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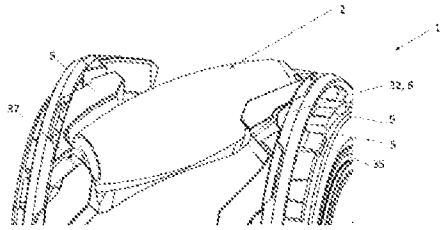
(54) Title **Locking ring for rollers on a mecanum wheel**

(57) Abstract

The invention describes a mecanum wheel (1) with a plurality of rollers (2) each with a rolling surface (4) rotating around an axel (3) with axel ends (7) protruding from each side of the rolling surface in the longitudinal direction of the roller (2). The mecanum wheel comprises a wheel frame (5) having mounting recesses (8) for mounting the rollers (2), wherein the mounting recess (8) interacts with the respective axel end (7) for structurally locking the axel (3) against all movements except movements along an insertion path (28) for inserting and removing the roller (2) into and from the mecanum wheel (1). The mecanum wheel further comprises a locking ring (9) provided with rebounding roller retaining structures (6) positioned at least partly inside each insertion path (28) providing sufficient force to prevent unintended release of the roller (2) along the insertion path (28).



Title: Locking ring for rollers on a mecanum wheel

Field of invention

The invention relates to mecanum wheels, more specifically the invention relates to a locking ring for fastening the rollers on a mecanum wheel in a manner enabling quick mounting and release.

Background

The applicant has previously developed a rolling device capable of being integrated in devices, such as a piece of furniture, a movable wall etc., for moving the device along a surface. The rolling device facilitates the moving of an object and can be used by everyone regardless of physical condition and capacity to lift different devices in which the rolling device is integrated. This device is described in Norwegian Patent NO 316760 B 1.

The rolling device of NO 316760 B 1 comprises a cylindrical sleeve device for mounting in, for example, the leg of a piece of furniture, and a piston that is movably arranged in the cylindrical sleeve device. A ball-shaped or spherical wheel is arranged in the piston. The piston is movable, with the aid of a click system comprising a spring, between an upper position and a lower position. When the piston is in the lower position, the piece of furniture can be rolled across the floor it is standing on, whilst when the piston is in the upper position, the wheel is inside the cylindrical sleeve device and the leg of the piece of furniture, in which the rolling device is arranged, thus stands on the floor. The piece of furniture thus stands in the desired position without rolling inadvertently across the floor when small forces are applied to the piece of furniture. The solution is completely mechanical.

In a further version as described in WO 2018138320, the applicant has evolved the concept of the rolling device further. WO 2018138320 presents a rolling device for arrangement for autonomously moving a device from a first position to a second position along a surface. The rolling device controls the movements of a rolling element according to position acquisitions and given position and movement instructions. The rolling element may have a set or fixed vertical position relative to the rolling device or may be arranged for displacement between a retracted position where the wheel element is prevented from moving along a surface and an extended position where the wheel element is prepared for movement along the surface, as described in EP 3102429 and NO 316760 B 1. Such a rolling device can be fitted with a mecanum wheel.

Mecanum wheels have been in use for a number of decades and are widely used for robotic movement. Mecanum wheels have a configuration allowing movement in any direction, and it is a conventional wheel with a series of rollers attached to its

circumference. These rollers may typically each have an axis of rotation at 45° to the plane of the wheel and at 45° to a line through the centre of the roller parallel to the axis of rotation of the wheel but may of course also be arranged with axis of rotation having other inclinations than 45°.

During normal use the forces acting on a roller 2 mounted on a mecanum wheel 1 will always have a component radially towards the center of the mecanum wheel and will also have an axial component as indicated by arrows in figure 12. However, apart from centrifugal forces and G-forces originating from bumps and high velocities there are no forces to speak of, acting radially outward from the wheel. Therefore, it is possible to simplify the ordinary cumbersome nut and bolt fixture of the rollers and replace it with structural features locking the rollers against movements in an axial and radial inwards direction and use a simpler 'quick release' mechanism for handling the minor forces acting radially outwards. An invention using this insight is the application NO20210995 describing a mecanum wheel comprising a plurality of rollers each with a rolling surface and an axel and a wheel frame for mounting the rollers with mounting units holding respective axel ends of each roller. Each mounting unit comprise a mounting recess with an opening, wherein the mounting recess interacts with the respective axel end for locking the roller against movements in directions having a component radially inwards. Each mounting unit further comprise a rebounding roller retaining structure positioned at least partly inside an insertion path causing resistance when the axel end is pushed or pulled past the roller retaining structure into, and out from, a resting position in the mounting unit recess, thus preventing unintended release in a radial outward directed component.

One problem relating to more heavy duty mecanum wheels with fixed roller axels is that the retaining structures are too weak or build to much volume close to the floor on which the mecanum wheel is rolling. The industry needs an easy way to replace the rollers and the current invention provide at least a partial solution to this problem.

Summary of the invention

In one aspect of the invention a mecanum wheel is described comprising a plurality of rollers each with a rolling surface rotating around an axel with axel ends protruding from each side of the rolling surface in the longitudinal direction of the roller. The mecanum wheel comprises a wheel frame for mounting the rollers. The frame comprises a mounting recess for each axel ends, each mounting recess having an opening for inserting an axel end, wherein the mounting recess interacts with the respective axel end for locking the axel against movements in sideways and radially inward directions of the mecanum wheel and in axial directions of the roller,

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The mecanum wheel further comprises a locking ring on each side of the mecanum wheel. The locking ring comprises fastening means for releasably fastening the locking ring to the mecanum wheel. The locking ring further comprises a rebounding roller retaining structure at least partly blocking extraction of respective axel ends from the mounting recesses causing resistance when the axel end is pushed or pulled past the rebounding roller retaining structure into, and out from, a resting position in the mounting recess, for preventing unintended release of the roller in substantially a radially outward direction of the mecanum wheel.

In an embodiment of the invention, the rebounding roller retaining structure comprises a resilient lip protruding from the locking ring, the lip at least partly blocking extraction of the respective axel ends from the mounting recesses when the locking ring is fastened to the mecanum wheel.

In another embodiment of the invention, the rebounding roller retaining structure comprises a deflective arm protruding from the locking ring, the deflective arm at least partly blocking extraction of the respective axel ends when the locking ring is fastened to the mecanum wheel.

In an embodiment of the invention, the axel end comprise an angled surface inclined towards the center of the mecanum wheel as it extends towards an end surface of the axel. The angled surface is substantially perpendicular to a vertical plane comprising the axis of the axel.

In yet an embodiment of the invention, the axel comprises an axial stopper surface essentially perpendicular to the axial axis of the axel at each axel end and the mounting recesses each comprises a stopper surface essentially perpendicular to the axial axis of the axel interacting with the axial stopper surface for locking the axel against movements relative to the wheel frame in directions along the axis of the roller.

In yet an embodiment of the invention, the axel ends each comprises two essentially parallel holding surfaces mating with two parallel side surfaces in the mounting recess for locking the axel against rotational movement and sideways movement.

In yet an embodiment of the invention the fastening means comprises a plurality of click-in arms arranged to click into mating gripping structures on the wheel frame.

In yet an embodiment of the invention the locking ring comprises a ring guiding structure mating with a ring guiding slot on the wheel frame for securing correct rotational position of the locking ring.

In yet an embodiment of the invention the axel ends comprise a gripping formation for gripping with an extraction tool for removal of the roller from the mecanum wheel.

In yet an embodiment of the invention the mounting recess is a U-shape structure for receiving the axel end.

In yet an embodiment of the invention the deflective arm is provided with a finger grip to ease manual release of the roller.

In another aspect of the invention it is described a rolling device for movement along a surface wherein the rolling device comprises a housing arranged for attachment to the device, a mecanum wheel according to the invention and driving means.

Brief description of the drawings

The invention will now be described in more detail by reference to the accompanying figures. The same numeral on different drawings refer to the same feature.

Fig. 1 shows a perspective view of a mecanum wheel according to the invention.

Fig 2 shows an exploded view of the mecanum wheel.

Fig. 3 shows a perspective view of an embodiment of the locking ring.

Fig 4 shows the locking ring of fig. 3 and one side of a matching mecanum wheel.

Fig. 5 shows an embodiment of the axel of a roller.

Fig. 6a shows a roller before being inserted into an embodiment of the mounting recess and fig. 6b shows an insertion path.

Fig. 7 shows the roller of fig. 6a after insertion.

Fig. 8 shows the rebounding roller retaining structure gripping the axel end.

Fig. 9 shows an embodiment of the locking ring and a matching mecanum wheel.

Fig. 10 shows another embodiment of the locking ring and a matching mecanum wheel.

Fig. 11 shows yet another embodiment of the locking ring and a matching mecanum wheel.

Fig. 12 shows the direction of the forces acting on a roller mounted on a mecanum wheel during normal use.

Fig. 13 indicates use of directions in the text.

Fig. 14 shows a rolling device comprising a mecanum wheel.

Detailed description

In this text the important directions are radially outward and radially inward of the mecanum wheel. The peripheral wheel plane is in this text a cylindrical plane along the outer rim of the mecanum wheel with the central axis coinciding with the axis of the mecanum wheel. When describing a roller, an axel and associated mounting recess, up and down, vertical and horizontal and radially inward and radially outward are as seen in fig. 13 and inner side of the mounting unit is toward the center of the roller and outer side is towards the rim of the mecanum wheel. In other words, we describe a roller and mounting recess when positioned on top of the mecanum wheel in a horizontal position, as seen in fig. 13.

A mecanum wheel according to the invention is shown in fig 1. A rolling surface 4 of a roller 2 must be positioned in the peripheral wheel plane of the wheel. This is always true in a mecanum wheel. The rolling surface 4 of the roller 2 is the surface that rolls on the ground or floor.

Fig. 1 shows the mecanum wheel 1 according to the invention and fig. 2 shows an exploded version of the same mecanum wheel. The mecanum wheel comprises a plurality of rollers 2. Each roller has an axel 3 with axel ends 7 protruding from a rolling surface 4 in an axial direction as seen in fig. 2 and fig. 6a. The rolling surface is rotating around the axel, which is coupled to a wheel frame 5 of the mecanum wheel in a non-rotational manner. The axel ends 7 protrudes from the rolling surfaces in an axial direction to enable interaction with a mounting recess 8 on the wheel frame 5. The axel ends may comprise an end surface 23 substantially perpendicular to the axel. The axel ends comprise an axial stopper surface 18 substantially perpendicular to the axial axis of the axel 3 as seen in fig. 5. The rollers are mounted on a wheel frame 5 by means of the mounting recesses 8. The wheel frame comprises one pair of mounting recesses for each roller 2.

As seen in fig. 6b, the mounting recess 8 comprises an opening 14 for receiving the axel end 7. The mounting recess 8 is mating with respective axel ends 7 on the end of each side of the axel 3 for structurally locking the axel of the roller 2 for any movements except for movements associated with insertion and removal of the roller along an insertion path 28 seen in fig. 6b. Such movements will have a large component directed radially outward from the mecanum wheel. In other words, the axel 3 is at least structurally locked for movements in directions having a component radially inwards of the mecanum wheel 1. The axel is also locked

against axial and sideways movements. The axel is also structurally locked against rotational movements. By 'structurally locked' against movements we mean that it is the geometric structure and the properties of the material of the mounting recess 8 and axel end 7 that prevents movements.

As seen in fig. 6a the mounting recess 8 further comprise a recess stopper surface 19 essentially perpendicular to the axial axis of the axel 3 (when positioned in the recess) interacting with the axial stopper surface 18 on the axel end 7 for locking the roller 2 against movements relative to the wheel frame 5 in directions along the axis of the roller 2. Examples of stopper surfaces 18, 19 are shown in fig. 5 and 6a.

In an embodiment seen in fig. 6a, the axel ends each comprises two essentially parallel holding surfaces 40 mating with two essentially parallel side surfaces 41 in the mounting recess 8 for locking the axel 3 against rotational movement and sideways movement.

As can be seen in fig. 2, 3 and 4, the mecanum wheel further comprises a locking ring 9 on each side of the peripheral wheel plane of the mecanum wheel. The purpose of the locking ring is to provide a rebounding roller retaining structure 6, see fig. 9, 10 and 11, for preventing unintended release of the rollers 2 in directions not being locked by the respective mounting unit recesses 8 interacting with the respective axel ends 7 of the axel 3. The axel end 7 of the axel 3 is held in position on the mecanum wheel by a mounting recess and a rebounding roller retaining structure 6 at least partly blocking the insertion path 28 of the axel end 7 when the locking ring 9 is fastened to the mecanum wheel 1 as seen in fig 7 and 8. In other words the rebounding roller retaining structure 6 is blocking at least partly the extraction of the axel end 7 from the mounting recess 8. The mentioned arrangement causes resistance when the axel end 7 is pushed or pulled past the roller retaining structure 6 into, and out from, a resting position in the mounting recess 8, thus preventing unintended release of the roller 2 along the insertion path 28 in a substantially radially outward direction.

Fig. 3, 9, 10 and 11 shows embodiments of the locking ring 9. The locking ring comprises fastening means 35 for fastening the locking ring to the wheel frame 5. The fastening means 35 may comprise a click-on arm 35 interacting with a frame gripping structure 37 like a recess as seen in fig. 4 and 10 or an edge as seen in fig. 11. In another embodiment the fastening means may comprise screws or bolts.

As previously mentioned, each of the two locking rings 9 comprises a rebounding roller retaining structure 6 for each roller 2 on the mecanum wheel 1. In an embodiment, the rebounding roller retaining structure 6 comprises a resilient lip 32 protruding from the locking ring 9, the lip being positioned at least partly inside each insertion path 28 of the respective axel ends 7 when the locking ring 9 is fastened to the mecanum wheel 1. In other words the lip 32 is blocking at least

partly the extraction of the axel end 7 from the mounting recess 8 as can be seen in fig 7 and 8.

In an embodiment seen in fig. 9, the rebounding roller retaining structure 6 comprises a deflective arm 15 protruding from the locking ring 9, the deflective arm 15 being positioned at least partly inside each insertion path 28 of the respective axel ends 7 when the locking ring 9 is fastened to the mecanum wheel 1. The deflective arm may comprise a finger grip 20 for easy removal of the roller.

In an embodiment seen in fig. 10 the rebounding roller retaining structure 6 comprises a protrusion 34 made of a resilient material and being shaped to be at least partly inside each insertion path 28 of the respective axel ends 7 when the locking ring 9 is fastened to the mecanum wheel 1.

Preferably, it is possible to insert and remove the roller 2 without any other action being necessary like e.g. pushing or pulling a grip, button or handle. This is most easily achieved by a rebounding roller retaining structure 6 at least partly positioned inside the mounting recess 8 or opening 14 or just outside the mounting recess or opening 14 in a manner such that the rebounding roller retaining structure 6 exerts a holding force on the axel end 7 when the axel end is in its resting position in the mounting recess 8 as shown in fig. 7 and 8. This is equivalent to the roller retaining structure being positioned in an insertion path 28 of the respective axial ends 7. Embodiments of an insertion path 28 is indicated by dotted lines shown in fig. 6b. The insertion path is the path the respective axel ends 7 follows when inserted into the respective recesses 8 and comprises the recess itself and the opening 14. Preferably, the mounting recess 8, the axel end 7 and the rebounding roller retaining structure 6 is configured such that the axel ends 7 are guided by the mounting recess 8 when the axel end is at the vertical position touching the rebounding roller retaining structure. In a preferred embodiment the lower part of the axel end 7 is rounded in order to ease deflection of the rebounding roller retaining structure 6 when the roller 2 is inserted into the mounting recesses 8. The rounded lower part of the axel ends combined with the previously described embodiment comprising parallel side surfaces 41 of the recess mating with parallel holding surfaces 40 on the axel ends 7 provides a distinct U-shape of the cross section of the mounting recess 8 and axel ends 7.

In an embodiment seen in fig. 5, the axel end 7 have an angled surface 33 inclined towards the center of the mecanum wheel as it extends outwards towards an end surface 34 of the axel 3. This feature is advantageous because it provides distance between the floor on which the mecanum wheel moves, and the rebounding roller retaining structure 6. The angled surface also enables the roller retaining structure 6 to more easily slide off the axel end 7.

The purpose of the rebounding roller retaining structure 6 is to provide a resistance when forces are pushing/pulling the roller in or out of the mounting unit recesses 8. The rebounding roller retaining structure 6 can obtain its rebounding characteristics by a deflective arm or a flexible material as described above. It is also conceivable with a structure pretensioned by a spring (not shown). The force needed to counteract the rebounding roller retaining structure 6, compressing the flexible material or bending the deflective arm combined with frictional forces will provide the resistance needed to hold the roller 2 in position.

It is possible to use such simplified and minimized features, as described above, for holding the rollers in position because there are no substantial forces acting on the rollers in a radially outward direction during normal use. The technical effect of the invention is that the rollers can be substantially faster replaced when needed. The invention puts a limit to the velocity the wheels can operate under due to centrifugal forces, but mecanum wheels do not operate at high velocities.

In a preferred embodiment seen in fig. 4, the locking ring 9 comprises a ring guiding structure 39 mating with a ring guiding slot 36 on the wheel frame 5 for securing correct rotational position of the locking ring 9.

In an embodiment shown in fig. 5 and 6a and b, the axial stopper surface 18 is a substantially vertical surface on each side of the axel end 7 stopping against a vertical stopper surface on the inner side of the mounting recess 8 constituting the mounting recess stopper surface 19 on the mounting recess 8. The mentioned stopper surfaces are essentially perpendicular to the axis of the roller.

The locking ring 9 may be made of a plastic product or a metal or metal alloy. In a preferred embodiment the locking ring is casted in a plastic product. However, for heavy duty versions a locking ring 9 of metal might be preferable. The embodiment shown in fig. 11 is suited for being produced from a material comprising a metal or metal alloy.

Removal of the roller 2 can be done symmetrically with both axial ends moving in parallel and with no action needed except from applying a force on the roller in a radial direction outward. The roller may then be removed by a robotic arm or tool clutching a gripping formation 38 on each axial end 7 as indicated in fig 5.

Figure 14 shows a rolling device 30 for movement along a surface comprising a mecanum wheel 1 according to the invention. Several rolling devices can be linked together. Each rolling device 30 comprises in some embodiments driving means, communication means, and sensors for autonomous operation when controlled by a central controller unit.

The rolling device 30 may comprise a control unit for controlling the rolling device. The control unit can receive control signals for operation of the first and/or second drive motor from a remote control, computer, cell phone or by voice-activation. It is also possible that the control unit comprises software for autonomous control of the rolling device.

The rolling device 30 may comprise or be arranged in a housing 31. The housing may be arranged to enclose some of, all or most of the parts of the rolling device, such as wheel axle, the wheel, the motor and possibly means for extending and retracting the wheel. The rolling device may be arranged in the housing 31in such a way that in the extended position at least a portion of the wheel 1 projects outside the housing 31.

Inventory

1 Mecanum wheel
2 Roller
3 Axel
4 Rolling surface
5 Wheel frame
6 Rebounding roller retaining structure
7 Axel end
8 Mounting recess
9 Locking ring
10 Bearing
14 Opening
15 Deflective arm
17 U-shape structure
18 Axial stopper surface
19 Mounting recess stopper surface
20 Finger grip
23 End surface of the axel
28 Insertion path
30 Rolling device
31 Housing
32 Lip
33 Angled surface of axle end
34 Protrusion
35 Fastening means / click-in arm
36 Ring guiding slot
37 Gripping structure for fastening means
38 Gripping formation

39 Ring guiding structure
40 Holding surfaces on axel ends
41 Side surfaces of recess

CLAIMS

1. A mecanum wheel (1) comprising:

a plurality of rollers (2) each with a rolling surface (4) rotating around an axel (3) with axel ends (7) protruding from each side of the rolling surface in the longitudinal direction of the roller (2),

a wheel frame (5) for mounting the rollers (2) comprising:

a mounting recess (8) for each axel ends, each mounting recess having an opening (14) for inserting an axel end (7), wherein the mounting recess (8) interacts with the respective axel end (7) for locking the axel (3) against movements in sideways and radially inward directions of the mecanum wheel and in axial directions of the roller,

characterized by a locking ring (9) on each side of the mecanum wheel, the locking ring comprising:

fastening means (35) for releasably fastening the locking ring to the mecanum wheel,

a rebounding roller retaining structure (6) at least partly blocking extraction of respective axel ends (7) from the mounting recesses (8) causing resistance when the axel end (7) is pushed or pulled past the roller retaining structure (6) into, and out from, a resting position in the mounting recess (8), for preventing unintended release of the roller (2) in substantially a radially outward direction of the mecanum wheel.

2. Mecanum wheel according to claim 1, wherein the rebounding roller retaining structure (6) comprises a resilient lip (32) protruding from the locking ring (9), the lip at least partly blocking extraction of the respective axel ends (7) from the mounting recesses (8) when the locking ring (9) is fastened to the mecanum wheel (1).

3. Mecanum wheel according to claim 1, wherein the rebounding roller retaining structure (6) comprises a deflective arm (15) protruding from the locking ring (9), the deflective arm (15) at least partly blocking extraction of the respective axel ends (7) from the mounting recesses (8) when the locking ring (9) is fastened to the mecanum wheel (1).

4. Mecanum Wheel according to any of the preceding claims, wherein the axel end (7) have an angled surface (33) inclined towards the center of the mecanum wheel as it extends towards an end surface (34) of the axel (3).

5. Mecanum Wheel according to any of the preceding claims, wherein the axel (3) comprises an axial stopper surface (18) essentially perpendicular to the axial axis of axel (3) at each axel end (7) and the mounting recesses (8) each comprises a stopper surface (19) essentially perpendicular to the axial axis of the axel interacting with the axial stopper surface (18) for locking the axel (3) against movements relative to the wheel frame (5) in directions along the axis of the roller (2).

6. Mecanum Wheel according to any of the preceding claims, wherein the axel ends each comprises two essentially parallel holding surfaces (40) mating with two parallel side surfaces (41) in the mounting recess (8) for locking the axel against rotational movement and sideways movement.

7. Mecanum wheel according to any of the preceding claims, wherein the fastening means (35) comprises a plurality of click-in arms (35) arranged to click into mating gripping structures (37) on the wheel frame (5).

8. Mecanum wheel according to any of the preceding claims, wherein the locking ring comprises a ring guiding structure (39) mating with a ring guiding slot (36) on the wheel frame (5) for securing correct rotational position of the locking ring (9)

9. Mecanum wheel according to any of the preceding claims, wherein the axel ends (7) have gripping formation (38) for gripping with an extraction tool for removal of the roller from the mecanum wheel (1).

10. Mecanum wheel according to any of the preceding claims, wherein the mounting recess (8) is a U-shape structure (17) for receiving the axel end (7).

11. Mecanum wheel according to any of the preceding claims, wherein the deflective arm (15) is provided with a finger grip (20) to ease manual release of the roller (2).

12. A rolling device (30) for movement along a surface wherein the rolling device comprises:
- a housing (31) arranged for attachment to the device (30),
- a mecanum wheel (1) according to any of the preceding claims,
-driving means.

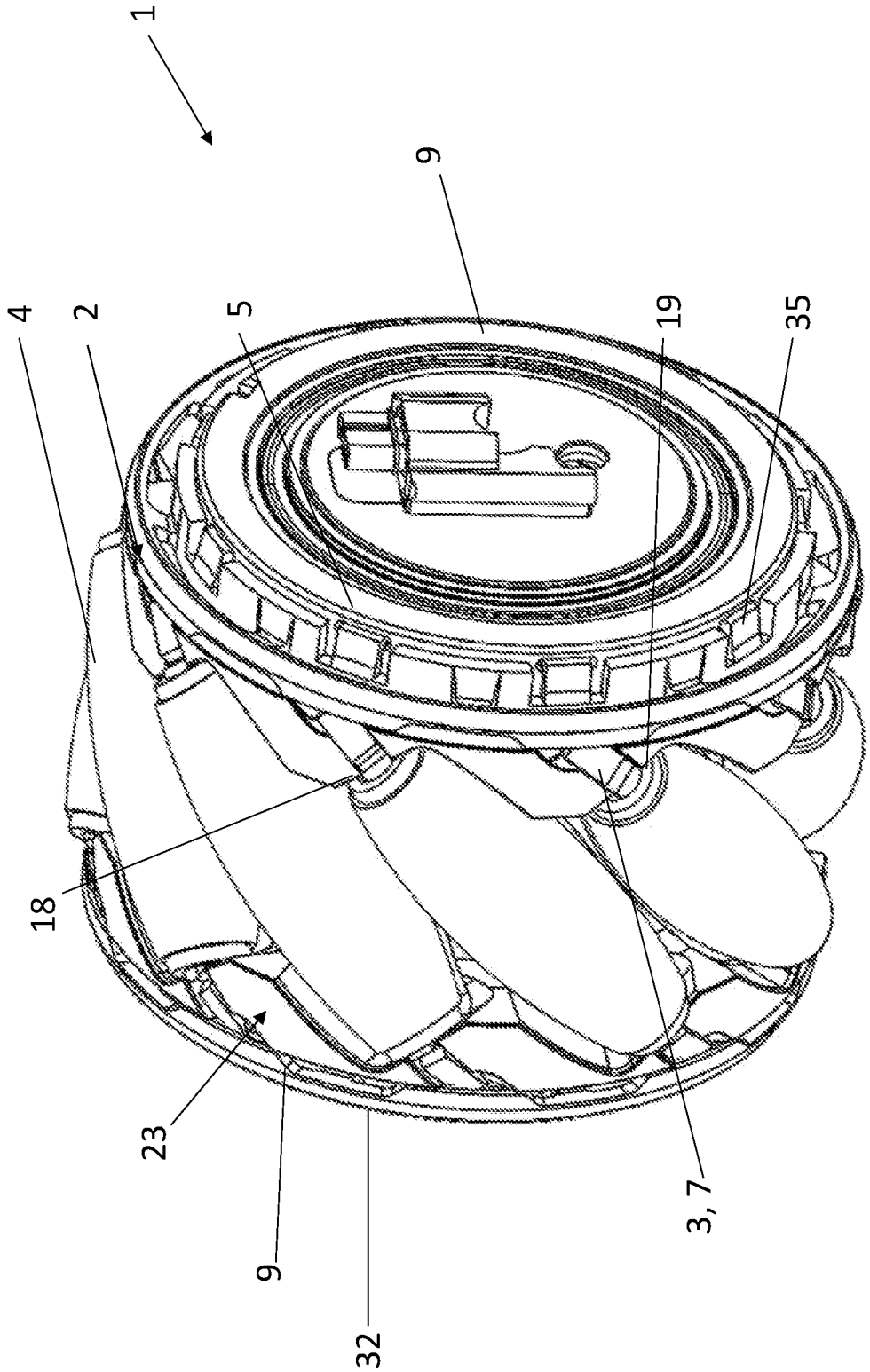

Fig. 1

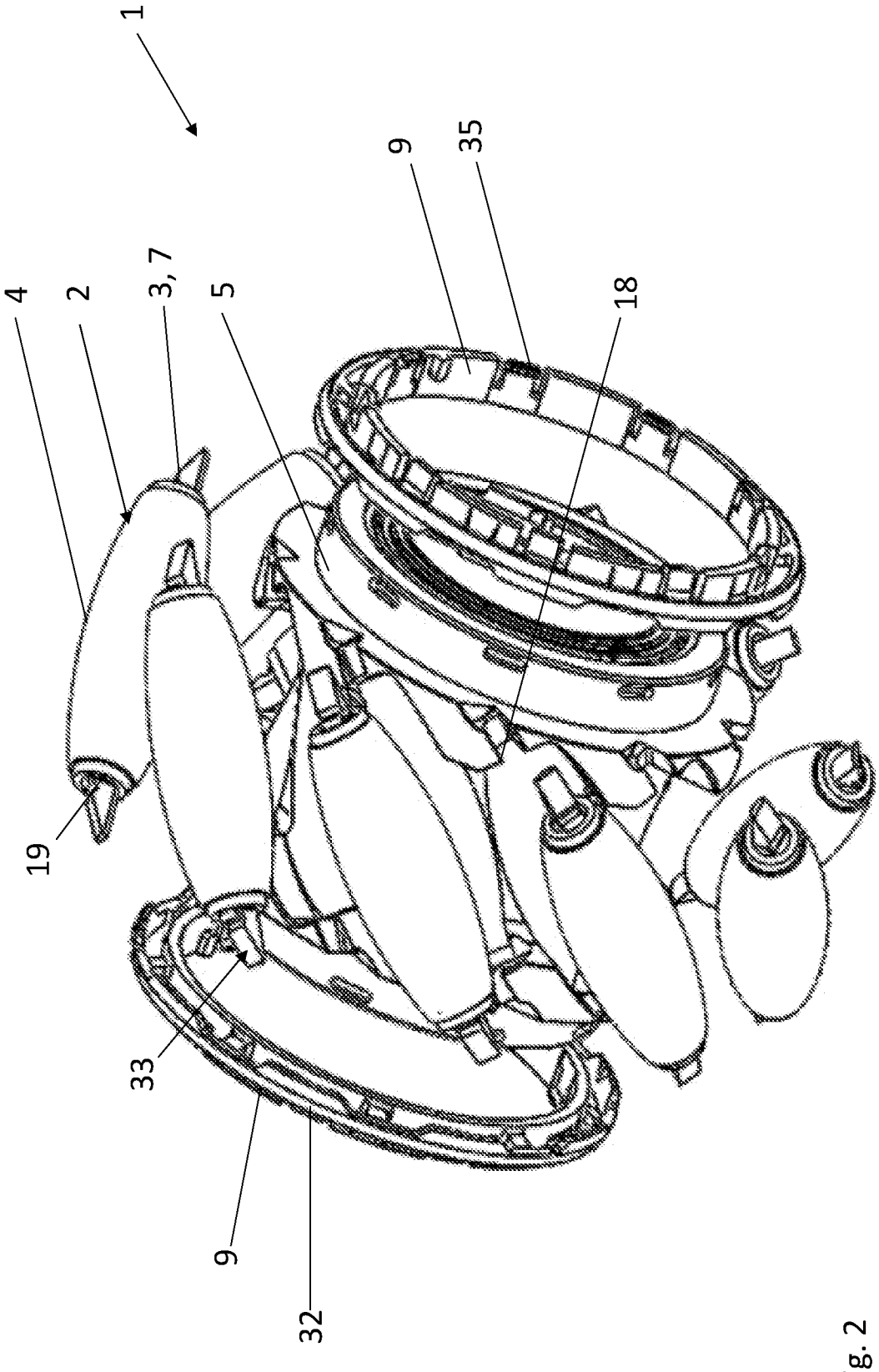

Fig. 2

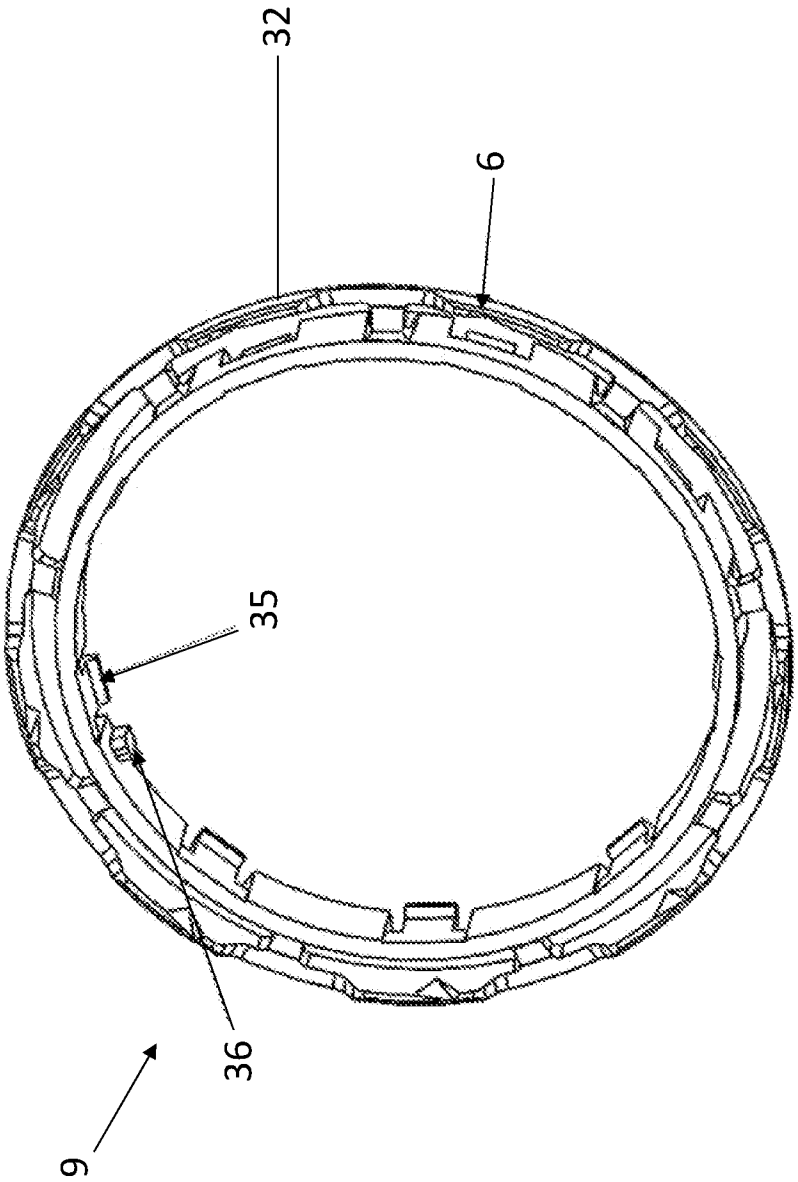

Fig. 3

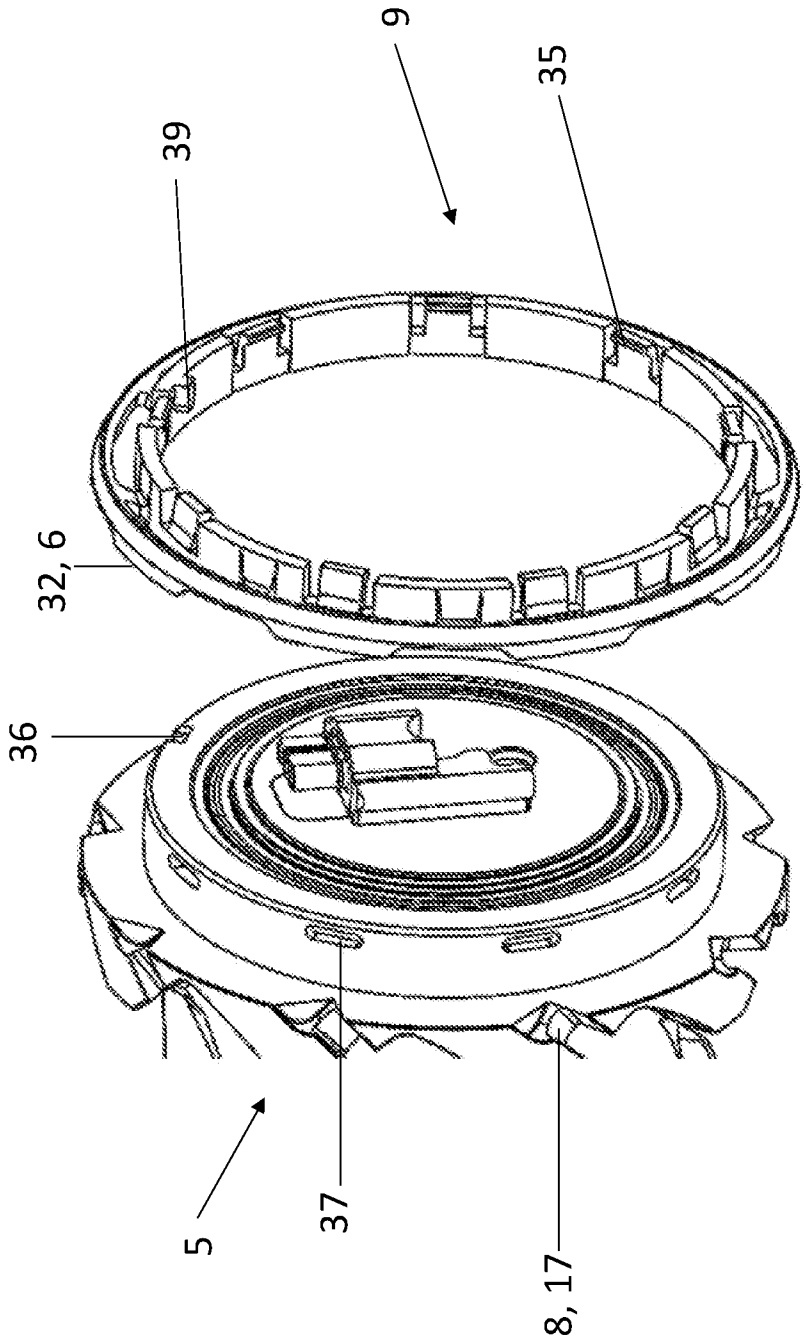

Fig. 4

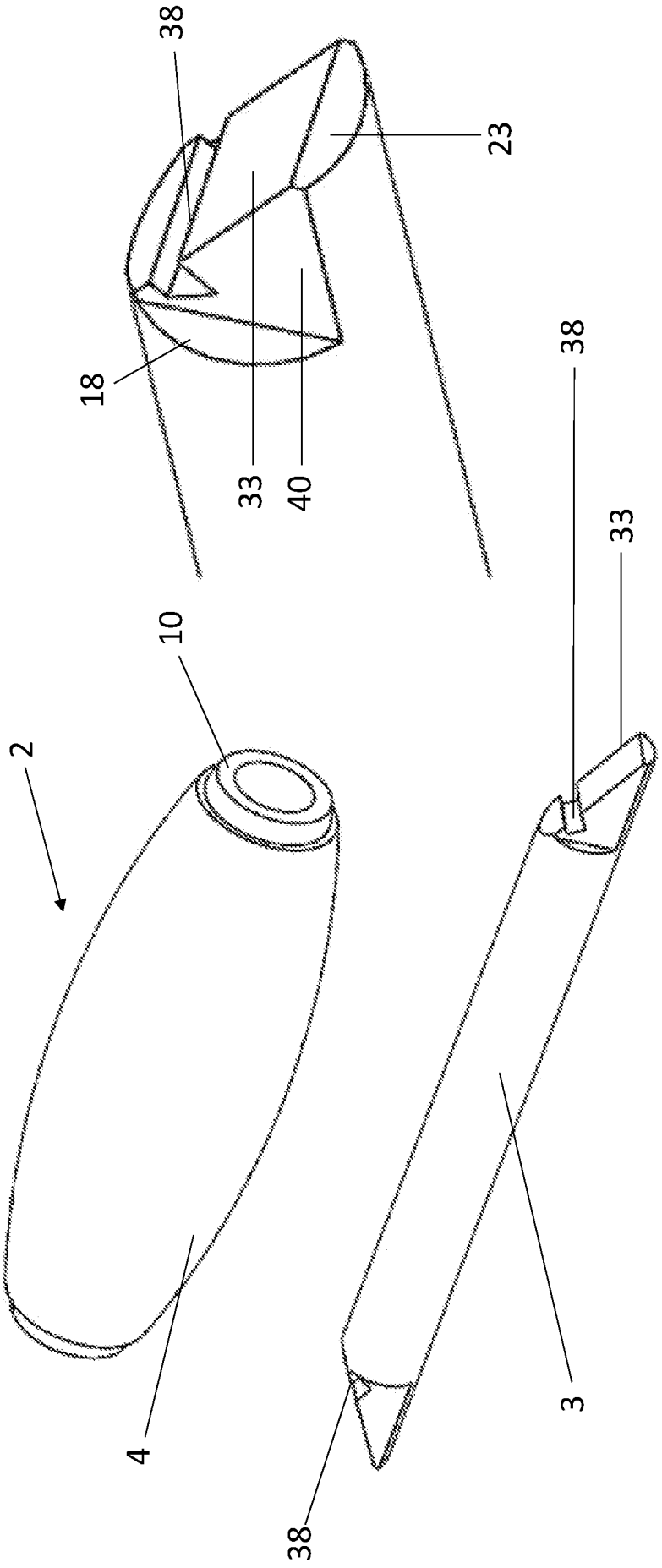

Fig. 5

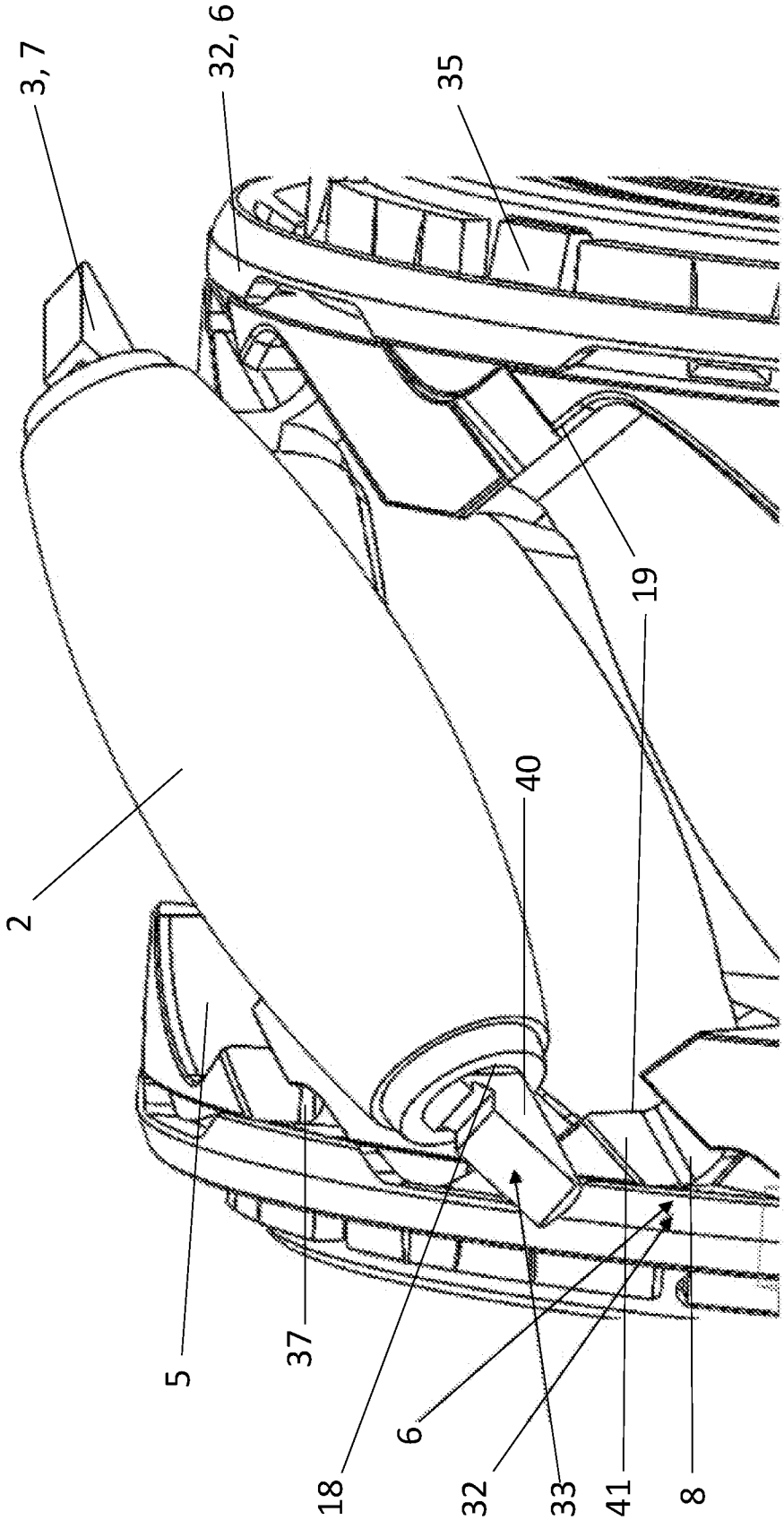

Fig. 6a

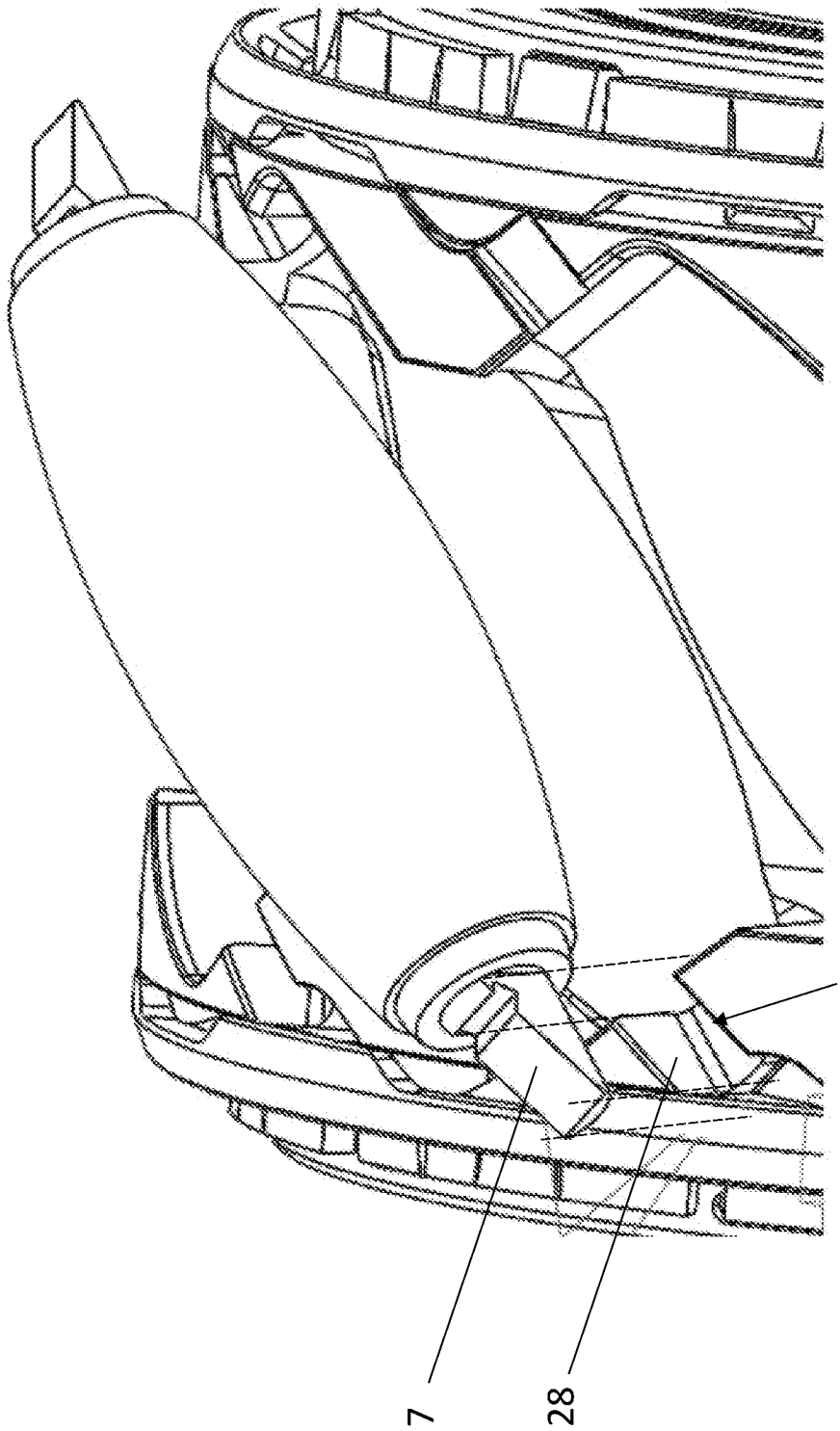

Fig. 6b

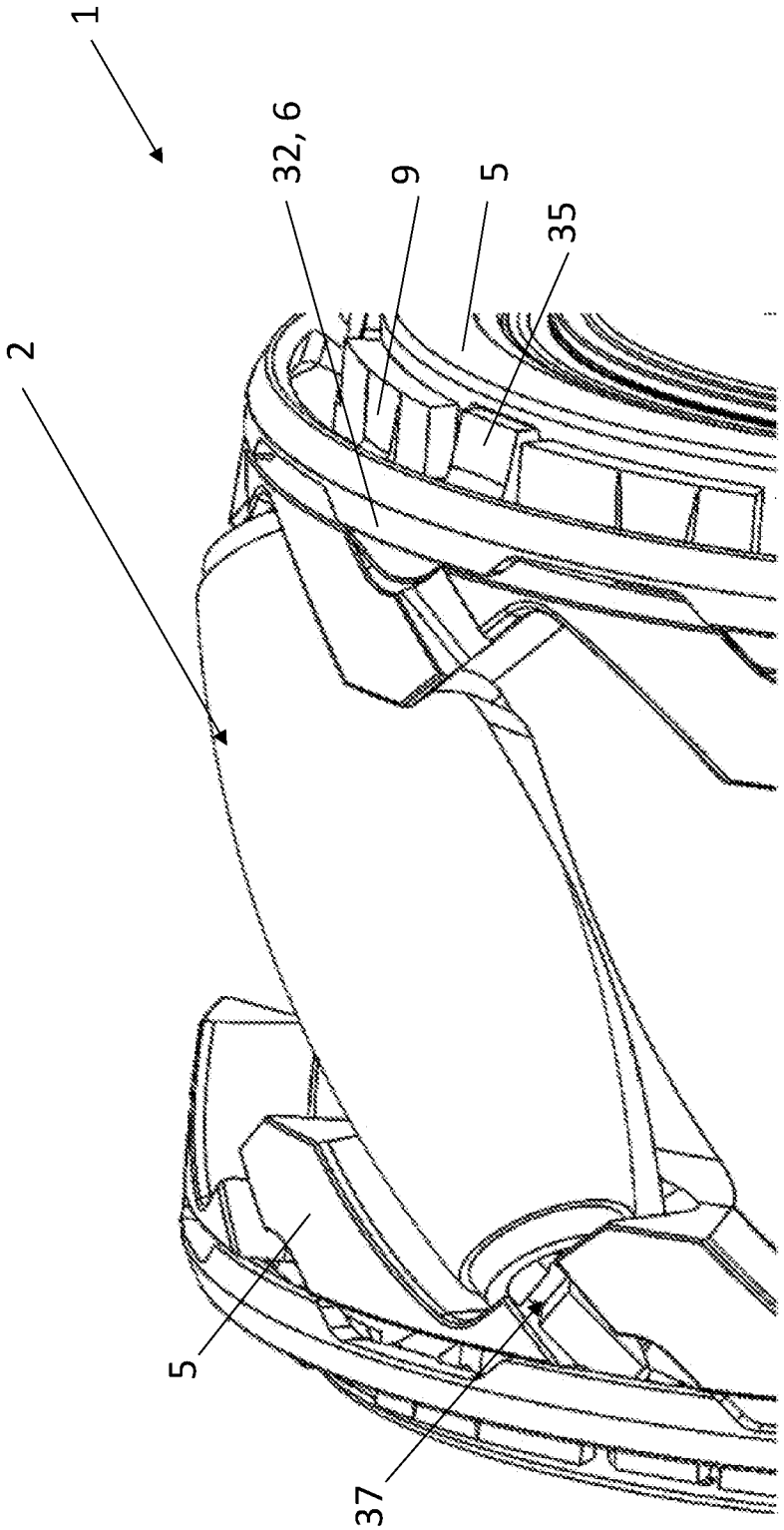

Fig. 7

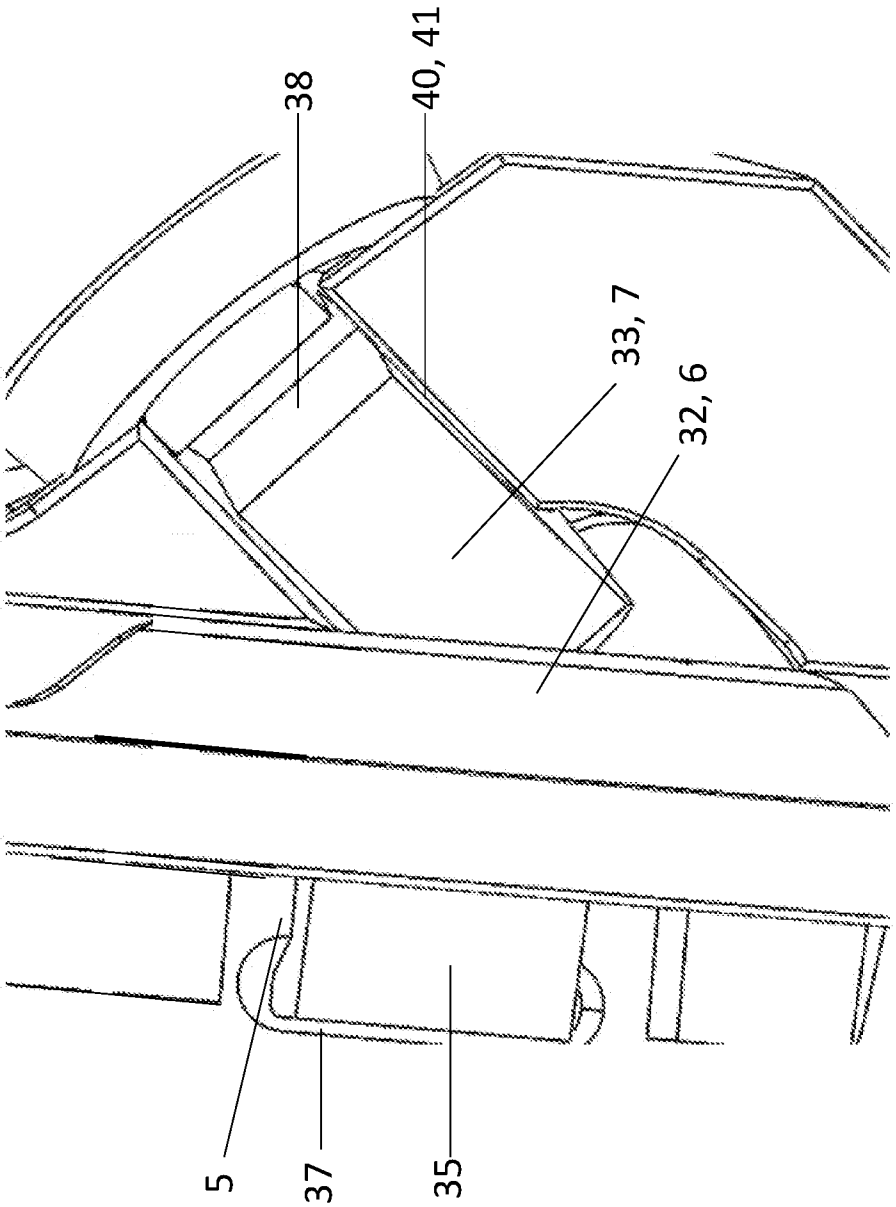

Fig. 8

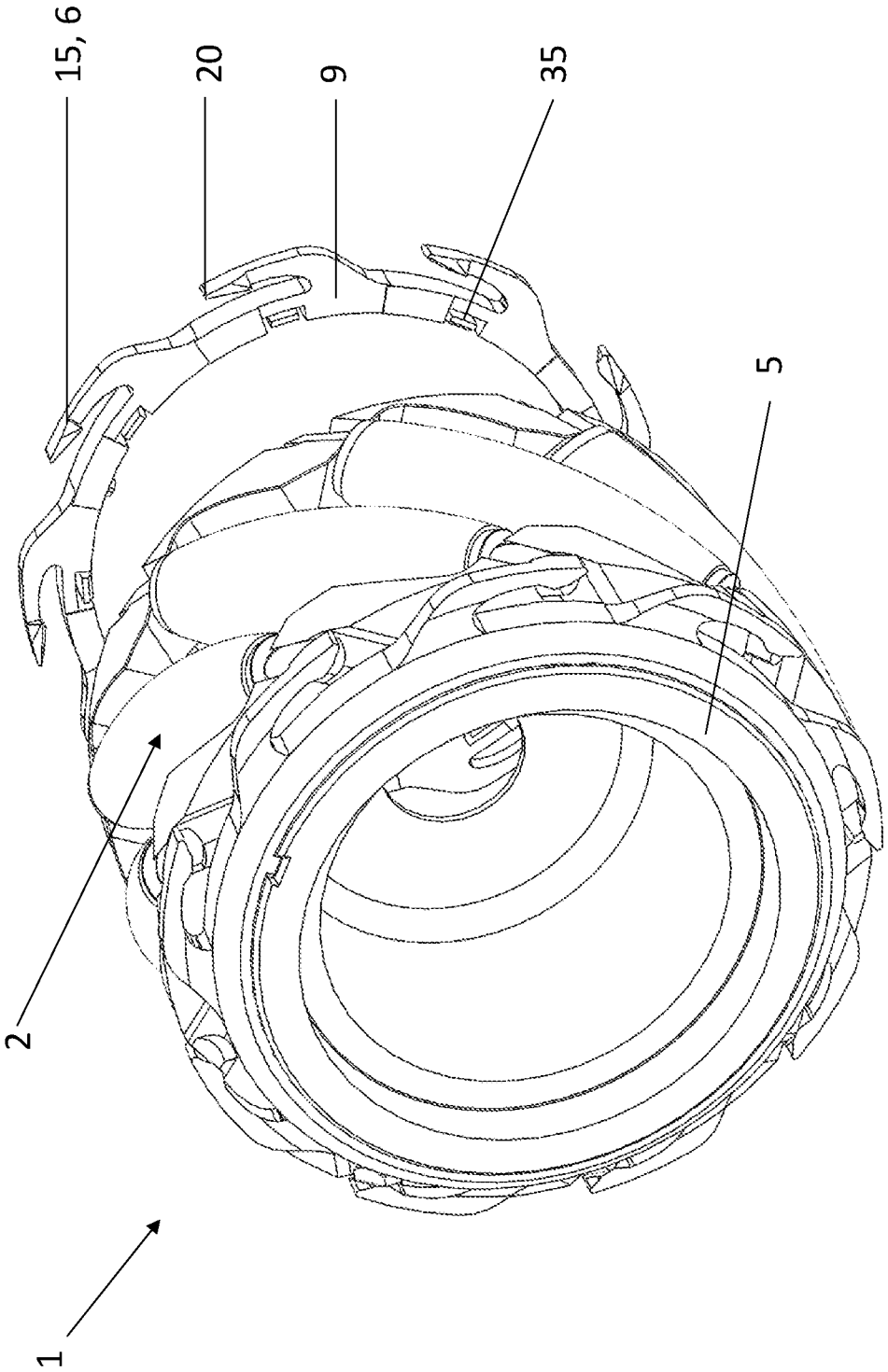

Fig. 9

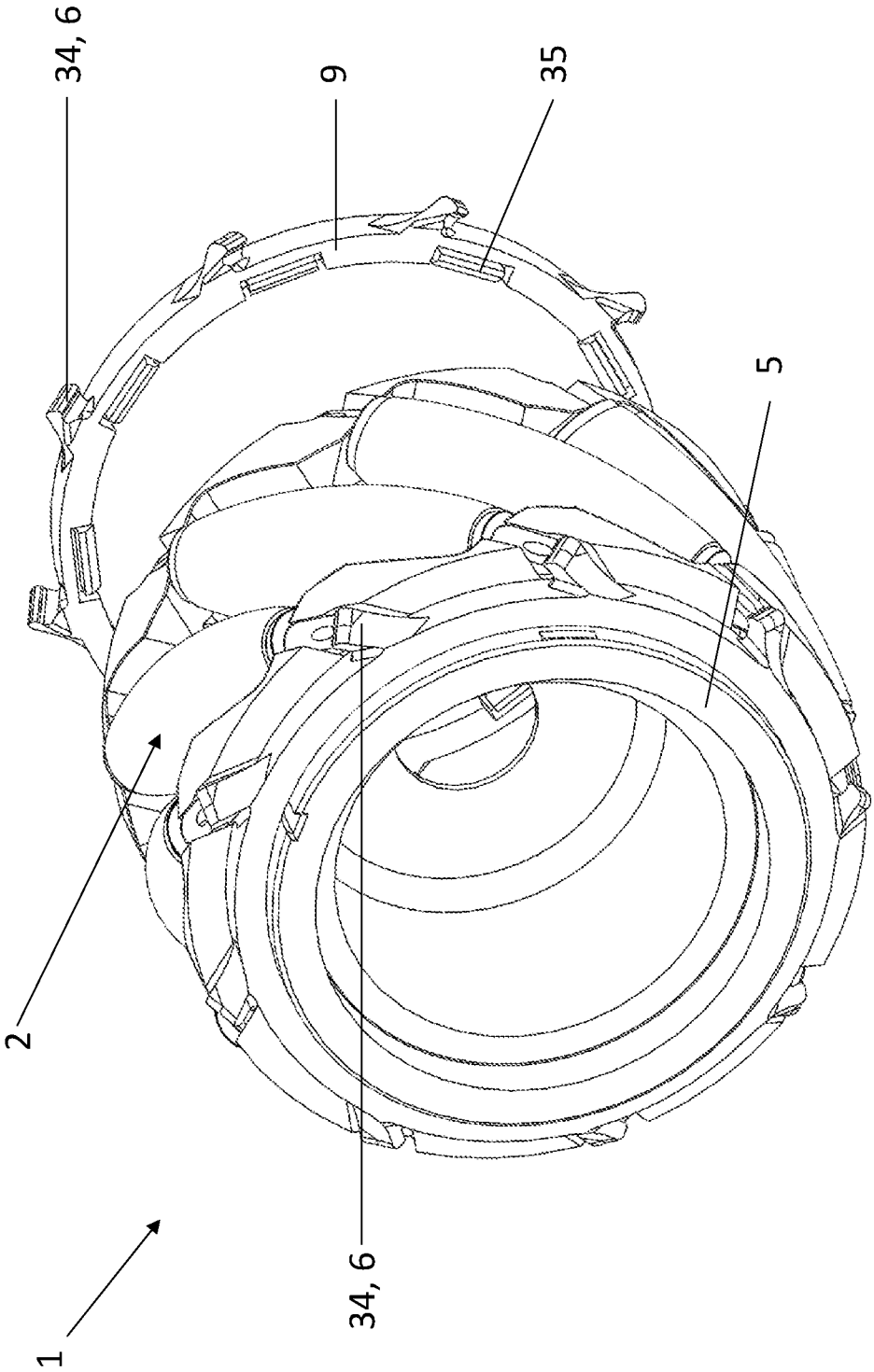

Fig. 10

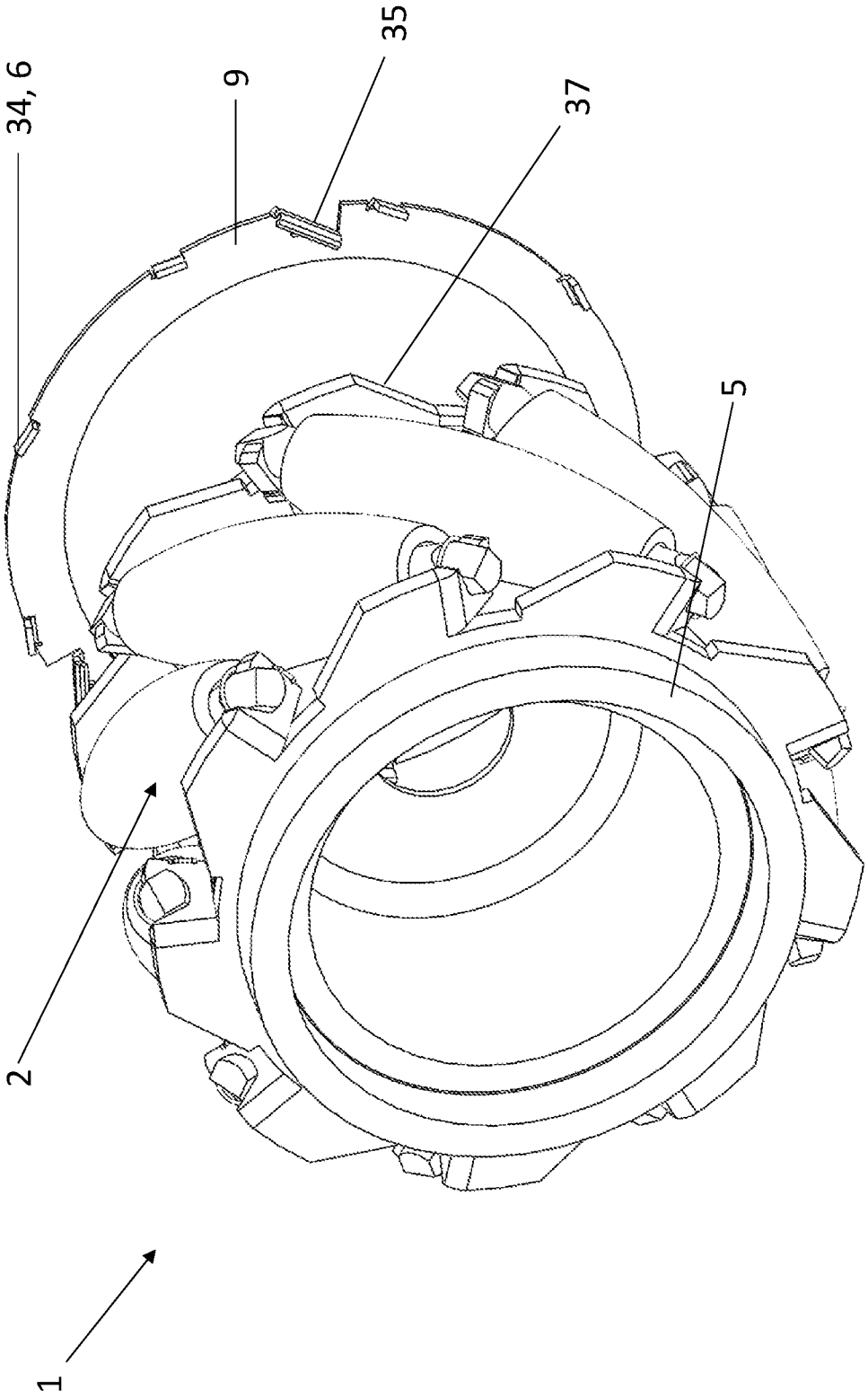

Fig. 11

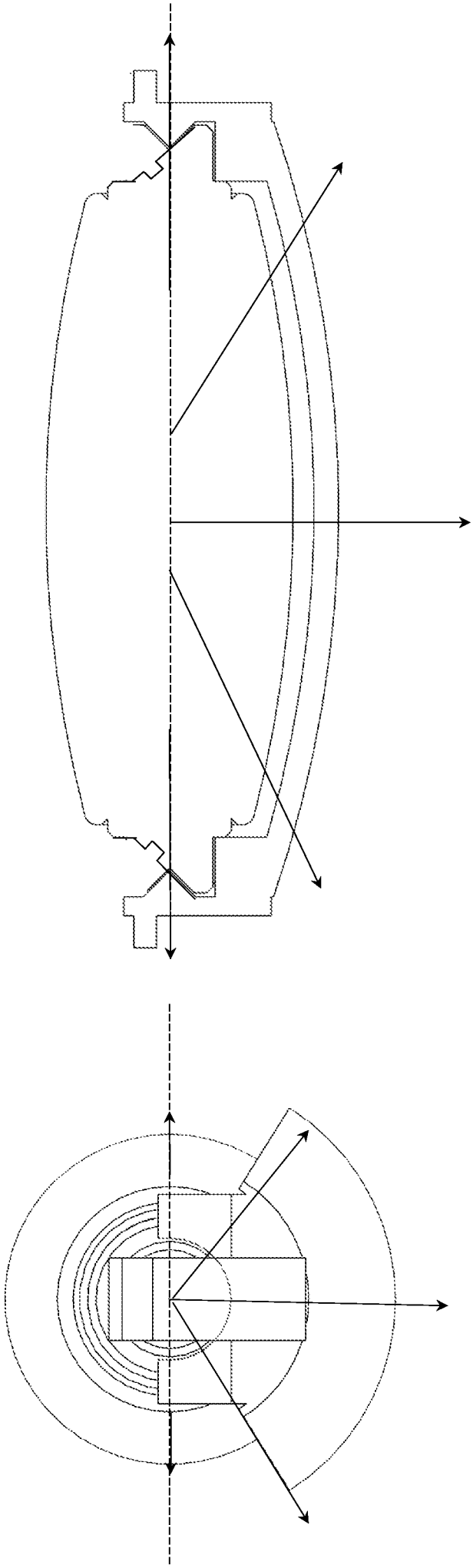

Fig. 12

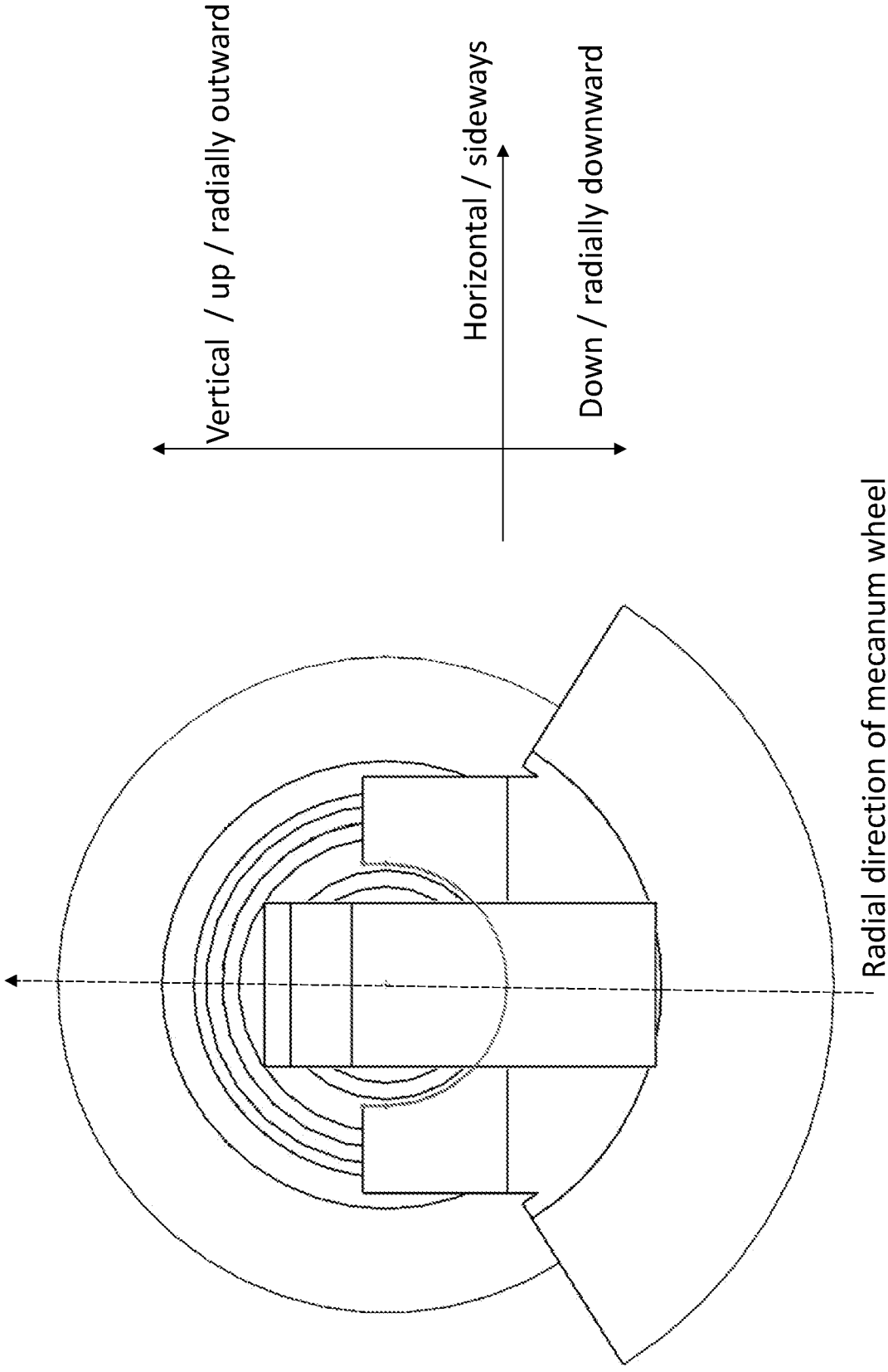
Vertical / up / radially outward
Horizontal / sideways
Down / radially downward
Radial direction of mecanum wheel

Fig. 13

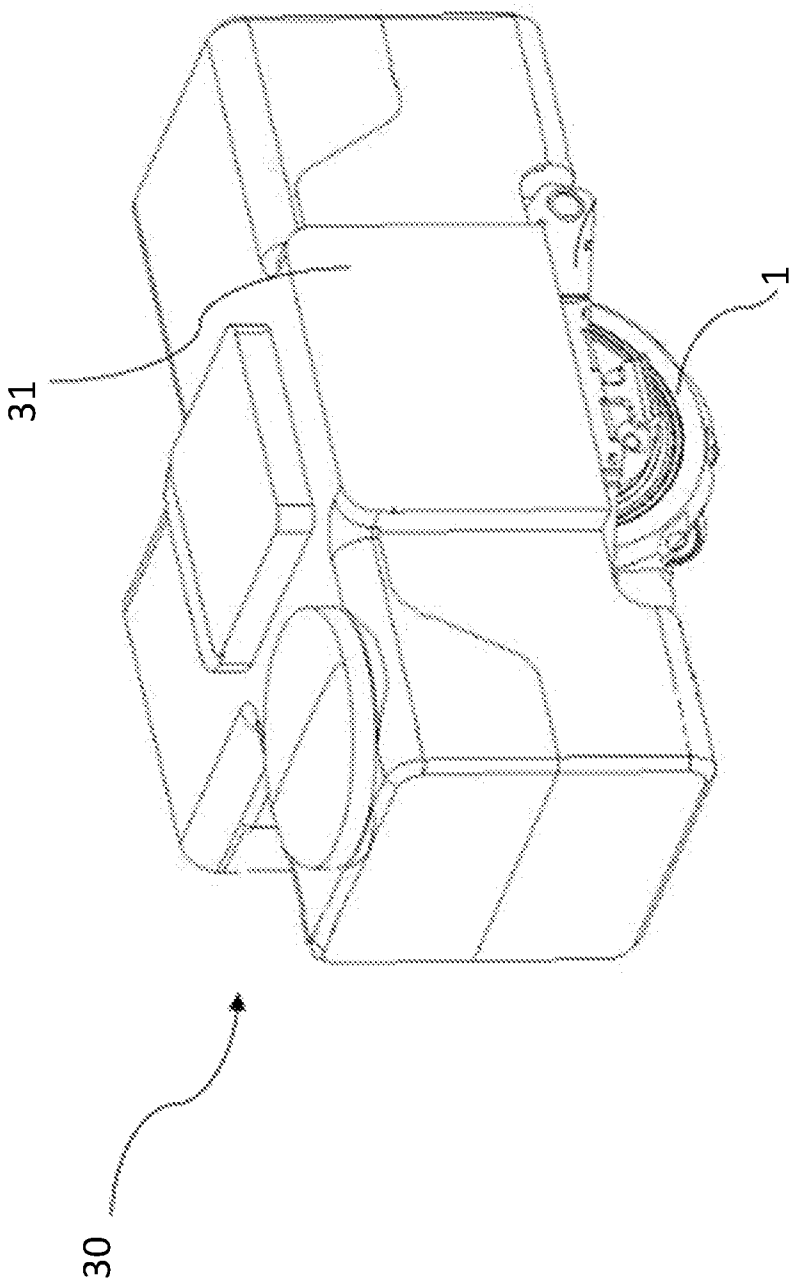

Fig. 14