and 3 with representations of cross sections of its main components,
- figures 5a, 5b, 5c show different positions of the coupling device of figure 4 illustrating the case of a push-push unit actuation,
- figures 6a, 6b, 6c show different positions of the coupling device of figure 4 illustrating the case of a motorized actuation.

[0024] In all figures, the same references apply to the same element.

[0025] Though the figures refer to precise embodiments of the invention, other embodiments may be obtained by combining or altering slightly the represented embodiments, said new embodiments are also within the scope of the invention.

[0026] Figure 1 shows a series of schematic cutaways of a vehicle door panel 100 having a built-in door handle 1. The door panel 100 forms an exterior surface of the vehicle, the door handle 1 is essentially represented by its handle lever 3 (the part meant to be grasped and set in motion by a user) and a handle frame 5 (part that remains stationary during actuation).

[0027] The terms like "inwards", "outwards" and equivalents are defined with respect to the vehicle interior and exterior.

[0028] In the first cutaway of figure 1, the handle lever 3 is in a flushing position. In said flushing position, the outer surface of the handle lever 3 is flushing with the door panel 100. Said flushing position is adopted when the vehicle is driving and when it is parked for longer times. In flushing position, the handle lever 3 is less likely, when parked, to be interacted with by passers-by, accidentally or not, and air drag is reduced when driving. In the flushing position, the handle lever 3 also appears integrated in the door panel 100 in a pleasant and discrete way.

[0029] In the second cutaway of figure 1, the handle lever 3 is in a ready position. In said ready position, the handle lever 3 has rotated outwards by a predefined an-

gle (20 to 45° for example) around a handle axis A, so as to be graspable by the user. Said ready position is adopted when the user approaches the vehicle or causes unlocking of the doors, for example using a remote control integrated in a key or a RFID security token. In said position the handle lever 3 is available and graspable for the user, but the handle is still latched.

[0030] In the third cutaway of figure 1, the handle lever 3 is in an open position. Compared to the ready position, the handle lever 3 has been rotated further outwards (40° to 60° and more) by the user, and the handle lever interacts with a latch mechanism to unlatch the door, which is consequently unlatched and ready to be opened by pulling further on the handle lever 3.

[0031] In the event of a mechanical or electrical failure of the mechanism that drives the lever 3 from the flushing position to the ready position, the user can push the lever 3 inwards with respect to the door panel 100, as in the fourth cutaway of figure 1, by applying inwards directed pressure P on the handle lever 3. The handle lever 3 is then in a position herein called clicking position, where a mechanical interaction (a "click") releases a spring of a push-push unit that drives the lever 3 in ready position without actuation of a motor.

[0032] Figure 2 is a view of the door handle 1 from inside. In figure 2, the handle lever 3 is rotatively mobile with respect to the handle frame 5, which is to be attached to an interior surface of the vehicle door panel 100. The frame 5 comprises housings for most parts of the door handle 1.

[0033] In a housing of the frame 5 is an electric motor 7 with a reduction mechanism 9. The electric motor 7 is activated by injection of electric current, in particular from a vehicle battery. The reduction mechanism 9 adapts the rotary output motion of the electric motor 7 by reducing rotational speed and increasing the torque values. The reduction mechanism 9 sets the handle lever 3 in motion, in particular from the flushing position to the ready position.

[0034] The reduction mechanism 9 comprises for example one or more reduction stages, with reduction gears and/or worm and gear systems.

[0035] The reduction mechanism 9 sets a coupling device 200 in motion. The coupling device 200 comprises a lever base 11, to which a handle lever body (not represented) is attached upon assembling the handle 1 to obtain the assembled handle lever 3.

[0036] The frame 5 also houses a push-push unit 13, comprising two push-push springs 15, placed around two guiding rods 17. The push-push springs 15 push when released a slider 19 carrying a protruding finger 21 which rests against a push-push lever 30 of the coupling device 200. The protruding finger 21 is in particular made of rubber, soft plastic or any shock absorbing material.

[0037] The springs 15 and guiding rods 17 are placed on each side of a release mechanism 23, which, when being compressed (clicking position), releases the slider 19 which is then pushed by the springs 15 along the guid-

ing rods 17, pushing the handle lever 3 in ready position.

[0038] The rotational position of the handle lever 3 is detected by positioning means 25, on the lower side of the coupling device 200. Said positioning means 25 comprise a magnetic index and a magnetic sensor (e.g. a Hall effect sensor). The magnetic index rotates with the coupling device 200 and the handle lever 3, the magnetic sensor then determinates the rotational position of the magnetic index, and thus the position of the handle lever 3.

[0039] Figure 3 is a view of the coupling device 200, taken out of the frame 5.

[0040] In figure 3, the coupling device 200 comprises the lever base 11, and surrounds in particular a lever shaft 27, which extends axially from the lever base 11. It comprises two axial portions 27a, 27b, corresponding to a push-push lever ring 29 and a coupling gear 31 which cover respectively one of the axial portions 27a, 27b in assembled state of the coupling device 200.

[0041] The push-push lever ring 29 is axially and rotatively linked to the lever shaft 27, and comprises the push-push lever 30, extending radially from a form fitting annular main body.

[0042] The coupling gear 31 comprises meshing teeth 33 on a portion of its outer, cylindrical, wall.

[0043] Figure 4 is an exploded view of the coupling device 200 comprising the lever shaft 27, the push-push lever ring 29 and the coupling gear 31.

[0044] The lever shaft 27 comprises two axial portions 27a, 27b, respectively surrounded by the push-push lever ring 29 and the coupling gear 31 when the coupling device 200 is assembled.

[0045] The first axial portion 27a when starting at the handle lever base 11 has four radial rails 35, which interact with a form fitting, cross-shaped hole in the push-push lever ring 29. The second axial portion 27b has two radial rails 35, which are prolongations of two opposite of the radial rails 35 of the first axial portion 27a.

[0046] The coupling gear 31 comprises a gear body in which an axial hole is made. Said hole comprises a central circular hole 37, and two circular arc shaped holes 39, extending on two radially opposite sides of the central circular hole 37.

[0047] The angular arc opening of the circular arc shaped holes 39 is at least equal to the angular distance between the clicking and ready positions of the handle lever 3 (or handle lever base 11). The angular arc opening of said holes 39 is in particular comprised between 30° and 150°.

[0048] The lower angular opening values (around 30°) correspond to embodiments where the free rotational movement of the lever shaft 27 and coupling gear 31 is equal to the angular distance between the clicking and ready positions of the handle lever 3. The circular arc shaped holes 39 with more important angular opening values (more than 90°) are indicated to dissipate the kinetic energy arising at the end of the motion during fast opening of the door panel 100.

[0049] The coupling gear 31 and the lever shaft 27 with its radial rails 35 form a coupling mechanism supported by the lever shaft 27, rotatively linking the lever shaft 27 and the coupling gear 31. Said coupling mechanism is configured to allow free rotational movement of the lever shaft 27 with respect to the coupling gear 31 within an angular range corresponding to the angular distance between the ready position and the clicking position of the handle lever 3.

[0050] Axial cutaways of the axial portions 27a, 27b and of the push-push lever ring 29 and the coupling gear 31 are also represented in figure 4.

[0051] Figures 5a, 5b and 5c illustrate the push-push actuation in case of electric failure (empty or faulty battery, failure of motor 7).

[0052] Said figures are schematic axial views of the coupling device 200 of figure 4, when looked on from the axial end opposite the handle lever base 11. The coupling device 200 is viewed along axis A, so that only the radial surfaces of the coupling gear 31 and the handle lever shaft 27 are visible, along with the push-push lever 30.

[0053] The push-push lever 30, the lever shaft 27 and the handle lever 3 are rotatively coupled : none can rotate without rotation of the others, due to the form fitting between the lever shaft 27 and the push-push lever ring 29.

[0054] In figure 5a, the handle lever 3 is in flush position. The lever shaft 27 and coupling gear 31 are in a relative position in which the radial rails 37 are in a non-extremal position within the circular arc shaped holes 39 : they do not rest against one of the radial walls of the circular arc shaped holes 39. The push-push unit 13 (represented schematically by one of its springs) is in its pre-loaded, unreleased ("armed") state.

[0055] In figure 5b, the user presses against the handle lever 3, causing a rotation of the lever shaft 27, and consequently of the push-push lever 30 so as to reach the clicking position, in which the push-push unit 13 is further compressed and released. In figure 5b, the radial extensions of the lever shaft 19 rest against one of the radial walls of their respective circular arc shaped hole 39. In both figures 5a, 5b, the reduction gear 31 is in the same rotational position.

[0056] In figure 5c, the released push-push unit 13 pushes the push-push lever 30, and in turn the handle lever 3 until the ready position is reached. In said ready position, the push-push lever 30 is pushed beyond its position of figure 5a (dotted outline corresponding to flush position), and the radial rails 35 rest against the other radial wall of their respective circular arc shaped hole 39.

[0057] In none of the figures 5a, 5b, 5c is the coupling gear 31 set in motion. The lever shaft 27 is rotatively freely movable relatively to the coupling gear 31 between the ready position and the clicking position. In particular, the angular opening of the circular arc shaped holes 39 corresponds at least to the angle of rotation of the handle lever 3 between the ready and clicking position.

[0058] The figures 6a, 6b and 6c illustrate the action of the motor 7 on the coupling gear 31 and consequently

of the handle lever shaft 27, for example during normal actuation when an approaching user has been detected.

[0059] Figure 6a is a representation of the coupling device 200 when the handle lever 3 is in flush position, figure 6a is therefore identical to figure 5a.

[0060] The motor 7 causes a rotation of the coupling gear 31. During a first part of said rotation, the coupling gear 31 moves without setting the lever shaft 27 in motion, in particular until the radial rails 35 rest against radial walls of the circular arc shaped holes 39. This situation is represented in figure 6b. The total angular range the lever shaft 27 can be rotated without applying an important torque to the reduction gear 31 corresponds to the angular opening of the circular arc holes 39, that is at least to the angle between the ready position and the clicking position of lever 3.

[0061] Further rotation of the coupling gear 31 causes said gear 31 to apply a torque on the radial rails 35 and consequently to the lever shaft 27, which is in turn set in motion until reaching the ready position as illustrated in figure 6c.

[0062] In all figures 6a, 6b, 6c the push-push unit 13 does not move, and remains pre-loaded and restrained by the release mechanism 23.

[0063] To enable both motions from figures 5a, 5b 5c and 6a, 6b, 6c, the angular portion of the coupling gear 31 bearing meshing teeth 33 to interact with for example a worm gear of the reduction mechanism 9, must cover and angular portion of the coupling gear 31 greater than the sum of the angle from clicking position to ready position (to overcome the limited free motion of the coupling gear 31 relatively to the lever shaft 27) and of the angle from flush position to ready position (to cover the actual motion of the lever shaft 27 when set in motion).

[0064] In case of a car battery failure due, for example, to prolonged parking or leaving the headlights on, the user will initiate a push-push actuation as illustrated in figures 5a, 5b, 5c by releasing the push-push unit 13.

[0065] Furthermore, to enable an automated return to pre-loaded and constrained ("armed") state of the push-push unit 13, the electric motor 7 must be able to return the handle lever 3 from the flush position to the clicking position. To enable automated rearming of the push-push unit 13 the angle of the coupling gear 31 that bears meshing teeth 33 is greater than the sum of the previously discussed angle (from clicking position to ready position added to the angle from flush position to ready position) and of the angle from flush position to clicking position (in absolute values).

[0066] Said sum of angles is equal to twice the angle from clicking position to ready position.

[0067] The coupling device 200, lever shaft 27, coupling gear 31 and push-push lever ring 29, can entirely be made of moulded plastic materials.

[0068] The invention allows a selective decoupling of the motion related to electric readying using electric motor 7, and of the motion related to back-up actuation using the push-push unit 13. The reduction stages and their

gears and worms can then be optimized only for transmitting motion and torque from the motor 7 to the lever shaft 27, without taking into account a possible reverse motion reduction from the lever 3 to the motor 7.

[0069] Irreversible reduction mechanisms are more temperature tolerant, require less precisely machined parts, and undergo much less stress and wear than reversible ones, allowing for more tolerance in component dimensioning and conception.

[0070] Motion of the lever 3 without motion of the reduction gears also causes less resistance and noise, which a user would perceive as unwanted and a token of lower quality.

[0071] The invention therefore makes the door handle 1 more robust and potentially cheaper, while increasing overall perceived quality.

Claims

1. Coupling device for a vehicle door handle (1), the door handle (1) having a handle lever (3) movable between a flush position in which it is flush with an exterior door panel (100) surface and a ready position in which it is protruding and graspable by a user by an electric motor (7), and between an inward clicking position in which a preloaded push-push unit (13) is released so as to bring the handle lever (3) in said ready position without actuation of the electric motor (7), comprising :

- a lever shaft (27), connected to the handle lever (3),
- a push-push lever ring (29), rotatively coupled with the lever shaft (19), interacting via a push-push lever (30) with the push-push unit (13) when the handle lever (3) is pushed inwards in the clicking position so as to release the preloaded push-push unit (13) and push the lever (3) in ready position,
- a coupling gear (31), rotatively coupled with the lever shaft (27), interacting with the electric motor (7) to move the handle lever (3) from the flush position to the ready position,

wherein the lever shaft (27) is rotatively coupled to the coupling gear (31) via a coupling mechanism supported by the lever shaft (27) and rotatively linking the lever shaft (27) and the coupling gear (31), the coupling mechanism being configured to allow free rotational movement of the lever shaft (27) with respect to the coupling gear (31) within an angular range corresponding to the angular distance between the ready position and the clicking position of the handle lever (3).

2. Coupling device according to claim 1, **characterized in that** the lever shaft (27) comprises on an axial

portion (27b) at least one radial rail (35), and the coupling gear (31) comprises at least one circular arc shaped hole (39) housing the radial rail (35), and the angular opening of the circular arc shaped hole (39) corresponds to the angular distance between the ready position and the clicking position of the handle lever (3).

3. Coupling device according to claim 2, **characterized in that** the lever shaft (27) comprises on an axial portion (27b) two diametrically opposite radial rails (35), and the reduction gear (31) comprises two radially opposite circular arc shaped holes (39) in which the radial rails (35) can move freely between angular positions corresponding to the ready position and the clicking position of the handle lever (3).

4. Coupling device according to any of claims 1 to 3, **characterized in that** the push-push lever (30) is carried by a push-push lever ring (29) form-fitted to a first axial portion (27a) of the lever shaft (27).

5. Coupling device according to any of the preceding claims, **characterized in that** the lever shaft (27), the coupling gear (31) and the push-push lever ring (29) are made of moulded plastic.

6. Coupling device according to any of the preceding claims, **characterized in that** the angular portion of the coupling gear (31) bearing meshing teeth (33) to interact with a reduction mechanism (9) covers an angular portion of the coupling gear (31) greater than the sum of the angle from clicking position to ready position and of the angle from flush position to ready position of the handle lever (3).

7. Coupling device according to any of the preceding claims, **characterized in that** the angular portion of the coupling gear (31) bearing meshing teeth (33) to interact with a reduction mechanism (9) covers an angular portion of the coupling gear (31) greater than twice the angle from clicking position to ready position of the handle lever (3).

8. Door handle, in particular for a vehicle door, having a handle lever (3) movable between a flush position in which it is flush with an exterior door panel (100) surface and a ready position in which it is protruding and graspable by a user by an electric motor (7), and between an inward clicking position in which a preloaded push-push unit (13) is released so as to bring the handle lever (3) in ready position without actuation of the electric motor (7), comprising :

- a lever shaft (27), connected to the handle lever (3),
- a push-push unit (13) with at least one preload-

ed spring (15) configured to bring a handle lever (3) from a clicking position in which the preloaded spring is released in a ready position without actuation of an electric motor (7),

- an electric motor (7) and a reduction mechanism (9) to transmit rotational movement from the motor (7) to the handle lever (3) comprising a coupling gear (31) the rotation of which causes the lever (3) to rotate,

wherein the lever shaft (27) is rotatively coupled to the coupling gear (31) via a coupling mechanism supported by the lever shaft (27) and rotatively linking the lever shaft (27) and the coupling gear (31), the coupling mechanism being configured to allow free rotational movement of the lever shaft (27) with respect to the coupling gear (31) within an angular range corresponding to the angular distance between the ready position and the clicking position of the handle lever (3).

9. Door handle according to the preceding claim, **characterized in that** the push-push unit (13) comprises two preloaded springs (15) pushing, when released, a slider (37) interacting via a protruding finger (21) with a push-push lever (30) protruding radially from the handle lever shaft (27).

10. Door handle according to claim 8 or 9, **characterized in that** the reduction mechanism (9) comprises a worm drive interacting with the coupling gear (31) to set the handle lever (3) in motion when the electric motor (7) is actuated.

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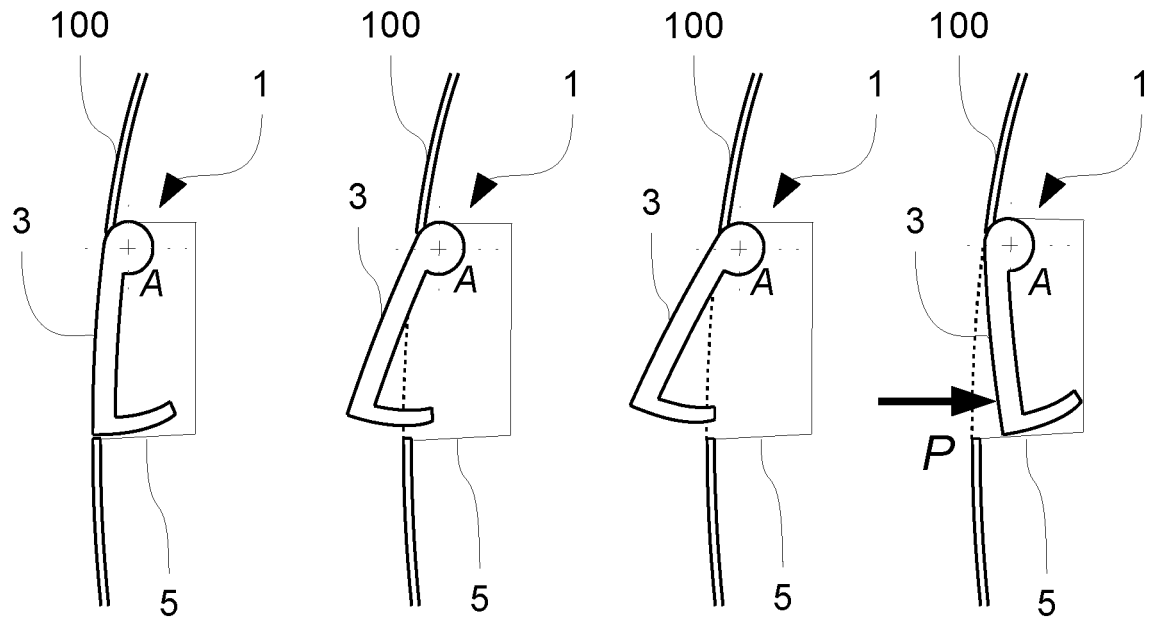


Fig. 1

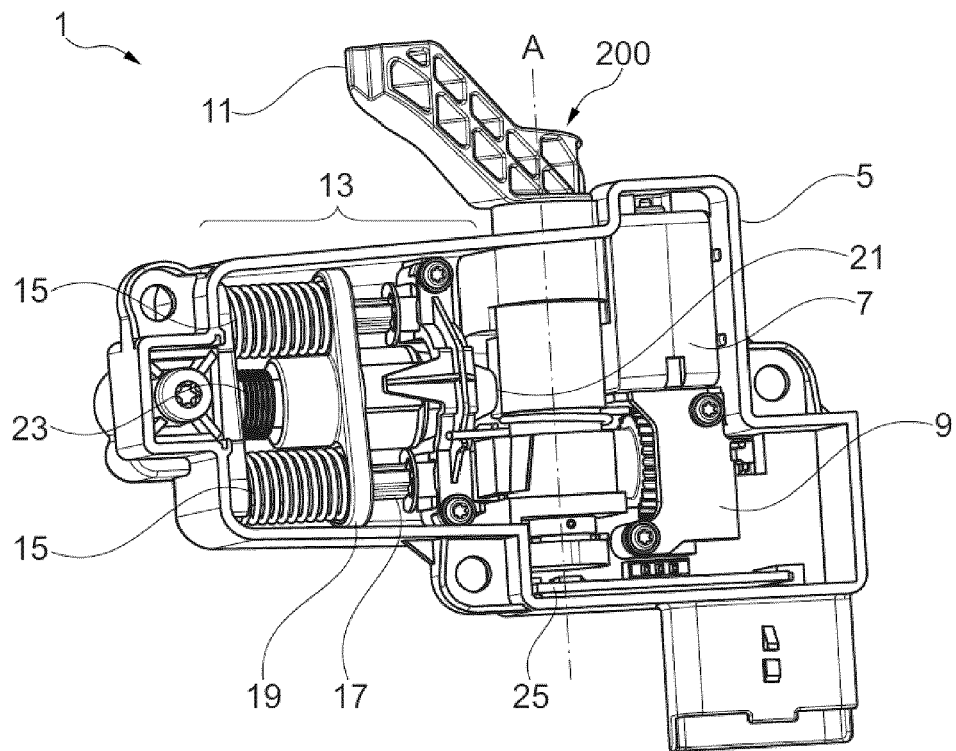


Fig. 2

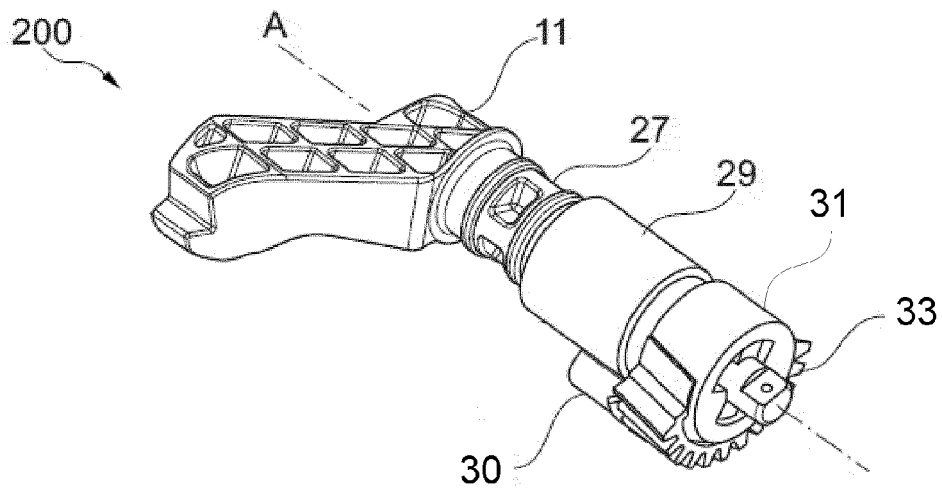


Fig. 3

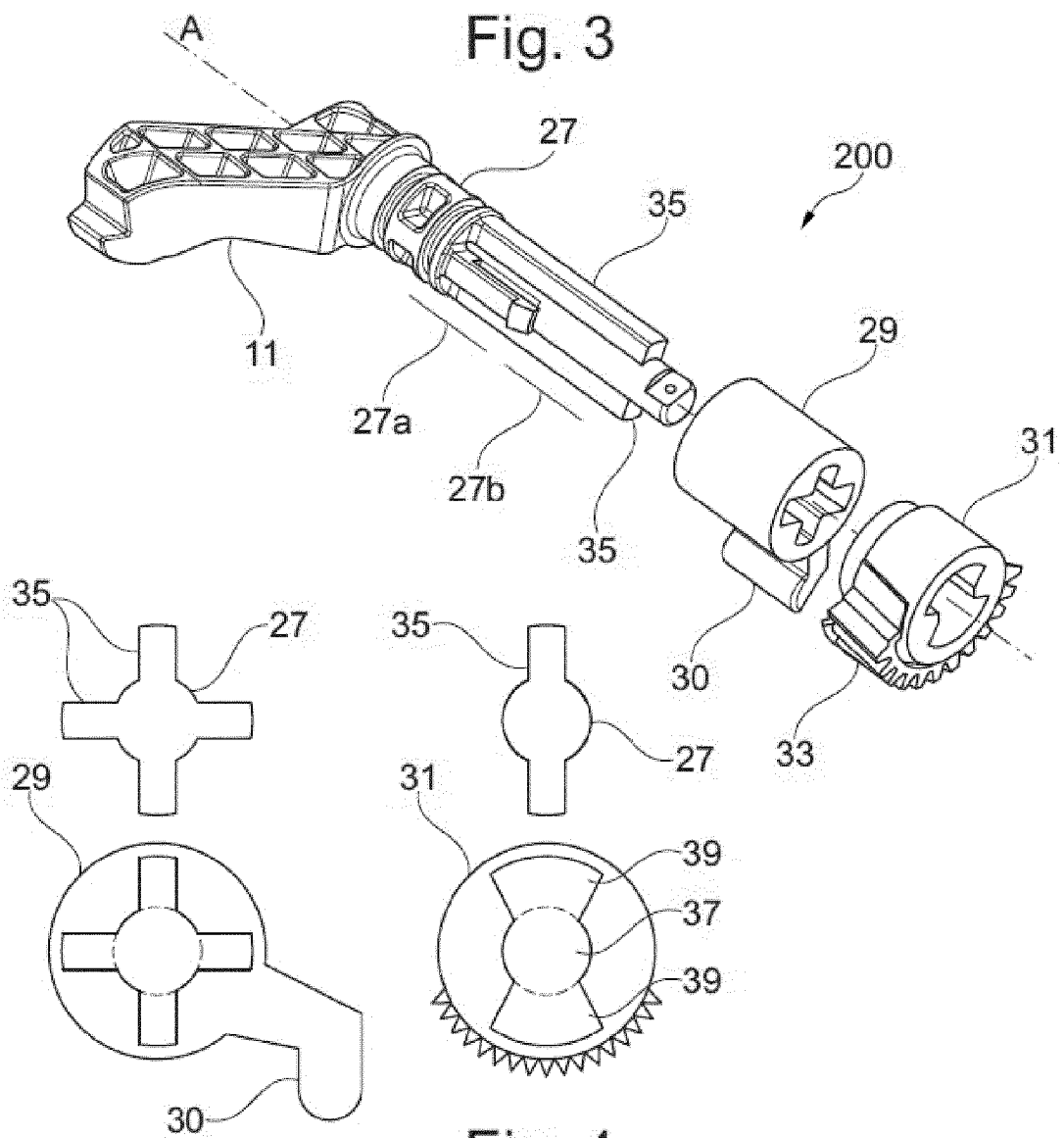


Fig. 4

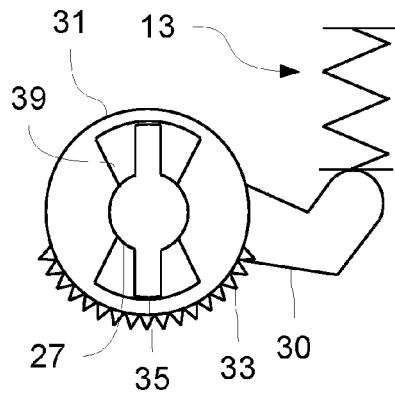


Fig. 5a

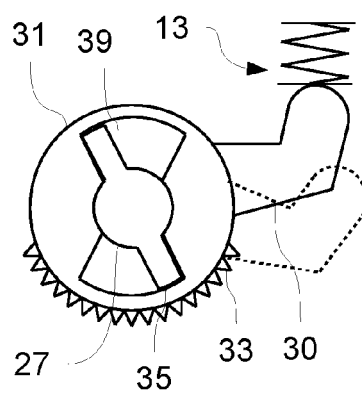


Fig. 5b

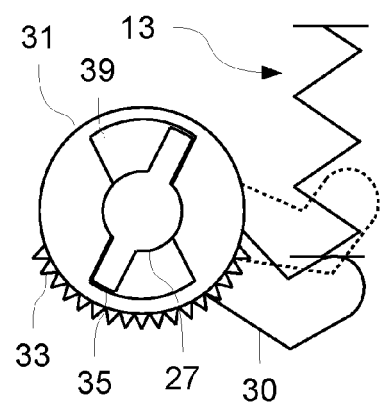


Fig. 5c

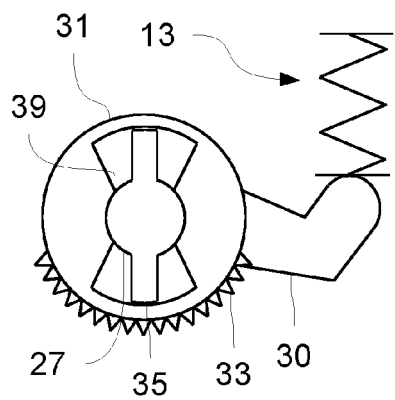


Fig. 6a

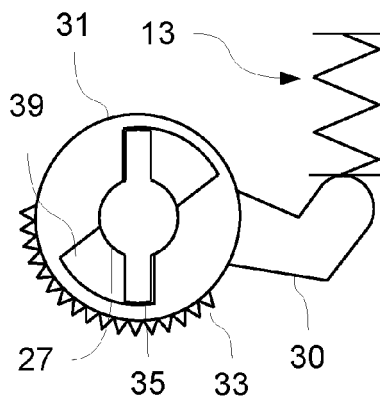


Fig. 6b

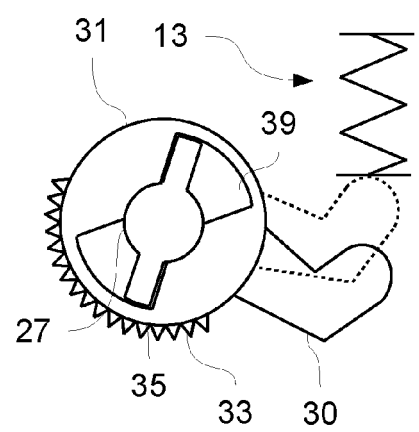


Fig. 6c



EUROPEAN SEARCH REPORT

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Place of search The Hague		Date of completion of the search 11 September 2017	Examiner Boufidou, Maria
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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