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(54) **MOTORIZED LOCK DEVICE**

(57) The invention relates to a motorised lock device (200) having a rotatable lock shaft (120) which can be connected to a door lock cylinder comprising a lock bolt. The device comprises a coupling bush (230) mounted around the lock shaft (120) and a gear wheel (240) mounted around the coupling bush, which engages therewith. The coupling bush is axially displaceable between a disengaged position and an engaged position in which the bush is rotationally coupled to the lock shaft, to enable motorised operation of the lock bolt. Axial dis-

placement is effected by driven rotation of the gear wheel (140), via cooperation between at least one first cam provided on the coupling bush and at least one second cam (245), whereby at least one of the first and second cams comprises a ramp surface (235) inclined in axial direction. The lock device is further provided with anti-rotation means for preventing rotation of bush when in the disengaged position and with a return mechanism (250) for returning the bush to the disengaged position.

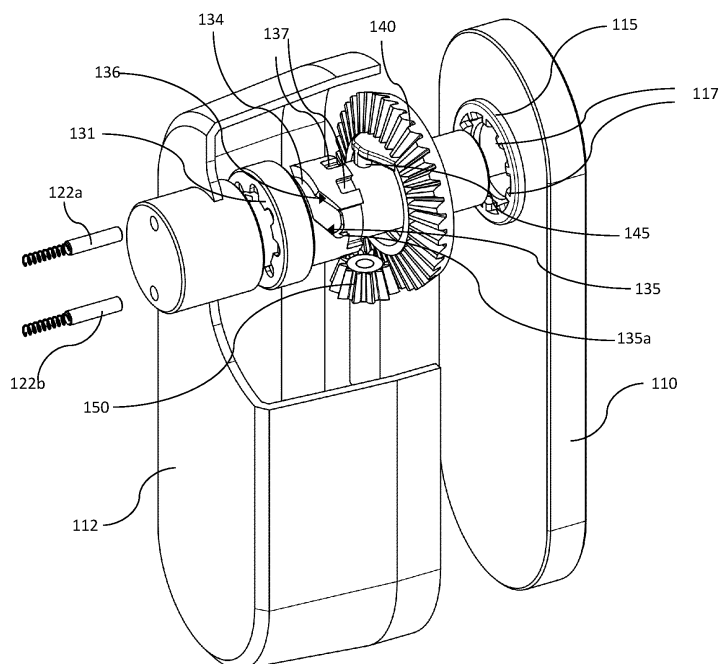


Fig. 1a

Description

FIELD OF THE INVENTION

[0001] The invention relates to a lock device for a building door comprising a rotatable lock shaft which can be operated both manually and electrically. The device comprises a motorized locking arrangement which can be rotationally coupled to the lock shaft for motorized operation of a door lock, and which can be decoupled therefrom to enable manual operation.

BACKGROUND ART

[0002] Such lock devices are often applied in building doors of care homes or private residences where it is important that a care-giver is able to unlock the door by e.g. entering a code in a smartphone that activates the motorized locking arrangement in order to gain access to a resident in need of care. It is also important the resident should be able to operate the door lock in the conventional manner via a key at the external side and a knob on the inside, after a motorized operation has occurred.

[0003] An example of an electronic lock device is disclosed in EP3317480. The device is configured to operate a door lock by moving a lock bolt of an associated lock case between a retracted position and a protruded position and comprises an electrical motor and a transmission for connecting the motor to the lock case. The transmission includes a gear wheel that is drivingly connected to the motor, a lock shaft that is rotatable in order to move the lock bolt, an engagement member and an intermediate disc comprising a pivot joint, which is arranged concentrically with the gear wheel. The engagement member is pivotally attached to the intermediate disc, such that the engagement member is allowed to pivot upon rotation of the gear wheel and thus engage with the lock shaft when the gear wheel is driven by the motor. Engagement is effected by causing the motor to rotate in a first direction; disengagement is effected by causing the motor to rotate in the opposite direction.

[0004] There is still room for improvement.

INVENTION SUMMARY

[0005] The present invention defines a motorised lock device comprising a rotatable lock shaft, which is configured for connection to a cylinder lock of a building door, such that in use, rotation of the lock shaft operates a lock bolt associated with the cylinder lock. The lock device comprises a coupling bush mounted around the lock shaft, which can be selectively coupled to the lock shaft to permit motorised operation of lock bolt, and which can be decoupled therefrom to enable manual operation. The lock device further comprises a gear wheel mounted around the coupling bush which engages with the coupling bush via an engagement member that extends in

a radially inward direction, whereby the gear wheel is drivable by a pinion gear mounted to an output shaft of an electric motor.

[0006] The coupling bush is displaceable in axial direction between a disengaged position and an engaged position in which the bush and the gear wheel are rotationally coupled to the lock shaft, via an axially compressible engagement mechanism that engages with the coupling bush at a first axial end thereof. Axial displacement of the coupling bush towards the engaged position is effected by driven rotation of the gear wheel, via cooperation between at least one first cam provided on the coupling bush and at least one second cam provided on a further component of the arrangement, whereby at least one of the first and second cams comprises an inclined ramp surface. The coupling bush is further provided with anti-rotation means, which prevents rotation of the coupling bush when the gearwheel is driven and the coupling bush is displaced from the disengaged position towards the engaged position. The lock device further comprises a return mechanism for returning the coupling bush from the engaged position to the disengaged position.

[0007] The axially compressible engagement mechanism may be formed by one or more spring-loaded lock pins, spring plungers or other compressible components which are in fixed connection with the lock shaft. The first end of the coupling bush is suitably provided with a number of first recesses arranged at angular intervals for receiving the one or more compressible mechanisms in the engaged position. To effect engagement, the motor is activated which causes rotation of the gear wheel. The engagement member extends into an angular opening of the coupling bush, arranged between the first and second ends thereof. An axial dimension of the angular opening is sufficient to permit axial displacement of the bush relative to the gear wheel. Rotation of the gear wheel brings the engagement member into contact with a surface of the angular opening, permitting torque to be transferred to the coupling bush. Initially, rotation of the gear wheel causes axial displacement of the bush, due to the anti-rotation means and cooperation between the first and second cams. When the coupling bush has been displaced by a sufficient amount in axial direction to release the bush from the anti-rotation means, further rotation of the gear wheel causes rotation of the coupling bush to a position in which one of the first recesses in the bush is alignment with the one or more compressible components. Preferably the lock shaft is provided with two such components arranged at opposite sides of the lock shaft in circumferential direction. When the first recesses are not in angular alignment, axial displacement of the coupling bush presses the axial end face against an end face of the compressible components, which are moved in axial direction so as to compress a spring. Rotation of the coupling bush then brings the bush to an aligned position and the spring return force causes the compressible components to engage in a corresponding first recess, to rotationally couple the bush with the lock

shaft. Further rotation of the gear wheel now causes rotation of the lock shaft, to operate the lock bolt. Disengagement is effected by rotating the gear wheel in an opposite direction, which enables the return mechanism to restore the coupling bush to the disengaged position.

[0008] Suitably, the electric motor comprises control means configured to receive an activation signal and to control the motor such that the gear wheel is rotated to perform an engagement action and then a disengagement action.

[0009] A lock device in accordance with the invention thus provides a straightforward and energy efficient means for effecting motorised operation of the lock shaft and ensuring that after motorised operation, manual operation in the normal manner via a key or a knob is possible. Furthermore, the axially displaceable coupling bush enables the use of a gear wheel which is relatively compact in radial direction, meaning that the lock device has a compact width. As a result, a lock device according to the invention is suitable for application on a wide variety of door structures, including doors with relatively narrow doorposts and doors which open in an outward direction.

[0010] The first recesses of the coupling bush which receive the one or more compressible components may be essentially circular in shape and have a diameter that is slightly larger than a corresponding diameter of the compressible component. In a further development, the first recesses are formed by angular slots that permit more movement of the coupling bush in rotational direction. This has the advantage that during a disengagement action, the lock shaft does not visibly rotate, thereby reducing the likelihood that a person might grasp a knob associated with the lock shaft during motor operation.

[0011] The anti-rotation means may be formed by a number of angularly spaced protrusions that extend in a radially inward direction from a toothed ring that is mounted to or forms an integral part of a base plate of the lock device, through which the lock shaft extends. A second end of the coupling shaft is suitably provided with a number of angularly spaced second recesses which receive the protrusions or teeth of the toothed ring when the coupling bush is in the disengaged position.

[0012] In an advantageous further development, the toothed ring is mounted to the base plate in a manner that permits a limited amount of rotation of the toothed ring relative to the base plate, for example, 5-15 degrees. When the coupling bush is decoupled from the lock shaft and axially displaced back to the disengaged position, this makes it easier for the second recesses of the coupling bush to be brought into angular alignment with the protrusions of the toothed ring.

[0013] As mentioned, axial displacement of the coupling bush towards the engaged position is effected via cooperation between at least one ramp surface on a first or second cam. In some embodiments, the lock device comprises a plurality of first or second cams and a corresponding plurality of ramp surfaces. Advantageously, each of the ramp surfaces may have a helical form, to

optimise contact in rotational direction with the cooperating cam.

[0014] In a first embodiment, the at least one ramp surface is provided on the coupling bush and the second cam is formed by the engagement member of the gear wheel. Suitably, the angular opening in the bush has a first portion that extends in a generally circumferential direction and a second portion that is delimited in a first direction of rotation by one ramp surface and is delimited in an opposite direction of rotation by a further ramp surface. The ramp surfaces extend in an axial direction towards the second end of the coupling bush, which can thus be axially displaced to the engaged position to effect motorized operation of the lock bolt in one direction of rotation to a retracted, unlocked position, and effect motorized operation of the lock bolt to a protruded, locked position in the opposite direction of rotation.

[0015] In one example of the first embodiment, the coupling bush is additionally provided with at least one second ramp surface with which the gear wheel engagement member cooperates during a disengagement action, such that driven rotation of the gear wheel effects axial displacement of the coupling bush out of the engaged position, to release the one or more compressible components, e.g. lock pins, from the corresponding first recesses of the coupling bush, back to the disengaged position. As will be understood, the coupling bush is suitably provided with a further second ramp surface for effecting axial displacement in an opposite direction of driven rotation of the gear wheel during a disengagement action.

[0016] In a further development, the return mechanism for restoring the coupling bush to the disengaged position comprises a compression spring arranged around the lock shaft between a housing of the lock device and the first end of the coupling bush. Axial displacement of the coupling bush to the engaged position compresses the spring against the housing and provides a return force for urging the coupling bush back to the disengaged position when motorized disengagement is initiated. This removes the need for second ramp surfaces on the coupling bush and the need to transfer torque during a disengagement action, which reduces power consumption. A further advantage is that in the event of manual operation of the lock shaft during a motorized disengagement action, there is no risk of the return action getting blocked, which would cause the coupling bush to remain in engagement with the lock pins of the lock shaft.

[0017] In a further embodiment of a lock device according to the invention, the at least one ramp surface is provided on the gear wheel engagement member. The coupling bush is provided with at least one first cam which cooperates therewith to effect axial displacement of the bush towards the engaged position in one direction of driven rotation of the gear wheel. Suitably, the gear wheel engagement member is provided with a further ramp surface to effect axial displacement in an opposite direction of driven rotation of the gear wheel. The at least one first cam may be formed by axially extending protrusion ar-

ranged between the first and second ends of the bush which has straight camming surfaces. Suitably, the return mechanism comprises a compression spring as described above.

[0018] In a still further embodiment, the at least one ramp surface is provided on the anti-rotation means. The protrusions of the toothed ring that is mounted to the base plate suitably comprise first and second ramp surfaces which are inclined in axial direction towards the coupling bush. The second recesses of the coupling bush are shaped to receive these protrusions, such that the coupling bush comprises a number of first cams. The protrusions of the toothed ring act as second cams, whereby driven rotation of the gear wheel in a first direction of rotation causes each first cam to cooperate with the first ramp surface of each second cam and driven rotation of the gear wheel in a second direction of rotation causes each first cam to cooperate with the second ramp surface of each second cam, thereby effecting axial displacement of the bush towards the engaged position. The return mechanism for restoring the bush to the disengaged position suitably comprises a compression spring as described above.

[0019] The angular opening of the coupling bush into which the engagement member of the gear wheel extends has a first portion arranged towards the first end of the bush, which is delimited in angular direction by first and second edges, which create rotational stops for the engagement member when the bush is in the disengaged position. A second portion of the angular opening has a greater extent in angular direction than the first portion, and likewise has first and second edges which form rotational stops for the gear wheel engagement member, when axial displacement of the bush towards the engaged position has released the second recesses of the bush (first cams) from the protrusions (second cams) of the toothed ring.

[0020] Advantageously, the first and second edges of each portion of the angular opening are straight edges. When the at least one ramp surface is provided on the bush, rotational force on the ramp surface and is partly converted in axial direction, leading to a reduction in the rotational torque. By implementing the ramp surfaces on the toothed ring, the coupling bush can be provided with straight surfaces that engage with the gear wheel engagement member, thereby improving the efficiency of the torque transfer. A further advantage of having the ramp surfaces on the toothed ring is that when the bush is returned to the disengaged position, there is an increased likelihood that the tooth-shaped second recesses of the bush will be in angular alignment with the tooth-shaped protrusions on the ring. If a slight misalignment remains after a disengagement operation, a small manual operation of the lock shaft will bring the second recesses and tooth-shaped protrusions into alignment with each other, to restore the bush to the disengaged position and enable manual operation of the lock shaft in the normal manner.

[0021] Preferably, the coupling bush is provided with first and second angular openings, at opposite sides of the bush in circumferential direction, and the gear wheel is provided with first and second engagement members at opposite circumferential sides of the gear wheel.

[0022] The interface between the first and second portions of each angular opening in the bush creates a stepped portion that generally faces in axial direction towards the second end of the bush. This stepped portion may be an essentially straight surface. In a further development, the stepped portion comprises a ramp surface which cooperates with the engagement member of the gear wheel and which is inclined so as to effect a small, additional axial displacement of the bush in the direction of engagement, after the bush has been released from the anti-rotation means. This has the advantage that the second end of the bush is free from contact with the protrusions of the toothed ring and prevents any rattling rotation of the bush.

[0023] These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter and with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

- Fig. 1a shows an exploded perspective view of components of a lock device according to a first embodiment of the invention;
- Fig. 1b shows a partially cut, perspective view of the assembled lock device of Fig. 1a;
- Fig. 1c shows a cross-sectional view of the assembled lock device of Fig. 1b in a disengaged position of the device;
- Fig. 1d shows an exploded perspective view of a further example of a lock device according to the first embodiment.
- Fig. 2a shows an exploded perspective view of components of a lock device according to a second embodiment of the invention;
- Fig. 2b shows a partially cut, perspective view of the assembled lock device of Fig. 2a;
- Fig. 3a shows an exploded perspective view of components of a lock device according to a third embodiment of the invention;
- Fig. 3b shows a partially cut, perspective view of the assembled lock device of Fig. 3a;
- Fig. 4a shows an exploded perspective view of components of a lock device according to a fourth embodiment of the invention;
- Fig. 4b shows a partially cut, perspective view of the assembled lock device of Fig. 4a;
- Fig. 4c shows a side view of a coupling bush used in the lock device of Fig. 4b;
- Fig. 4d shows a detail in side view of the assembled lock device of Fig. 4b, with the coupling bush

in an engaged position;
 Fig. 4e shows a detail in side view of an assembled lock device according to the fourth embodiment comprising a further example of a coupling bush in the engaged position.

[0025] It should be noted that items which have the same reference numbers in different figures, have the same structural features and the same functions. Where the function and/or structure of such an item has been explained, there is no necessity for repeated explanation thereof in the detailed description.

DETAILED DESCRIPTION OF EMBODIMENTS

[0026] A first embodiment of a motorized lock device according to the invention is depicted in Fig. 1a in an exploded, perspective view and in assembled view in Fig. 1b.

[0027] The lock device 100 comprises a base plate 110 and a lock shaft 120 that extends through an opening in the base plate which, in use of the lock device, extends through an opening in a building door. The lock shaft is configured to be mounted to a lock cylinder comprising a lock bolt, which inserts into a mortise lock of the building door. A Euro-profile cylinder is one example of a suitable lock cylinder. The lock shaft 120 is rotatable in order to move the associated lock bolt between a protruded, locked position and a retracted, unlocked position in a conventionally known manner. In use, the lock bolt can be operated manually from an exterior side via a key and can be operated from an interior side via e.g. a knob.

[0028] To permit motorized unlocking and locking, the lock device is provided with a coupling arrangement which can be driven by an electric motor. The arrangement comprises a coupling bush 130, which is mounted around the lock shaft 120 and is displaceable in axial direction from a disengaged position, in which there is no rotational coupling with the lock shaft 120, to an engaged, rotationally coupled position. Fig. 1c shows a cross-sectional view of the arrangement when the coupling bush 130 is in the disengaged position. The bush is generally cylindrical in shape and has a first end in axial direction, which will be defined as the end which faces away from the base plate 110, and has a second end which will be defined as the end which faces towards the base plate. This definition of first and second ends in axial direction will also be used for further components of the lock device.

[0029] In the disengaged position, the second end of the bush 130 suitably bears against the base plate 110. The first end of the bush has an end face 131 provided with a plurality of first recesses 132, which are arranged at angular intervals (refer Fig. 1a) and are adapted to receive first and second lock pins 122a, 122b that are mounted to the lock shaft 120. The lock shaft comprises first and second axially extending openings in which the first and second lock pins 122a, 122b are received (refer

Fig. 1c). A first end of the lock pins bears against corresponding first and second compression springs 123a, 123b which are arranged in the openings. A second end of the lock pins 122a, 122b protrudes from the opening and is axially delimited by a stepped portion of the lock shaft 120. The coupling bush 130 is axially displaceable by an amount that enables the second end of the lock pins to be received in the first recesses 132. During axial displacement of the bush towards the engaged position, it may occur that the second end of the lock pins 122a, 122b make contact with the end face 131 of the bush 130. The lock pins 122a, 122b are then pushed into the corresponding openings in the lock shaft and compress the corresponding springs 123a, 123b. Rotation of the bush 130 will bring the second ends of the lock pins into alignment with the first recesses 132 of the bush 130, in which aligned position the springs urge lock pins into engagement with the first recesses. The bush 130 is then rotationally coupled with the lock shaft 120 and rotation of bush will cause rotation of the lock shaft, to operate the lock bolt.

[0030] The initial axial displacement and then rotational displacement of the coupling bush 130 is effected via driven rotation of a gear wheel 140, which engages with the bush. The gear wheel 140 is mounted against an interior side of the base plate 110 in a manner that permits rotation of the gear wheel. In the depicted embodiment, the base plate comprises an annular protrusion 115 which supports the gear wheel in radial direction. A sliding bearing made of e.g. PTFE may be arranged between the base plate and an opposing surface of the gear wheel, for reducing friction. The gear wheel has radially extending gear teeth 142, which suitably engage with gear teeth of a pinion gear 150 (refer Figs 1a, 1b) that is coupled to the output shaft of the electric motor (not visible) that is mounted in a housing 112 of the device.

[0031] The gear wheel further comprises an engagement member 145 that extends in a radially inward direction into an angular opening 134 in the coupling bush 130. In accordance with the invention, axial displacement of the coupling bush 130 is effected via cooperating first and second cams, one of which comprises an inclined surface that extends in axial direction, which will be defined as a ramp surface. In the depicted embodiment, the engagement member 145 of the gear wheel acts as a drive cam and the opening in the coupling bush has ramp surface 135 that is inclined in axial direction towards the second end of the bush. The ramp surface may have a helical form. The angular opening 134 in the coupling bush comprises a first portion that generally extends in circumferential direction and is arranged towards the first end of the bush. In the disengaged position, the engagement member 145 of the gear wheel extends into this first portion of the opening 134. With reference to Fig. 1b, driven rotation of the gear wheel in anticlockwise direction will bring the engagement member into contact with an edge of the opening 134 that forms the start of the ramp surface 135. Further rotation of the gear wheel

causes the ramp surface 135 to follow the engagement member 145 and cause axial displacement of the coupling bush 130. As will be understood, the angular opening in the bush suitably comprises a further ramp surface that extends from the first portion of the angular opening 134 at an opposite circumferential side, for effecting axial displacement of the bush when the gear wheel is driven in an opposite direction of rotation.

[0032] Transformation of the rotational movement of the gear wheel into axial displacement of the bush is possible in that the lock device comprises anti-rotation means, which prevents the coupling bush 130 from rotating with the gear wheel when the device is in the disengaged position. In the depicted embodiment, a radially outer surface of the coupling bush is provided, at the second end thereof, with a number of second recesses 137. These recesses may have a square or rectangular shape. The annular protrusion 115 on the base plate over which the gear wheel 140 is mounted is formed by a toothed ring and comprises a number of protrusions or teeth 117 arranged with an angular spacing that extend in a radially inward direction. The teeth 117 of the ring 115 have a square or rectangular shape that fits into the second recesses. In the disengaged position, these teeth 117 engage in the second recesses 137 of the coupling bush and prevent rotation of the coupling bush until a sufficient amount of axial displacement has occurred which releases the second recesses 137 from the teeth 117. Suitably, the device is configured such that this occurs when the gear wheel engagement member 145 reaches the end of the ramp surface 135 and encounters a straight edge 135a of the bush opening. Further rotation of the gear wheel 140 now causes rotation of the coupling bush 130, allowing it to adopt an angular orientation in which the first and second lock pins 122a, 122b engage in the first recesses 132 of the bush as described above, such that further rotation of the gear wheel 140 causes rotation of the lock shaft 120.

[0033] To decouple the bush 130 from the lock shaft, to permit manual operation of the shaft 120, a lock device of the invention is provided with a return mechanism for returning the coupling bush to the disengaged position. In the depicted first embodiment of the invention, the bush 130 is axially displaced back towards the base plate 110 via driven rotation of the gear wheel 140. The angular opening 134 in the coupling bush 130 is provided with a second ramp surface 136, with which the gear wheel engagement member 145 cooperates when the gear wheel is drivingly rotated in the opposite direction. In the engaged position, the coupling bush 130 is prevented from rotating with the gear wheel via the lock pins 122a, 122b engaging in the first recesses 132, such that rotation of the gear wheel is transformed into axial displacement of the bush back towards the base plate 110, until the lock pins are released from the first recesses 132 in the bush 130.

[0034] In order for the coupling bush 130 to fully return to the disengaged position, the second recesses 137

need to be in an angular position relative to the teeth 117 of the base plate ring 115 that permits the teeth to extend into the second recesses. It might occur that during the return movement, a second end face of the bush makes contact with the teeth 117, which blocks axial displacement. In a further development, the base plate ring is mounted to the base plate in a manner that permits a limited amount of rotation of the ring relative to the base plate, such that the ring may adopt different angular positions. An example of such a ring is shown in shown in Fig. 1d. The base plate 110 comprises angular slots 118 at either side of a central opening through which the lock shaft 120 extends. The toothed ring 215 is provided with an axial extension 218 that fits into each slot 118 and allows angular displacement of the ring 215 by e.g. 5 -15 degrees. Further components of the lock device depicted in Fig. 1d are identical to those depicted in Figs. 1a - 1c. Thus, if the second end face of the coupling bush 130 encounters teeth 217 of the ring 215 during the return movement, the ring 215 can be angularly displaced into a position of alignment with the second recesses 137 of the bush 130, such that bush is restored to the disengaged position.

[0035] An example of a second embodiment of a lock device 200 according to the invention is shown in exploded view in Fig. 2a and in assembled view in Fig. 2b. In the second embodiment, the return mechanism for restoring the coupling bush to the disengaged position comprises a compression spring 250 arranged around the lock shaft 120. A first end of the spring bears against an inside surface of the device housing 112 and a flange part 236 of the coupling bush 230. The provision of a compression spring removes the need to have a second ramp surface 136 on the coupling bush as described with reference to Figs 1a and 1b. This has the advantage of eliminating any risk that motorized return movement of the lock shaft 120 during this movement. The mechanism for effecting axial displacement of the coupling bush from the disengaged position to the engaged position is the same as that described for the first embodiment. The coupling bush 230 has first recesses 232 that receive the first and second lock pins 122a, 122b in the engaged position and has second recesses 237 that receive the teeth 117 of the base plate ring when the bush is in the disengaged position. The base plate ring may also be angularly displaceable relative to the base plate 110 such as described with reference to Fig. 1d. The coupling bush 230 is provided with an angular opening 234 having a first ramp surface 235 which is contacted by the engagement member 245 of the gear wheel 240 to effect axial displacement of the bush 230 via rotation of the gear wheel and then rotational displacement of the bush when the engagement member encounters a straight edge or stop 235a in the angular opening 234 in a first direction of rotation and the second recesses 237 have been released from the teeth 117. Suitably, the angular opening 234 comprises a second ramp surface, which ends in a

straight stop surface, at an opposite side in circumferential direction, for moving the bush 230 from the disengaged position to the engaged position when the gear wheel is rotated in a second direction of rotation. As mentioned, the coupling bush 230 comprises a flange part 236, generally arranged at the first end of the bush which axially retains the compression spring 250. Axial displacement of the bush towards the engaged position compresses the spring against the device housing.

[0036] Let us assume that the gear wheel 240 has been rotated in clockwise direction to displace the bush 230 to the engaged position. Disengagement is effected by rotating the gear wheel 240 in anti-clockwise direction, which brings the gear wheel engagement member 245 from the stop 235a into a central portion of the angular opening 234. This central portion has a larger dimension in axial direction than a corresponding axial extension of the engagement member 245, such that the compressed spring 250 urges the bush back towards the disengaged position. If the second recesses 237 of the bush are not in angular alignment with the teeth 117 of a base plate ring 115, a small amount of manual rotation of the lock shaft 120 will bring them into alignment, such that further axial displacement is permitted which releases the lock pins from the first recesses 237 and returns the bush to the disengaged position.

[0037] In a third embodiment of a lock device according to the invention, the ramp surface for effecting axial displacement of the coupling bush towards the engaged position, in one direction of rotation, is provided on the gear wheel. An example of such a lock device 300 is depicted in exploded view in Fig. 3a and in assembled view in Fig. 3b. The gear wheel 340 has an engagement member 345 which makes contact with at least one cam on coupling bush 330. The cam is formed by a protrusion 335 that extends in axial direction from a central region of the coupling bush. Preferably, the bush is provided with a further cam at an opposite side in circumferential direction. Only the first cam 335 is visible in Figs. 3a and 3b. Suitably, the cams 335 have straight camming surfaces. Each cam extends into an angular opening 346 in the engagement member, whereby the opening is delimited in angular direction by a first ramp surface 347 for engagement with one cam in one direction of rotation and by a second ramp surface for engaging with the cam and effecting axial displacement in an opposite direction of rotation. Suitably, each ramp surface 347 ends with a straight stop edge 347a. The ramp surfaces may have a helical form.

[0038] Further, the coupling bush is provided with first recesses for receiving the spring-loaded lock pins in the engaged position and with second recesses which engage with anti-rotation means when the bush is in the disengaged position, as described for the previous embodiments. The lock device is further provided with a compression spring 250 as described with reference to Figs 2a and 2b for returning the bush to the disengaged position after the gear wheel has been rotated in an op-

posite direction that brings each cam 335 into a central region of the corresponding angular opening 346 in the gear wheel engagement member 345.

[0039] A fourth embodiment of a lock device according to the invention is depicted in exploded view in Fig 4a and in assembled view Fig. 4b. In the fourth embodiment, the ramp surfaces for effecting axial displacement of the coupling bush are provided on the anti-rotation means.

[0040] The device 400 comprises a toothed ring 415 that is preferably mounted to the base plate 110 so as to permit a small amount of angular displacement of the ring 415 relative to the base plate. The ring 415 comprises a plurality of teeth 417, which extend in a radially inward direction. Each tooth is additionally provided with a first ramp surface 417a and a second ramp surface 417b that taper in axial direction towards the coupling bush 440. The base plate teeth 417 therefore additionally acts as cams. A side view of the coupling bush is shown in Fig. 4c. The bush 430 has plurality of second recesses 437 which are shaped to receive the teeth 417 of the base plate ring 415 when the bush 430 is in the disengaged position. The second recesses 437 have an axial depth X and create cams 438 on the bush. Rotation of the gear wheel 440 in a first direction of rotation effects axial displacement of the bush via cooperation of the first ramp surface 417a of each tooth 417 and a corresponding cam 438 on the bush. Rotation of the gear wheel 440 in a second direction of rotation effects axial displacement of the bush via cooperation of the second ramp surface 417a of each tooth 417 and a corresponding cam 438 on the bush.

[0041] Torque is transferred from rotation of the gear wheel 440 to the coupling bush 430 by first and second engagement members 445a, 445b, suitably arranged at opposite sides of the gear wheel in circumferential direction. The engagement members extend axially over the coupling bush and radially into first and second angular openings in the coupling bush. The bush is suitably provided with first and second axially extending slots 439 to permit mounting. Fig. 4c shows the first slot 439 and the first angular opening 434. Each angular opening has a first portion and a second portion, whereby the second portion has a greater angular dimension than the first. The first portion of the opening is delimited in angular direction by first and second edges 434a, 434b, which form rotation stops for the first engagement member 445a in first and second directions of rotation when the bush is in the disengaged position. The dimension in axial direction of the first portion may be essentially equal to the axial depth X of the second recesses 437. When the gear wheel 440 is drivingly rotated in a first direction, the first engagement member 445a will make contact with the first stop 434a. Further rotation transfers torque to the coupling bush 430, which initially causes axial displacement of the bush 430 by the amount X, until the camming teeth 417 of the base plate ring 415 have been released from the second recesses 437 on the bush. This also releases the engagement member 445a from the

first portion of the angular opening into the second portion. The second portion of the opening is delimited in angular direction by first and second edges 435a, 435b and form stops for the first engagement member 445a in first and second directions of rotation. Further rotation of the gear wheel in the first direction brings the engagement member into the contact with the first edge 435a of the second portion of the angular opening and still further rotation transfer torque which causes rotation of the bush and rotation of the lock shaft 120 when the lock pins engage in the first recesses of the bush.

[0042] Each first edge 435a and each second edge 435b are straight surfaces that extend in axial direction. During the initial axial displacement, rotational force is transferred from the engagement member 445a, 445b to the bush 440 via the corresponding first straight edge 434a of the angular opening 434. As a result, none of the applied rotational force has an axial component, as is the case when torque is transferred via an inclined ramp surface is provided on the bush or on the gear wheel engagement member. The efficiency of torque transfer is thus improved. This is one advantage of implementing the ramp surfaces 417a, 417b on the teeth of the ring component 415. A further advantage is that the resulting essentially triangular shape of the teeth 417, and correspondingly shaped second recesses 437 of the bush, make it more likely that these teeth and recesses will adopt a position of alignment with each other that enables the compression spring to restore the bush to the disengaged position in a disengagement action.

[0043] Fid. 4d shows a detail of the assembled arrangement when the coupling bush 430 has been axially displaced to the engaged position and the first engagement member 445a is in contact with the first edge of the second portion of the angular opening. Disengagement is effected by rotation of the gear wheel in the second direction until the engagement member 445a has passed a stepped portion 436 of the angular opening, which forms an interface between the first and second portions. The compression spring 250 arranged between the bush and the device housing is then able to axially displace the coupling bush 430 back towards the disengaged position.

[0044] In the example shown in Figs. 4c and 4d, the stepped portion has a straight surface. In a further development, the stepped portion has a ramp surface, such as shown in Fig. 4e. The angular opening has a first and second ramp surfaces, whereby only the second ramp surface 436b is visible in Fig. 4e. Each ramp surface is inclined such that rotation of the gear wheel 440 in the direction which moves the coupling bush towards the engaged position causes a small amount of additional axial displacement of the bush 430. The total amount of axial displacement of the bush, relative to the disengaged position, is Y, which is greater than X. This ensures that an axial end face of the cams 438 on the bush are not in contact with the camming teeth 417 of the base plate ring 415 during the final phase of the engagement action. This

has the advantage of preventing any rattling rotation of the bush.

[0045] Examples, embodiments or optional features, whether indicated as non-limiting or not, are not to be understood as limiting the invention as claimed. It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims.

[0046] In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

List of references and abbreviations

[0047] The following list of references and abbreviations is provided for facilitating the interpretation of the drawings and shall not be construed as limiting the claims.

100, 200, 300, 400 motorized lock device
 110 base plate of lock device
 112 housing of lock device
 115, 215, 415 toothed ring
 117, 217, 417 radially extending protrusions of toothed ring
 417a, 417b first and second ramp surfaces on protrusions of toothed ring
 118 angular slot in base plate for mounting toothed ring
 218 axial extension on toothed ring that fits into angular slot
 120 lock shaft
 122a, 122b first and second lock pins
 123a, 123b first and second springs
 130, 230, 330, 430 coupling bush
 131 first axial end face of coupling bush
 132, 232 first recesses provided at first axial end of coupling bush
 134, 234, 434 angular opening in coupling bush
 135, 235 first ramp surface on coupling bush for effecting axial displacement towards engaged position
 135a, 235a straight stop surface at end of first ramp surface
 136 second ramp surface on coupling bush for ef-

fecting axial displacement towards disengaged position

236 flange portion of coupling bush

335 axial protrusion on coupling bush that acts a first cam

137, 437 second recesses on coupling bush at second axial end thereof

140, 240, 340, 440 gear wheel

142 gear wheel teeth

145, 245, 346, 445a, 445b engagement member of gear wheel

346 angular opening in gear wheel engagement member

347 ramp surface on gear wheel engagement member

347a straight stop surface at end of ramp surface

434a, 434b straight stop surfaces of a first portion of the angular opening in the coupling bush

435a, 435b straight stop surfaces of a second portion of the angular opening in the coupling bush

436 interface between first and second portions of angular opening

436b ramp surface on interface

438 first cams on coupling bush

439 mounting slot on coupling bush

150 pinion gear

250 compression spring

Claims

1. A motorised lock device (100, 200, 300, 400) comprising a rotatable lock shaft (120) configured for mounting to a cylinder lock of a building door, such that in use, rotation of the lock shaft operates a lock bolt associated with the cylinder lock, the device further comprising a coupling bush (130, 230, 330, 430) mounted around the lock shaft, and a gearwheel (140, 240, 340, 440) mounted around the coupling bush, which engages therewith via an engagement member (145, 245, 345, 445a, 445b) that extends in a radially inward direction, whereby the gear wheel is drivable by a pinion gear (150) mounted to an output shaft of an electric motor; **characterized in that:**

- the coupling bush is displaceable in axial direction between a disengaged position and an engaged position in which the bush (130, 230, 330, 430) and the gearwheel (140, 240, 340, 440) are rotationally coupled to the lock shaft (120) via an axially compressible engagement mechanism that engages with the coupling bush at a first end thereof;
- axial displacement of the coupling bush towards the engaged position is effected by driven rotation of the gearwheel (140, 240, 340, 440), via cooperation between at least one first cam (335, 438) provided on the coupling bush and

at least at least one second cam (145, 245, 345, 417) provided on a further component of the lock device, whereby at least one of the first and second cams comprises a ramp surface (135, 235, 347, 417a, 417b) inclined in axial direction, and whereby the lock device is provided with anti-rotation means, which prevent rotation of the coupling bush during displacement from the disengaged position towards the engaged position; and

- the lock device further comprises a return mechanism (136, 250) for returning the coupling bush from the engaged position to the disengaged position.

2. The lock device of claim 1, wherein the first axial end of the coupling bush comprises a number of first recesses (132, 232) arranged at angular intervals, and wherein the axially compressible engagement mechanism is formed by one or more spring-loaded lock pins (122a, 122b), which lock pins are in fixed connection with the lock shaft (120) and engage in the first recesses when the coupling bush is an angular position that aligns the corresponding first recess with a position of the one or more lock pins.
3. The lock device of claim 1 or 2, wherein the anti-rotation means is formed by a plurality of angularly spaced protrusions (117, 417) that extend in a radially inward direction from a toothed component (115, 215, 415), through which the lock shaft (120) extends, that is mounted to a base plate (110) of the lock device, which protrusions engage in second recesses (137, 237) provided at a second axial end of the coupling bush (130, 230, 330, 430).
4. The lock device of claim 3, wherein the toothed component 115, 215, 415) is mounted to the base plate (110) in a manner that permits a limited amount of rotation of the toothed component relative to the base plate.
5. The lock device of claim 3 or 4, wherein the protrusions (417) of the toothed component (415) comprise first and second ramp surfaces (417a, 417b) which act as second cams and wherein the second recesses (437) of the coupling bush (430) create first cams (438) which cooperate therewith.
6. The lock device of claim 5, wherein the engagement member (445a, 445b) of the gear wheel (440) extends into an angular opening (434) in the coupling bush, whereby:
 - the angular opening has a first portion comprising first and second straight edges (434a, 434b) which form a rotational stop for the engagement member when the coupling bush

- (430) is in the disengaged position; and
- the angular opening has a second portion, which has a larger angular extent than the first portion and which comprises first and second straight edges (435a, 435b) that form a rotational stop for the gear wheel engagement member when axial displacement of the bush (430) has released the second recesses (437) of the bush from the protrusions (417) on the toothed ring (415).
7. The lock device of claim 6, wherein an interface between the first and second portions of the angular opening (434) in the coupling bush (430) comprises a ramp surface (436b) with which the gear wheel engagement member (445a, 445b) cooperates to effect an additional axial displacement of the coupling bush, after the coupling bush has been released from the anti-rotation means.
8. The lock device of any of claims 1-4, wherein the gear wheel engagement member (145, 245, 345) acts as the second cam.
9. The lock device of claim 8, wherein:
- the coupling bush (130, 230) comprises an angular opening (134, 234) arranged between the first and second axial ends; and
 - first and second edges of the angular opening comprise a ramp surface (135, 235) which act as a first cam in each direction of rotation.
10. The lock device of claim 8, wherein:
- the gear wheel engagement member (345) comprises at least one angular opening (346) which is delimited in angular direction by a first ramp surface (347) and by a second ramp surface, which act as a second cam in each direction of rotation; and
 - the coupling bush (330) comprises at least one axially extending protrusion (335), which extends into the angular opening (346) and acts as the first cam.
11. The lock device of any preceding claim, wherein the return mechanism comprises a compression spring (250) arranged axially between the first end of the coupling bush (230, 330, 430) and a housing (112) of the lock device.
12. The lock device of claim 8, wherein the return mechanism is formed by a second ramp surface (136) of the coupling bush, which cooperates with the gear wheel engagement member (145) to effect axial displacement of the bush (130) back to the disengaged position when the gear wheel is rotated in an opposite direction from the direction of rotation which caused axial displacement of the bush to the engaged position.
13. The lock device of any preceding claim, wherein each ramp surface of the at least one first or second cam has a helical form.
14. The lock device of any of claims 2 - 13, wherein the first recesses (132, 232) of the coupling bush (130, 230, 330, 430), which receive the one or more spring-loaded lock pins (122a, 122b) when the coupling bush is in the engaged position, are formed by angular slots which permit a limited amount of rotation of the coupling bush relative to the one or more lock pins.
15. The lock device of any preceding claim, wherein the electric motor comprises control means configured to receive an activation signal and to control the motor such that the gearwheel (140, 240, 340, 440) is rotated to perform an engagement action and then a disengagement action.

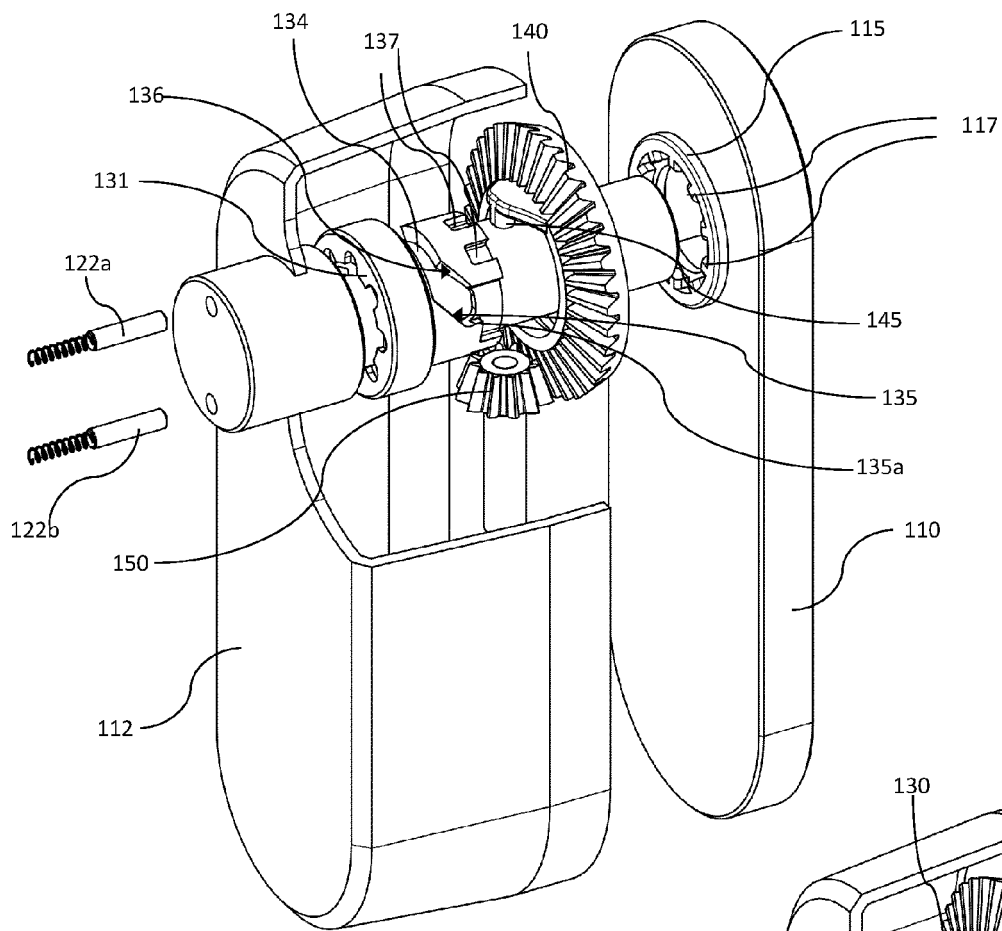


Fig. 1a

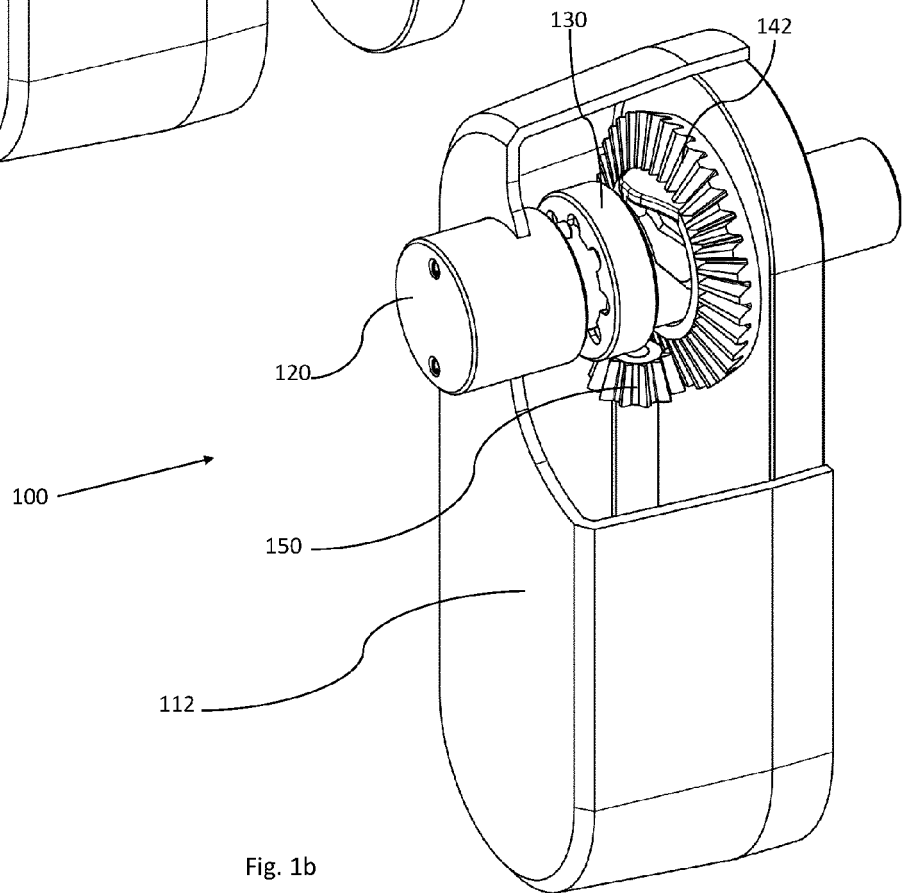


Fig. 1b

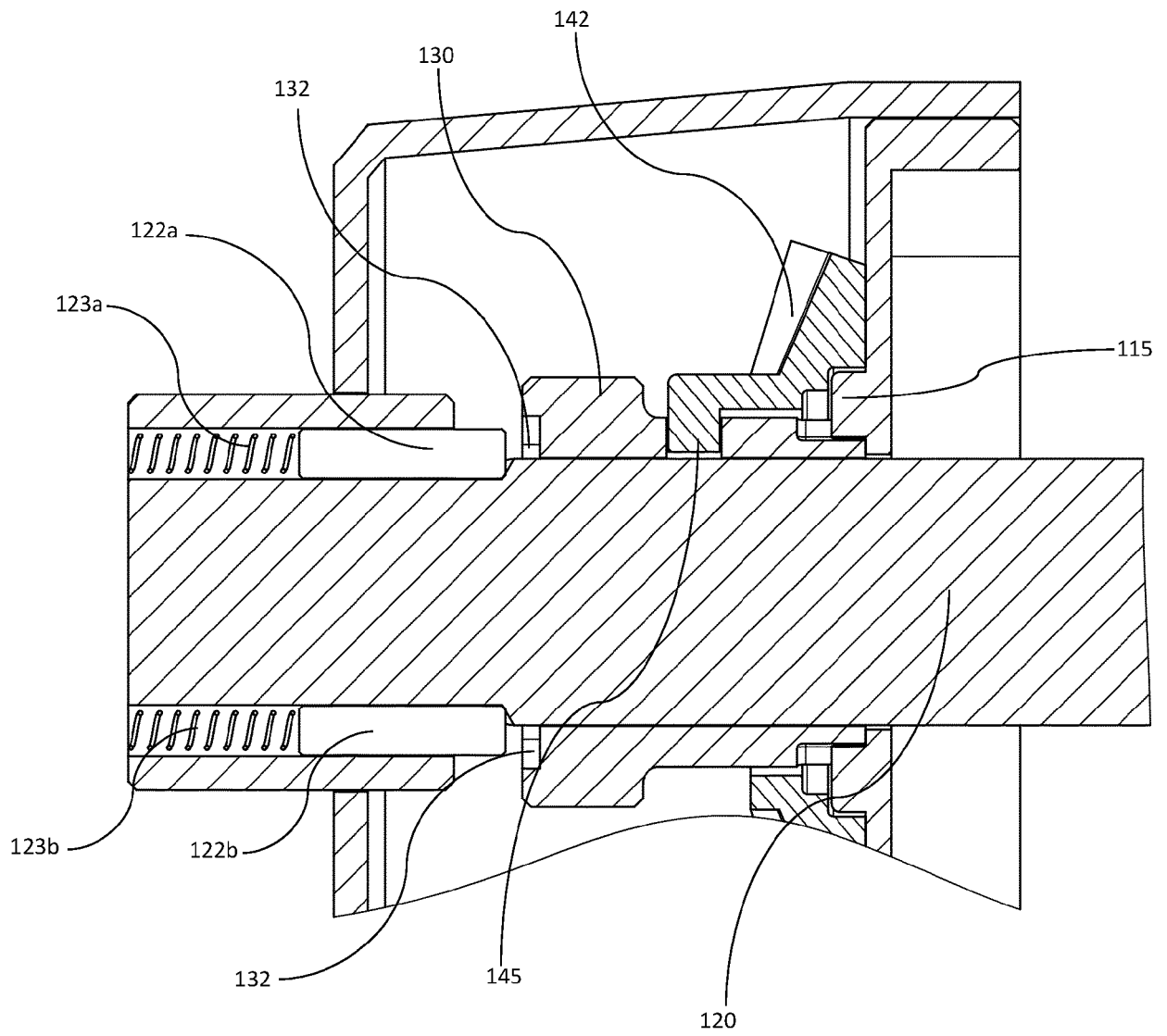


Fig. 1c

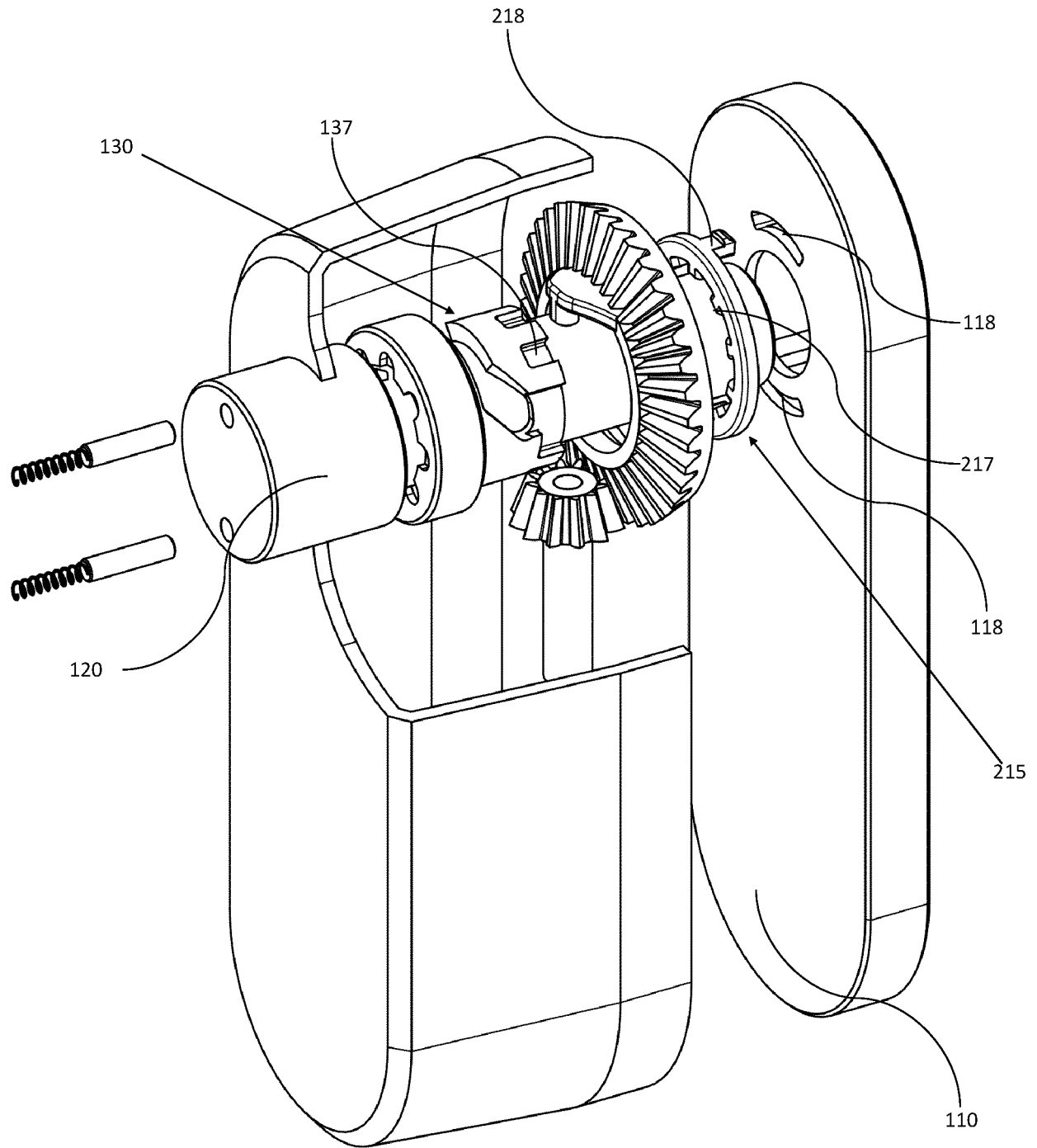
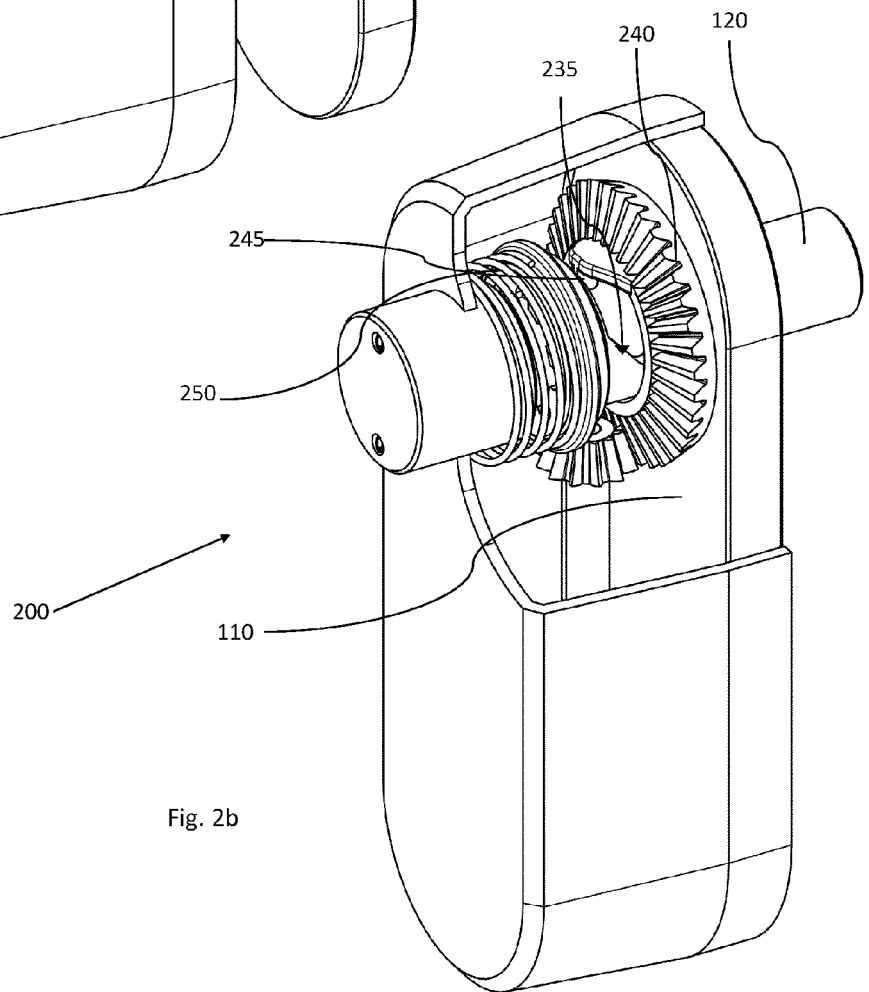
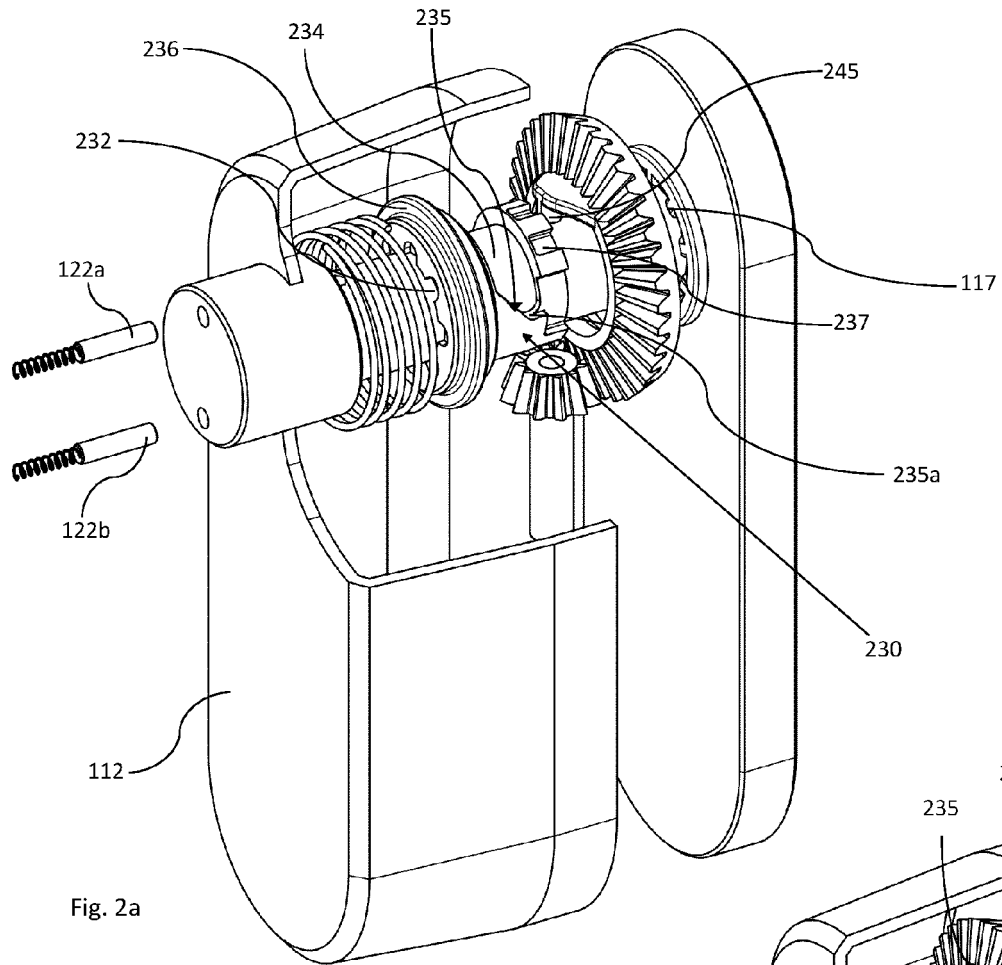


Fig. 1d



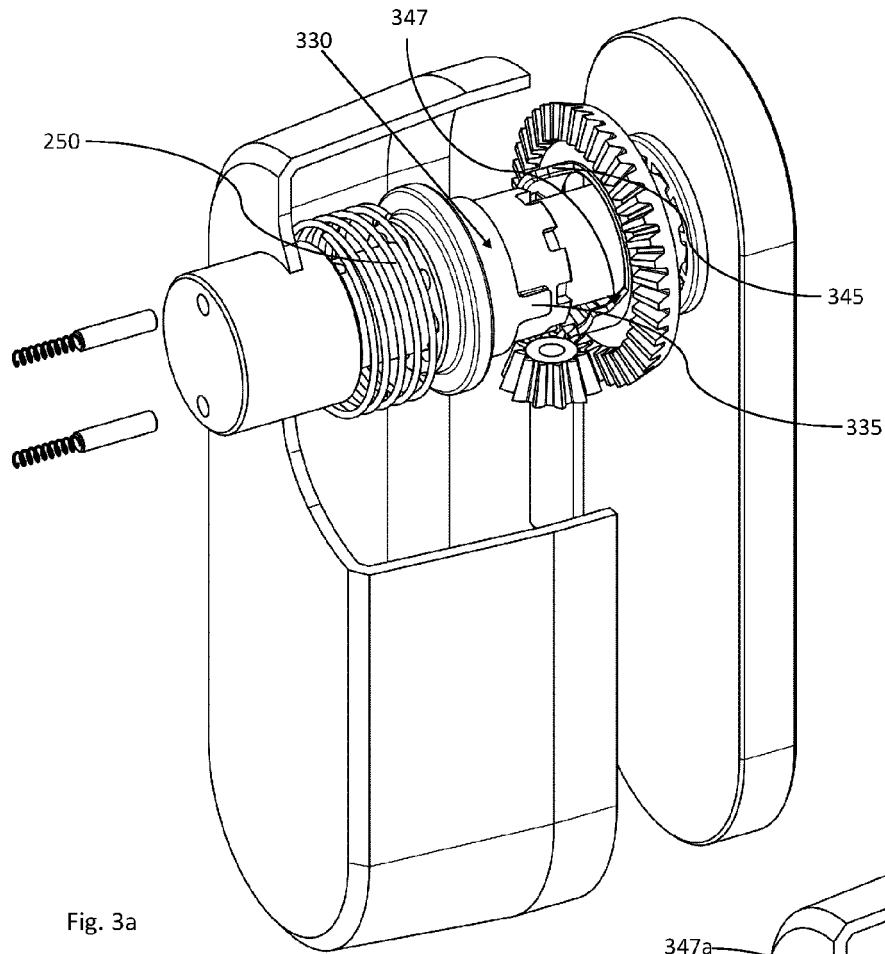


Fig. 3a

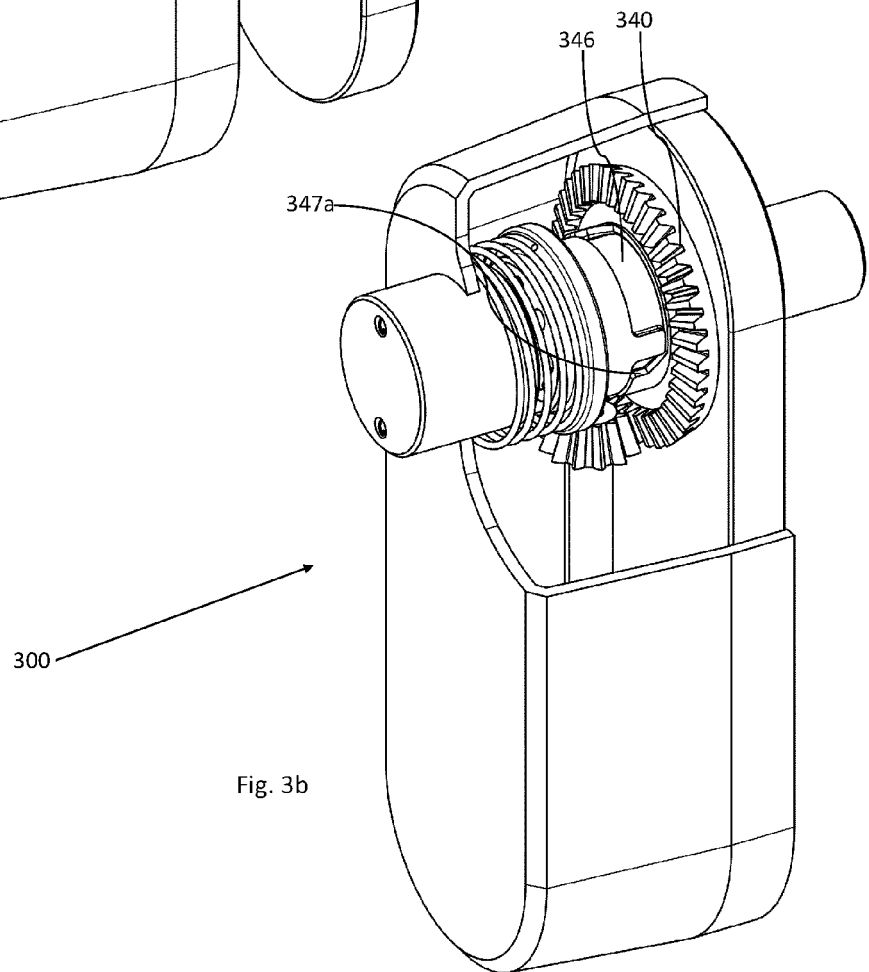


Fig. 3b

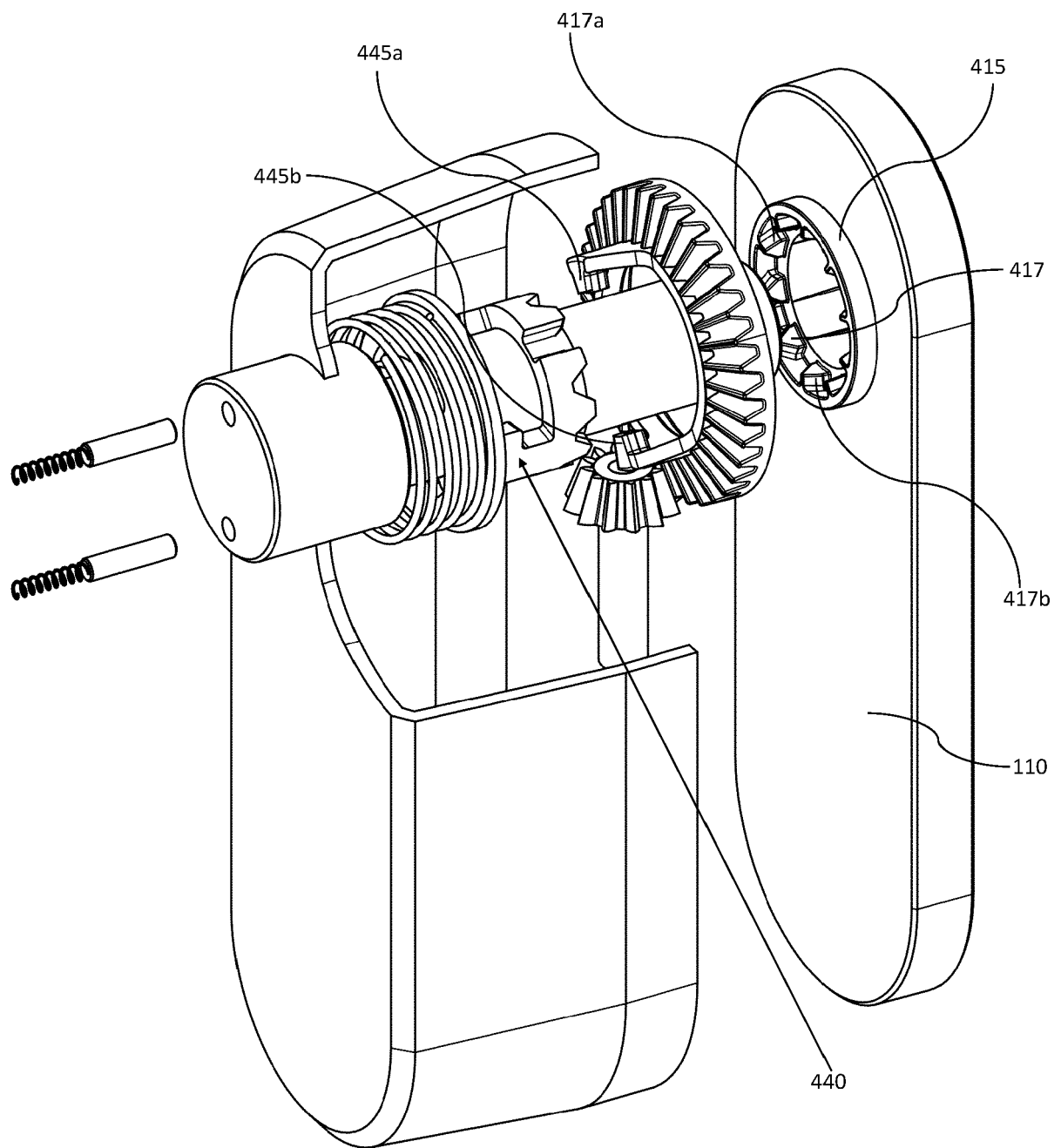
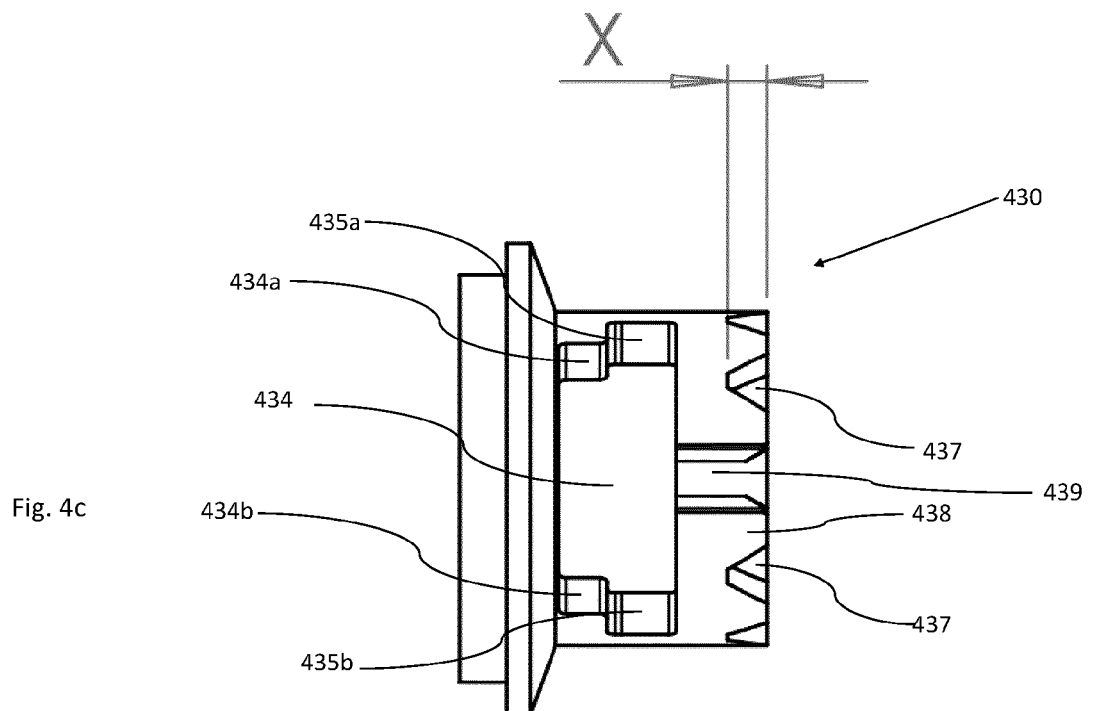
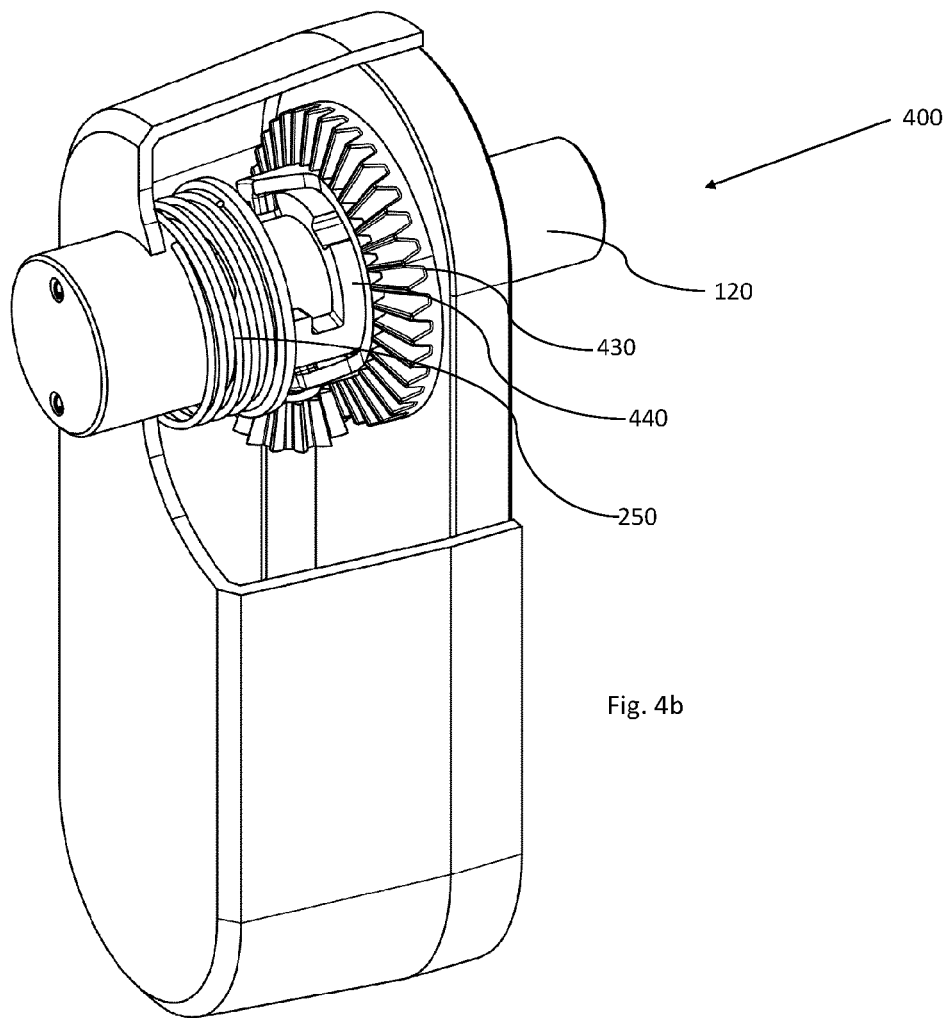


Fig. 4a



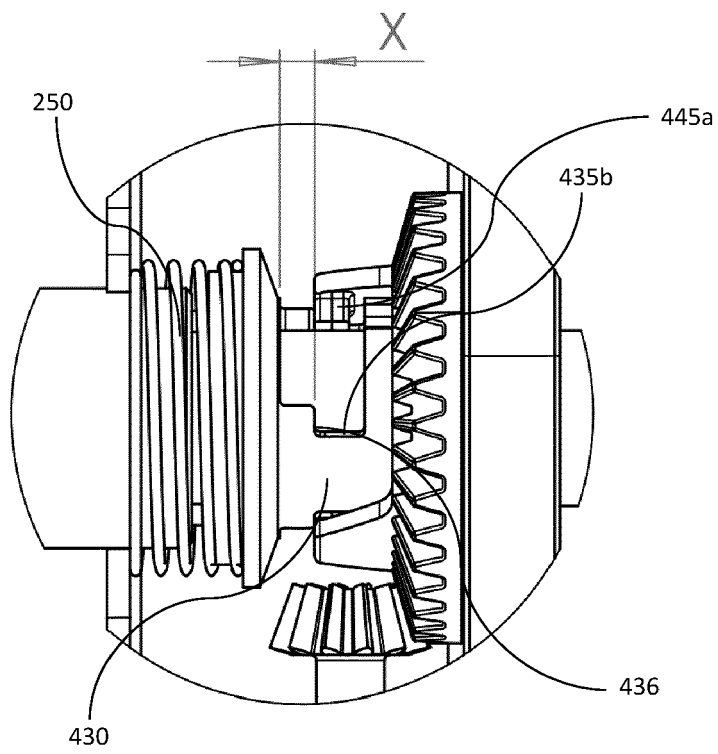


Fig. 4d

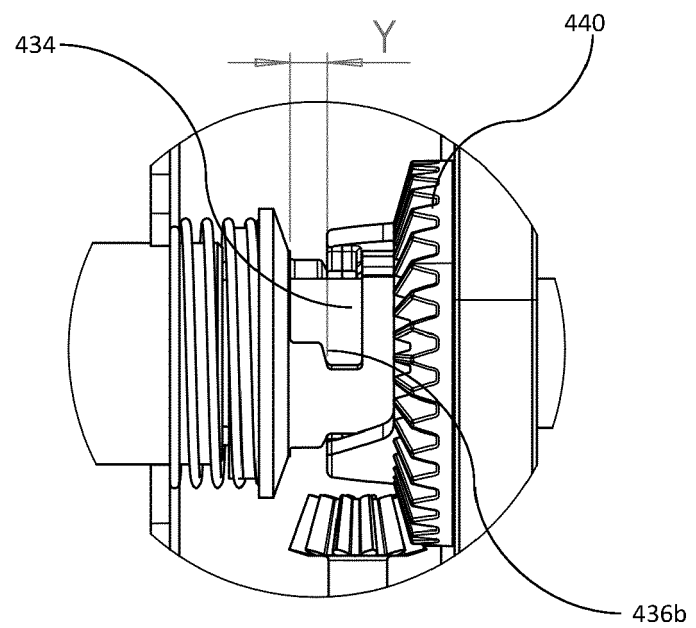


Fig. 4e



EUROPEAN SEARCH REPORT

Application Number

EP 23 15 3476

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Place of search		Date of completion of the search	Examiner
The Hague		7 July 2023	Koster, Michael
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