

(43) International Publication Date
28 August 2014 (28.08.2014)(51) International Patent Classification:
E21B 23/14 (2006.01)(21) International Application Number:
PCT/EP2014/053434(22) International Filing Date:
21 February 2014 (21.02.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13156273.8 22 February 2013 (22.02.2013) EP

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

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(54) Title: ELECTRICAL WHEEL ASSEMBLY

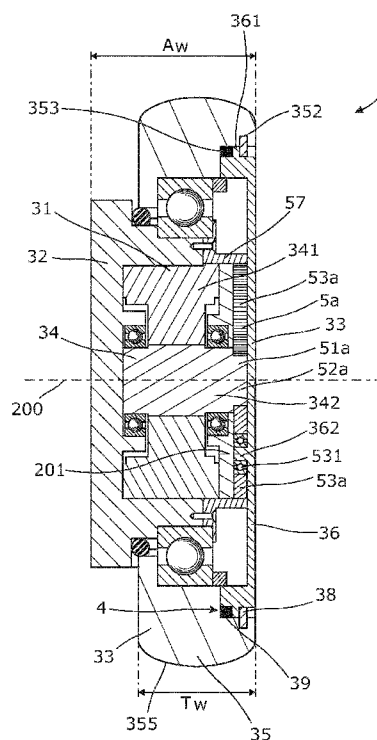


Fig. 4

(57) Abstract: The present invention relates to a downhole electrically driven driving unit, e.g. powered by a battery, for insertion into a well or borehole. The downhole driving unit comprises a driving section comprising a driving section housing and a plurality of wheel assemblies 35 coupled to the driving section housing and adapted to extend from the driving section housing to contact an inner wall of the well. Each of the wheel assemblies 35 comprises a motor housing defined by a fixed stationary part 341 and a rotational part 342 configured for rotation, and an electrical motor arranged in the motor housing for driving the rotational part 342, wherein a section of the rotational part constitutes a wheel 33 and the wheel assembly 35 comprises only one dynamic sealing 4 provided between the fixed stationary part and the rotational part, the dynamic sealing being configured for sealing the motor housing to prevent ingress of well fluids.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, **Published:**
KM, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted
a patent (Rule 4.17(ii))*

ELECTRICAL WHEEL ASSEMBLYField of the invention

The present invention relates to a downhole electrically driven driving unit, e.g.
5 powered by a battery, for insertion into a well or borehole, comprising a driving
section comprising a driving section housing, and a plurality of wheel assemblies
coupled to the driving section housing. The invention furthermore relates to a
downhole system comprising the downhole electrically driven driving unit and to
the use of the downhole electrically driven driving unit for moving the driving unit
10 itself and/or an operational tool forward in the well or borehole.

Background art

When operating downhole driving units, such as downhole tractors, the ability of
15 the driving unit to convert hydraulic or electrical power into propulsion is of
crucial importance. When downhole driving units rely on wheels as their means
for moving, traction between the wheels and the inside wall of the casing or the
wall of the borehole may have a great effect on the conversion of electrical power
into propulsion of the driving unit. In this regard, it may be desirable to be able
20 to modify the traction properties of the wheels to match specific conditions
downhole.

Depending on the type of downhole operation, different requirements may exist
in relation to the propulsion provided by the downhole driving unit. In some types
25 of operations, it may be desirable to be able to drive at a relatively high speed if
for example a downhole tool has to be moved deep into a well. In other types of
operations, the ability of the downhole driving unit to provide a significant
pushing or pulling force may be of greater importance than speed. Accordingly, it
may be desirable to be able to modify the speed and torque characteristics of the
30 downhole driving unit. It may further be advantageous to be able to tailor the
downhole driving unit during production and/or perform post production
modification of the downhole driving units.

At the same time, downhole conditions constrain the available amount of space,
35 and the maximum diameter of downhole tool may not exceed a certain threshold.

Accordingly, the design of downhole tools has to be very compact, and downhole tools are often constructed in such a way that the tools may be compressed by parts of the tools being extendable and retractable downhole. Hereby, space obtained by the downhole tools and the maximum diameter of the downhole tools may be adjusted according to specific requirements in different sections of a well. With these constraints in mind, it is not possible to endlessly increase the size of the wheel or the number of wheels of a downhole driving unit to modify the traction properties.

Further, the design of downhole driving units must be adapted to the harsh environment downhole. Especially the ingress of well fluids into some parts of a downhole driving unit is undesirable. In this regard, factors such as the pressure downhole and the existence of various types of well fluid, including corrosive and abrasive fluids, have to be considered when designing seals capable of preventing or reducing the ingress of well fluid. In particular, the sealing between a stationary and a moving component, also known as a dynamic sealing, is a weak spot in the design of downhole driving units. Accordingly, in order to reduce the risk of ingress of well fluids into a downhole driving unit, it may be advantageous to reduce the number of seals, especially dynamic seals, utilised in a downhole driving unit.

A downhole driving unit is known from US 6,273,189. However, tests have shown that this type of construction cannot withstand the harsh environment downhole as ingress of well fluid into the electrical motor occurs, causing the motor and the gear to clot and malfunction, and thus the wheel may get stuck.

Summary of the invention

It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved downhole driving unit with a reduced number of seals.

A further object is to provide an improved downhole driving unit wherein the potential contact area between a wheel ring and an inner wall of the well (in the following denoted as the traction surface area) is increased in relation to the total width of the wheel.

A still further object is to provide a downhole driving unit wherein the speed and torque characteristics of the downhole driving unit may be modified or altered according to specific requirements without substantially changing the design of the downhole driving unit.

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The above objects, together with numerous other objects, advantages and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a downhole electrically driven driving unit, e.g. powered by a battery, for insertion into a well or borehole, comprising a driving section comprising:

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- a driving section housing, and
- a plurality of wheel assemblies coupled to the driving section housing and adapted to extend from the driving section housing to contact an inner wall of the well, each of the wheel assemblies comprising:

15

- a motor housing defined by a fixed stationary part and a rotational part configured for rotation, and
- an electrical motor arranged in the motor housing for driving the rotational part,

20

wherein a section of the rotational part constitutes a wheel and the wheel assembly comprises only one dynamic sealing provided between the fixed stationary part and the rotational part, the dynamic sealing being configured for sealing the motor housing to prevent ingress of well fluids, and

25

wherein the electrical motor comprises an outer stator part and an inner rotor part, and the downhole electrically driven driving unit further comprises a gearing system arranged in the motor housing, the gearing system being coupled to the rotor part and to the rotational part, wherein the gearing system is a planetary gearing system.

The electrical motor may be a step motor.

30

By using a step motor, the propelling direction of the downhole driving unit can be changed so that the downhole driving unit can drive back and forth in the well.

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Moreover, the wheel may have a traction surface area which is a continuous contact surface for contacting a wall of the well or borehole.

The traction surface mentioned above may constitute at least 50 % of the rotational part.

Further, the rotational part may have a circular part and a circumferential face
5 perpendicular to the circular part and circumferencing the circular part.

Additionally, the circular part and the circumferential face may be fixedly fasten, providing sealed connection therebetween.

10 Also, the traction surface area may be the circumferential face.

Furthermore, the fixed stationary part may be rotationally connected with the rotational part on the opposite site of the circumferential face.

15 The downhole electrically driven driving unit as described above may further comprise a battery for providing electric power.

Also, the downhole electrically driven driving unit may operate wirelessly powered by the battery.

20 Further, the inner rotor part of the electrical motor may rotate by at least 3,500 revolutions per minute.

The rotational part of the motor housing may define a cavity in which the
25 electrical motor is arranged, and the fixed stationary part of the motor housing may close the cavity by the dynamic sealing arranged therebetween.

Additionally, the electrical motor may be connected to the fixed stationary part of the motor housing.

30 By providing only one sealing between a fixed part and a rotating part, compared to designs using multiple seals between fixed and rotating parts, the risk of ingress of well fluids into the motor housing is reduced. In the context of the present invention, a sealing provided between a fixed part and a rotating or
35 otherwise moving part is considered a dynamic sealing and referred to as such. Seals providing a sealing relationship between mutually fixed parts are thus not considered dynamic seals in the context of the invention. A further advantage is

that maintenance and replacement of the sealing are faster compared to driving units utilising wheel constructions provided with a plurality of seals.

Furthermore, the dynamic sealing may comprise a sealing member, such as an elastomeric seal, an O-ring, a spring-energised seal or a PTFE spring-energised seal.

Moreover, the inner rotor part may rotate inside the outer stator part.

By providing a gearing system, the speed and torque characteristics of the downhole driving unit may be better controlled.

In addition, the planetary gearing system may comprise a sun gear coupled to the inner rotor part of the electrical motor, a plurality of planet gears rotatably mounted on a face of the rotational part facing towards the motor housing and meshing with the sun gear, and a stationary ring gear fixedly connected with the stationary part of the motor housing and meshing with the planet gears, whereby rotation of the inner rotor causes the rotational part to rotate.

Also, the gearing system may be a multistage planetary gearing system comprising multiple stages each comprising a sun gear and multiple planet gears.

By increasing gearing ration of the gearing system, defined as the ratio between the rotation of the rotor of the electrical motor and the corresponding rotation of the rotating part, the maximum torqued provided may be increased and the downhole driving unit may provide an increased pushing or pulling force.

In another embodiment, the planetary gearing system may be a double planetary gearing system comprising a first sun gear coupled to the inner rotor part of the electrical motor, a first plurality of planet gears rotatably mounted on one side of a carrier member and meshing with the first sun gear, a second sun gear provided on an opposite side of the carrier member, a second plurality of planet gears rotatably mounted on a face of the rotational part facing towards the motor housing and meshing with the second sun gear, and a stationary ring gear fixedly connected with the stationary part of the motor housing and meshing with the first and second plurality of planet gears, whereby rotation of the inner rotor causes the rotational part to rotate.

Furthermore, a gearing ratio of the gearing system may be between 1:60 and 1:75, preferably about 1:70.

5 Additionally, the rotational part may comprise a circumferential wheel ring provided with a lit part.

By dividing the rotational part into a lit part and a wheel ring, the lit part may be modified to accommodate various configurations of the gearing systems without affecting the design of the remaining parts of the wheel assembly. For example,
10 an extra stage may be added to the gearing system and the lit part may be modified to accommodate this.

Moreover, the planet gears may be rotatably mounted on a face of the rotational part facing towards the motor housing are rotatably mounted on a face of the lit
15 part facing towards the motor housing.

Further, the planetary gearing system may be arranged between the electrical motor and the rotational part.

20 By stacking the planetary gearing system on top of the electrical motor, access to the gearing system is provided by simply removing the lit part. Hereby, the gearing system may be easily maintained, modified or replaced, e.g. to modify or alter the speed and torque characteristics of the downhole driving unit. Further, by arranging the gearing system in continuation of the electrical motor, as
25 opposed to in a position encircling the electrical motor, the total diameter of the wheel assembly may be reduced.

In addition, a traction surface area width of a traction surface area of the wheel may be between 50% and 85%, preferably between 55% and 65%, more
30 preferably about 60% of the total width of the wheel assembly.

In an embodiment, the wheel assembly may be arranged on a wheel arm coupled to the driving section housing, the wheel arm and the wheel assembly being movable between a retracted position, wherein the wheel assembly may be
35 substantially inside the driving section housing, and a projected position, wherein the wheel assembly may be translated away from the driving section housing.

Furthermore, the wheel arm may be coupled to a hydraulic piston arranged in the driving section housing, the hydraulic piston being operable to move the wheel arm between the retracted position and the projected position.

5 The present invention furthermore relates to a downhole system comprising the electrically driven driving unit as described above and an operational tool connected with the driving unit for being moved forward in a well or borehole.

Moreover, the present invention relates to the use of the electrically driven driving unit as described above in a well or borehole for moving the driving unit
10 itself and/or an operational tool forward in the well or borehole.

Further, the invention relates to a downhole electrically driven driving unit for insertion into a well, comprising a driving section comprising:

- a housing, and
- 15 - a plurality of wheel assemblies coupled to the housing, adapted to extend from the housing to contact an inner wall of the well, each of the wheel assemblies comprising:
 - a motor housing,
 - a rotational part constituting a wheel, and
 - 20 - an electrical motor arranged in the motor housing for driving the rotational part,

wherein the wheel assembly further comprises a planetary gearing system arranged in the motor housing, the planetary gearing system being coupled to the electrical motor and to the rotational part.

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In an embodiment, the planetary gearing system may be driven by the electrical motor for driving the rotational part.

In one embodiment of the above-mentioned downhole driving unit, the planetary
30 gearing system may comprise a sun gear coupled to the inner rotor part of the electrical motor, a plurality of planet gears rotatably mounted on a face of the rotational part facing towards the motor housing and meshing with the sun gear, and a stationary ring gear fixedly connected with the stationary part of the motor housing and meshing with the planet gears, whereby rotation of the inner rotor
35 causes the rotational part to rotate.

Additionally, the planetary gearing system may be arranged between the electrical motor and the rotational part.

Also, the gearing system may be a multistage planetary gearing system comprising multiple stages each comprising planet gears and a sun gear.

Furthermore, the planetary gearing system may be a double planetary gearing system comprising a first sun gear coupled to the inner rotor part of the electrical motor, a first plurality of planet gears rotatably mounted on one side of a carrier member and meshing with the first sun gear, a second sun gear provided on an opposite side of the carrier member, a second plurality of planet gears rotatably mounted on a face of the rotational part facing towards the motor housing and meshing with the second sun gear, and a stationary ring gear fixedly connected with the stationary part of the motor housing and meshing with the first and second plurality of planet gears, whereby rotation of the inner rotor causes the rotational part to rotate.

In addition, the rotational part may comprise a circumferential wheel ring provided with a lit part.

Moreover, a traction surface area width of a traction surface area of the wheel may be between 50% and 85%, preferably between 55% and 65%, more preferably about 60% of the total width of the wheel assembly.

Further, the wheel assembly may be arranged on a wheel arm coupled to the driving section housing, the wheel arm and the wheel assembly being movable between a retracted position, wherein the wheel assembly may be substantially inside the driving section housing, and a projected position, wherein the wheel assembly may be translated away from the driving section housing.

Also, the wheel arm may be coupled to a hydraulic piston arranged in the driving section housing, the hydraulic piston being operable to move the wheel arm between the retracted position and the projected position.

The present invention further relates to a downhole driving unit for insertion into a well, comprising a driving section comprising:

- a housing, and

- a plurality of wheel assemblies coupled to the housing, adapted to extend from the housing to contact an inner wall of the well, each of the wheel assemblies comprising:

- a motor housing,
- 5 - a rotational part constituting a wheel, and
- an electrical motor arranged in the motor housing for driving the rotational part,

wherein a traction surface area width of a traction surface area of the wheel is between 50% and 85%, preferably between 55% and 65%, more preferably
10 about 60% of the total width of the wheel assembly.

In an embodiment, the electrical motor may comprise an outer stator part and an inner rotor part.

- 15 In another embodiment, the downhole driving unit may further comprise a gearing system arranged in the motor housing, the gearing system being coupled to the rotor part and to the rotational part.

Furthermore, the gearing system may be a planetary gearing system.

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- In one embodiment of the above-mentioned downhole driving unit, the planetary gearing system comprises a sun gear coupled to the inner rotor part of the electrical motor, a plurality of planet gears rotatably mounted on a face of the rotational part facing towards the motor housing and meshing with the sun gear,
25 and a stationary ring gear fixedly connected with the stationary part of the motor housing and meshing with the planet gears, whereby rotation of the inner rotor causes the rotational part to rotate.

- In another embodiment of the above-mentioned downhole driving unit, the
30 planetary gearing system may be arranged between the electrical motor and the rotational part.

Moreover, the gearing system may be a multistage planetary gearing system comprising multiple stages each comprising planet gears and a sun gear.

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In addition, the planetary gearing system may be a double planetary gearing system comprising a first sun gear coupled to the inner rotor part of the electrical

motor, a first plurality of planet gears rotatably mounted on one side of a carrier member and meshing with the first sun gear, a second sun gear provided on an opposite side of the carrier member, a second plurality of planet gears rotatably mounted on a face of the rotational part facing towards the motor housing and
5 meshing with the second sun gear, and a stationary ring gear fixedly connected with the stationary part of the motor housing and meshing with the first and second plurality of planet gears, whereby rotation of the inner rotor causes the rotational part to rotate.

10 Also, the rotational part may comprise a circumferential wheel ring provided with a lit part.

Additionally, the wheel assembly may be arranged on a wheel arm coupled to the driving section housing, the wheel arm and the wheel assembly being movable
15 between a retracted position, wherein the wheel assembly may be substantially inside the driving section housing, and a projected position, wherein the wheel assembly may be translated away from the driving section housing.

Finally, the wheel arm may be coupled to a hydraulic piston arranged in the
20 driving section housing, the hydraulic piston being operable to move the wheel arm between the retracted position and the projected position.

Brief description of the drawings

25 The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a downhole driving unit in a well comprising suspendedly connected
30 wheel assemblies,

Fig. 2 shows another driving unit in a well comprising wheel assemblies positioned on projectable arms,

35 Fig. 3 shows a close-up of a wheel assembly according to one embodiment of the invention,

Fig. 4 shows a cross-sectional view of the a wheel assembly of Fig. 3,

Fig. 5 shows a cross-sectional view of anther wheel assembly according to one embodiment of the invention,

5

Fig. 6 shows a cross-sectional view of yet another wheel assembly according to one embodiment of the invention, and

Fig. 7 shows a hydraulic piston for moving a wheel arm.

10

All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

15 Detailed description of the invention

Fig. 1 shows a downhole driving unit 1 arranged in a well or borehole 100 in the formation 103, the well being provided with a casing 101 having an inner wall 102. The downhole driving unit 1 is powered through a wireline 9 which is connected with the driving unit via a top connector 12. The downhole driving unit 1 further comprises mode shift electronics 13 and control electronics 14 through which electricity passes before being supplied to an electrical motor 15 which may be driving a hydraulic pump 16. The downhole driving unit 1 shown in Fig. 1 comprises two driving sections 2 each comprising a driving section housing 21 in which wheel assemblies 3 are suspendedly connected. Part of the wheel assembly 3 projects from the driving section housing 21 while the remaining part is arranged in a slot in the driving section housing. The downhole driving unit 1 may comprise a higher or lower number of driving sections than that of the embodiment shown in Fig. 1, and the driving sections may be angled in relation to one another in such a way that the wheel assemblies project in various directions, as shown in Fig. 1.

In continuation of the driving sections 2, a compensating device 17 is provided for compensating the pressure within the driving unit so that a high pressure does not result in the driving unit bulging outwards or collapsing inwards. Further, various other sections and operational tools 8 may be arranged in continuation of the compensation device, whereby a downhole tool or system 11

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is established. The additional sections and/or operational tools 8 may possess different functionalities, enabling the downhole tool to perform various operations downhole. For example, the operational tool 8 may be a stroker tool for providing an axial force in one or more strokes, a key tool for opening or closing valves in the well, a positioning tool such as a casing collar locator (CCL), a milling tool or a drilling tool.

Fig. 2 shows another embodiment of a downhole driving unit 1 comprising driving sections 2 comprising projectable wheel arms 6 carrying wheel assemblies 3. The wheel arms 6 are movable between a retracted position and a projected position in relation to the driving section housing 21 of the driving sections 2. In the retracted position, the wheel assembly is substantially inside the driving section housing, and in the projected position, the wheel assemblies are translated away from the driving section housing. The wheel arms 6 are shown in the projected position, and the wheel assemblies 3 are arranged at an outermost end of the wheel arms 6, extending away from the driving section housing 21. To move the wheel arms 6 carrying wheel assemblies 3, the downhole driving unit comprises hydraulic pistons 7 arranged in the driving section housing, as indicated by the dotted lines in Fig. 2.

Fig. 7 shows one embodiment of a hydraulic piston 7 driven in one direction by the hydraulic pump supplying a hydraulic fluid under pressure to a piston chamber 72 via a conduit 71. In the opposite direction, the hydraulic piston is driven by a spring member 77. The hydraulic piston 7 is coupled to a wheel arm (not shown in Fig. 7) via a crank member 73 comprising a shaft part 74 and a lever arm 75 extending from the shaft part. The shaft part is configured for rotating about a rotation axis 741, as indicated by the arrows in Fig. 7, and the lever arm is arranged in a groove 76 of the hydraulic piston. This shaft part 74 is coupled to the wheel arm, and when the hydraulic piston displaces the lever arm 75, the shaft part rotates, thereby moving the wheel arm between the retracted and the projected position.

The wheel assemblies 3 provide the force necessary for driving the driving unit forward in the well, as will be disclosed in further detail below. As shown in Fig. 4, each wheel assembly 3 comprises a motor housing 31 defined by a stationary part 32, which may be an integrated part of the wheel arm, and a rotational part 33. A section of the rotational part constitutes a wheel 35, and the rotational part

is configured for being rotated in relation to the stationary part 32 about a wheel rotation axis 200. Inside the motor housing, an electrical motor 34 is provided for driving the rotational part and thus the wheel 35 when the wheel assemblies are active in order to propel the driving unit. The motor housing is sealed by one
5 dynamic sealing 4 only, provided between the fixed stationary part 32 and the rotating rotational part 33. The dynamic sealing 4 is configured for preventing ingress of well fluids into the motor housing between the rotating and stationary parts defining the motor housing. The dynamic sealing 4 comprises a sealing member 39, such as an elastomeric seal, an O-ring, a spring-energised seal, a
10 PTFE spring-energised seal or other sealing means known to the skilled person. The electrical motor comprises an outer stator part 341 and an inner rotor part 342. When electrical power is supplied to the electrical motor, the rotor part 342 rotates under the influence of the stator part 341, thereby rotating the rotational part 33 and the wheel 35. When the wheel rotates, the dynamic sealing 4
15 provides a sealing relationship between the fixated stationary part 32 and the rotating rotational part 33. As shown in Fig. 3, an outer traction surface area 355 of the wheel 35 may comprise indentations 351 to obtain a better grip in the casing wall or in a borehole wall of and open hole completion. The wheel 35 may also comprise other friction-enhancing means, such as spikes or grooves, to
20 improve the traction of the wheel.

In one embodiment, the rotational part comprises a lit part 36 and a cooperating circumferential wheel ring 35. The wheel ring 35 is arranged around the lit part 36 and is fixedly coupled thereto by means of a snap ring 38. The snap ring 38
25 is arranged in a groove 352 in the wheel ring 35 to keep a projecting flange 361 of the lit part 36 fixedly coupled to the wheel ring 35. The wheel ring 35 may also be connected with the lit part 36 by any other means known to the skilled person. Between the flange 361 and an inner face 353 of the wheel ring, a sealing member 39, such as an O-ring or a spring-energised seal, is arranged for
30 providing a dynamic sealing 4 sealing between the fixed stationary part 32 and the rotating rotational part 33.

The rotational force generated by the rotor 342 of the electrical motor is transferred to the lit part 36 of the rotational part via a gearing system. The
35 gearing system is arranged in the motor housing together with the electrical motor 34, thereby preventing well fluid from interfering with the transmission of power from the electrical motor to the wheel 35. The gearing system is stacked

on the electrical motor and is thus arranged directly inside the lit part 36. Thus, to access the gearing system, only the lit part has to be removed.

According to the invention, various gearing systems may be utilised to suit various types of downhole operations. Depending on the specific gearing system used, the downhole driving unit may have different characteristics. For example, a gearing system having a high gearing ration may result in the wheel assembly being capable of supplying a larger maximum torque, whereas the maximum speed may be reduced. On the contrary, a lower gearing ratio may result in higher speeds but lower torque generation. In one embodiment, the gearing ratio of the gearing system is about 1:70, however, the gearing ratio may be varied between approximately 1:4 and 1:75 by modifying the gearing system.

Fig. 4 shows a wheel assembly 3 comprising a gearing system in the form of a planetary gearing system 5a. The planetary gearing system 5a comprises a sun gear 52a coupled to the inner rotor part 342 of the electrical motor. The sun gear 52a may also be an integrated part of the rotor part. The sun gear 52a meshes with planet gears 53a rotatably mounted on a face of the lit part 36 facing towards the motor housing 31. The planet gears are fitted with ball bearings 531 mounted on projecting parts 362 of the lit part. The planet gears 53a further mesh with a stationary ring gear 57 fixedly connected with the stationary part 32 of the motor housing. Thus, when the rotor of the electrical motor rotates, the sun gear 52a rotates the planet gears 53a which rotate individually about a rotation axis 201. Further, the cooperation of the sun gear 52a and the planet gears 53a causes the lit part 36 of the rotational part 33 to rotate about the wheel rotation axis 200 as the planet gears travel around the sun gear. The rotational force generated by the electrical motor is hereby transferred to the lit part 36 of the rotational part 33 and thus to the wheel 35.

Fig. 5 shows another wheel assembly 3 comprising a gearing system in the form of a double planetary gearing system 5b. The double planetary gearing system 5b comprises multiple stages 51a, 51b, each comprising a sun gear 52a, 52b meshing with planet gears 53a, 53b. A first stage 51a of the double planetary gearing closest to the electrical motor comprises a sun gear 52a coupled to the inner rotor part 342 of the electrical motor. The sun gear 52a may also be an integrated part of the rotor part. The sun gear 52a meshes with planet gears 53a rotatably mounted on a carrier member 37. The planet gears are fitted with ball

bearings 531 mounted on projecting parts 371 of the carrier member 37. The planet gears further mesh with a stationary ring gear 57 fixedly connected with the stationary part 32 of the motor housing. A second stage 51b of the double planetary gearing closest to lit part 36 comprises a sun gear 52b mounted on or
5 being an integral part of the carrier member 37. The sun gear 52b is arranged on a site of the carrier member opposite the planet gears 53a of the first stage 51a of the gearing system. The sun gear 52b meshes with planet gears 53b of the second stage of the gearing system mounted on a face of the lit part 36 facing towards the motor housing 31. The planet gears 53b are fitted with ball bearings
10 531 mounted on projecting parts 362 of the lit part. As the planet gears 53a of the first gearing stage, the planet gears 53b further mesh with the stationary ring gear 57. Thus, when the rotor of the electrical motor rotates, the sun gear 52a rotates the planet gears 53a of the first gearing stage, which planet gears rotate individually about the rotation axis 200 and cause the carrier member 37 to
15 rotate about the wheel rotation axis 200. As the carrier member 37 rotates, the planet gears 53b of the second gearing stage also rotate individually about the rotation axis 200 and about the wheel rotation axis 200. This causes the lit part 36 of the rotational part 33 to rotate about the wheel rotation axis 200 as the planet gears travel around the sun gear 52b. The rotational force generated by
20 the electrical motor is hereby transferred to the lit part 36 via the multistage gearing system, and the wheel 35 is rotated.

As can be seen from the gearing system shown in Fig. 5, the geometry of the lit part has been modified to accommodate the additional gearing stage 51b.
25 Hereby, the design of the remaining parts of the wheel assembly may be kept unchanged, and a uniform design of the wheel assembly may be utilised in various configurations of a wheel assembly by only modifying the geometry of the lit part.

30 Instead of utilising a lit part 36 of varying geometry for accommodating the gearing system used, the geometry of the wheel ring 35 may be changed to reduce or enhance the size of the motor housing accommodating the electrical motor and the gearings system. According to the embodiments of the invention, the geometry of the wheel ring 35, in particular the width of the wheel ring 35,
35 may also be changed to modify the traction properties of the wheel assembly. By increasing or reducing the width of the wheel, the potential contact area between the wheel ring and the inner wall of the well, i.e. the traction surface area, may

be modified, thereby also modifying the traction properties of the wheel assembly.

Fig. 6 shows an embodiment of the invention where a traction surface area width
5 Tw of a traction surface area 355 of the wheel 35 has been enhanced to increase the traction surface area of the wheel assembly. The electrical motor shown is also enlarged, however, this may also *not* be the case in embodiments according to the invention. The gearing system shown in Fig. 6 is identical to and operated in a manner similar to the gearing system described above and shown in Fig. 5.
10 From Fig. 6, it is evident that the traction surface area width Tw has been increased in relation to a total width Aw of the wheel assembly.

In the shown embodiments, the traction surface area width Tw is between 50% and 85 % of the total width (Aw) of the wheel assembly. However, the width of
15 the traction surface may take on any other width without departing from the invention.

By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is
20 meant any kind of gas composition present in a well, completion, or open hole, and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

25 By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

In the event that the tool is not submergible all the way into the casing, a downhole tractor can be used to push the tool all the way into position in the
30 well. The downhole tractor may have projectable arms having wheels, wherein the wheels contact the inner surface of the casing for propelling the tractor and the tool forward in the casing. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

35 Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in

the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. A downhole electrically driven driving unit (1) , e.g. powered by a battery, for insertion into a well or borehole (100), comprising a driving section (2) comprising:
- 5 - a driving section housing (21), and
- a plurality of wheel assemblies (3) coupled to the driving section housing and adapted to extend from the driving section housing to contact an inner wall (102) of the well, each of the wheel assemblies comprising:
- 10 - a motor housing (31) defined by a fixed stationary part (32) and a rotational part (33) configured for rotation, and
- an electrical motor (34) arranged in the motor housing for driving the rotational part,
- wherein a section of the rotational part constitutes a wheel (35) and the wheel assembly comprises only one dynamic sealing (4) provided between the fixed stationary part and the rotational part, the dynamic sealing being configured for sealing the motor housing to prevent ingress of well fluids, and
- 15 wherein the electrical motor comprises an outer stator part (341) and an inner rotor part (342), and the downhole electrically driven driving unit further comprises a gearing system (5a, 5b) arranged in the motor housing, the gearing system being coupled to the rotor part and to the rotational part, wherein the gearing system is a planetary gearing system (5a).
2. A downhole electrically driven driving unit according to claim 1, wherein the electrical motor is a step motor.
- 25
3. A downhole electrically driven driving unit according to any of the preceding claims, wherein the wheel has a traction surface area which is a continuous contact surface for contacting a wall of the well or borehole.
- 30
4. A downhole electrically driven driving unit according to any of the preceding claims, further comprising a battery for providing electric power.
5. A downhole electrically driven driving unit according to claim 4, wherein the downhole electrically driven driving unit operates wirelessly powered by the battery.
- 35

6. A downhole electrically driven driving unit according to any of the preceding claims, wherein the inner rotor part of the electrical motor rotates by at least 3,500 revolutions per minute.
- 5 7. A downhole electrically driven driving unit according to any of the preceding claims, wherein the rotational part of the motor housing defines a cavity in which the electrical motor is arranged, and the fixed stationary part of the motor housing closes the cavity by the dynamic sealing arranged therebetween.
- 10 8. A downhole electrically driven driving unit according to any of the preceding claims, wherein the electrical motor is connected to the fixed stationary part of the motor housing.
9. A downhole electrically driven driving unit according to any of the preceding
15 claims, wherein the wheel the fixed stationary part and the rotational part
10. A downhole electrically driven driving unit according to claim 1, wherein the gearing system is a multistage planetary gearing system (5b) comprising multiple stages (51) each comprising a sun gear (52a, 52b) and multiple planet gears
20 (53a, 53b).
11. A downhole electrically driven driving unit according to claim 1, wherein a gearing ratio of the gearing system is between 1:60 and 1:75, preferably about 1:70.
25
12. A downhole electrically driven driving unit according to any of the preceding claims, wherein the rotational part comprises a circumferential wheel ring (35) provided with a lit part (36).
- 30 13. A downhole electrically driven driving unit according to claim 11 or 12, wherein the planetary gearing system is arranged between the electrical motor and the rotational part.
14. A downhole electrically driven driving unit according to any of the
35 preceding claims, wherein a traction surface area width (Tw) of a traction surface area (355) of the wheel 35 is between 50% and 85%, preferably between 55%

and 65%, more preferably about 60% of the total width (A_w) of the wheel assembly.

15. A downhole electrically driven driving unit according to any of the preceding
5 claims, wherein the wheel assembly is arranged on a wheel arm (6) coupled to the driving section housing, the wheel arm and the wheel assembly being movable between a retracted position, wherein the wheel assembly is substantially inside the driving section housing, and a projected position, wherein the wheel assembly is translated away from the driving section housing.
- 10 16. A downhole electrically driven driving unit according to claim 15, wherein the wheel arm is coupled to a hydraulic piston (7) arranged in the driving section housing, the hydraulic piston being operable to move the wheel arm between the retracted position and the projected position.
- 15 17. A downhole system (11) comprising the downhole electrically driven driving unit according to any of claims 1-16 and an operational tool (8) connected with the driving unit for being moved forward in a well or borehole.
- 20 18. Use of the downhole electrically driven driving unit according to any of claims 1-16 in a well or borehole (100) for moving the driving unit itself and/or an operational tool (8) forward in the well or borehole.

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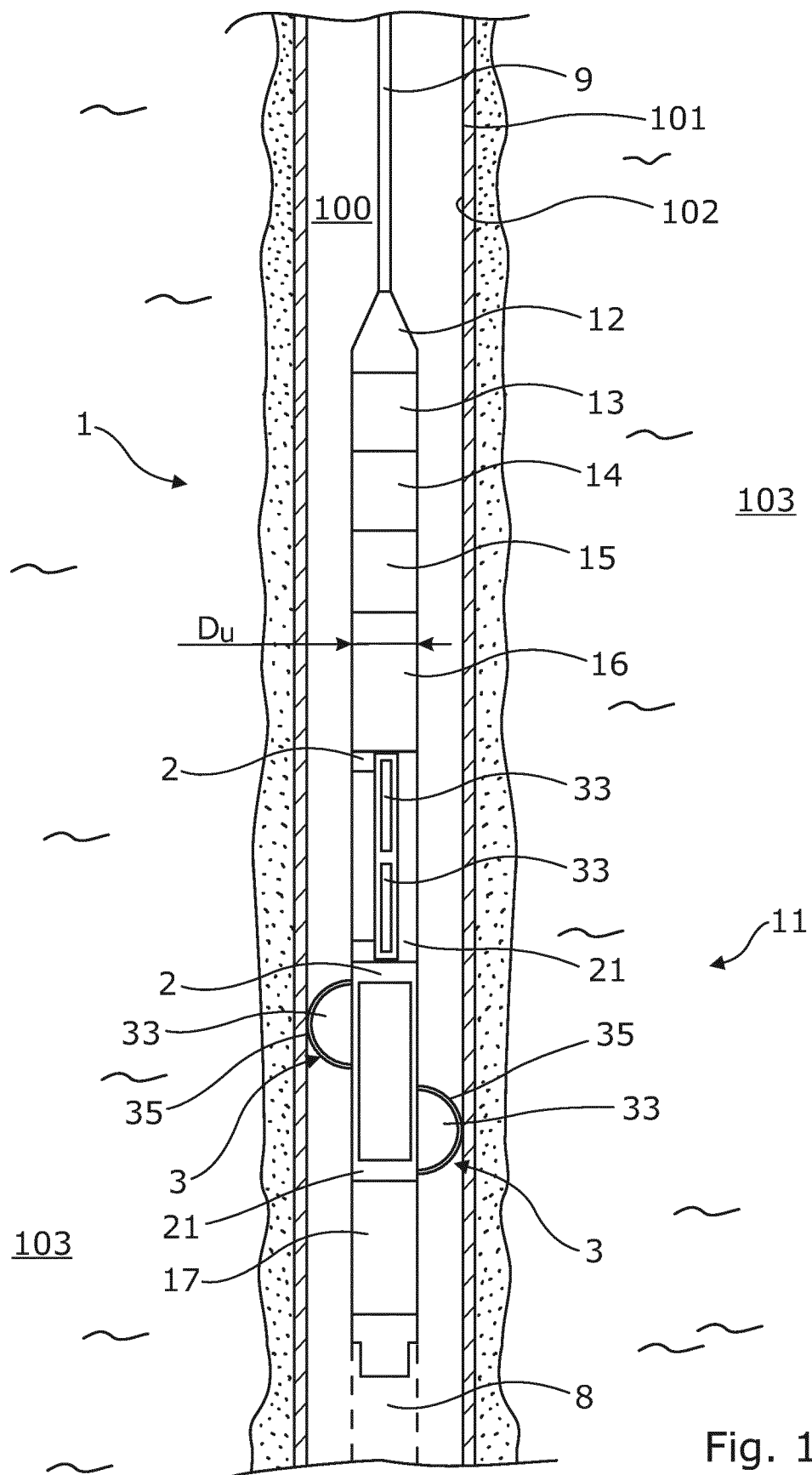
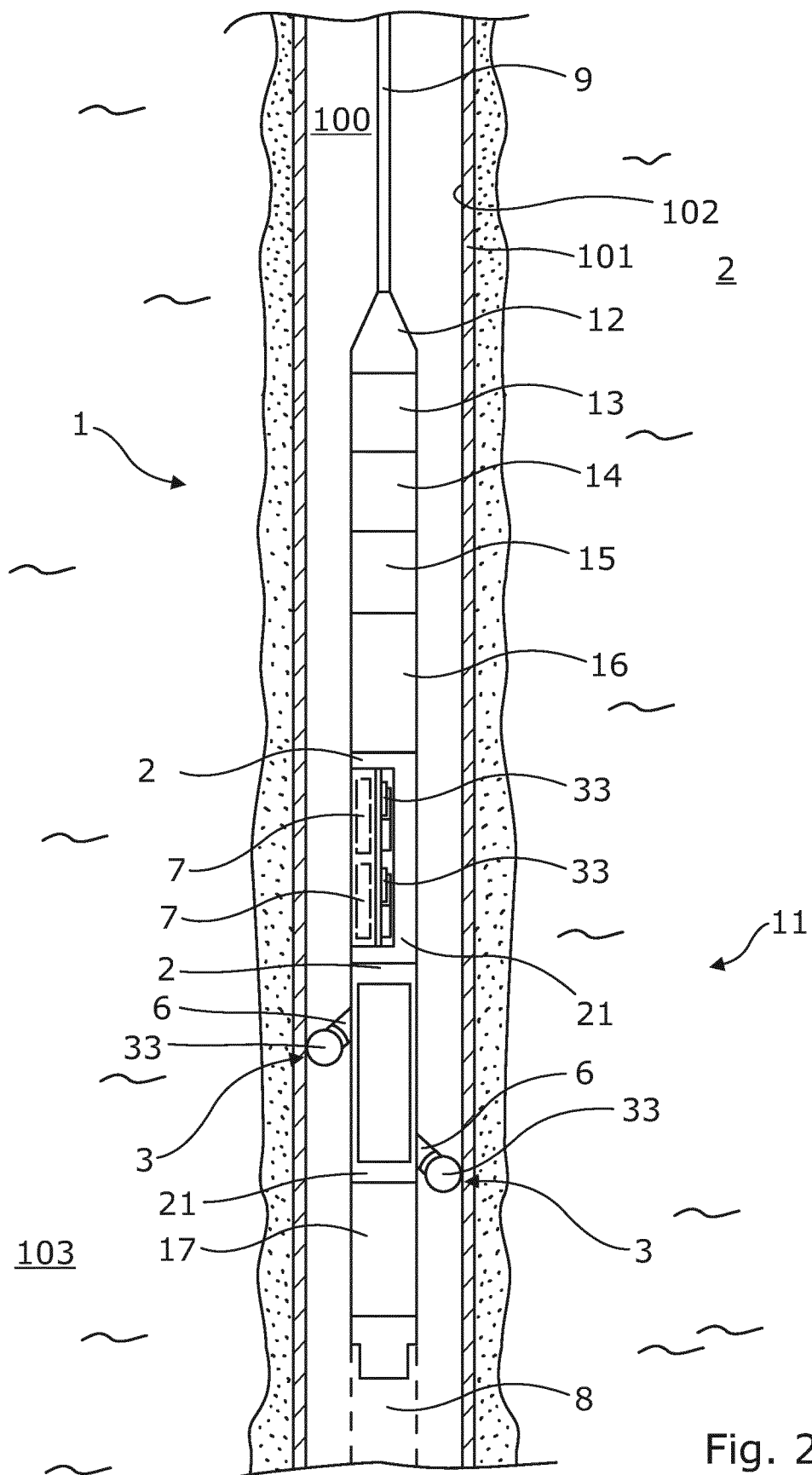


Fig. 1



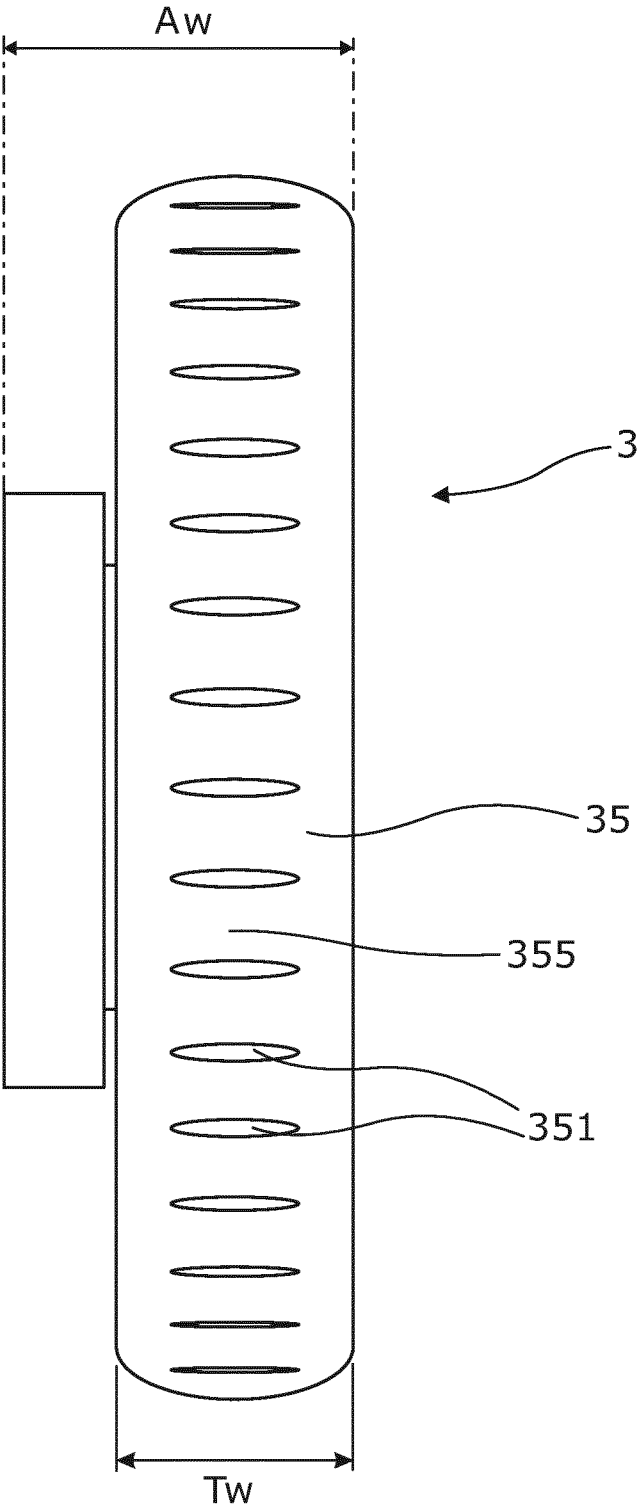


Fig. 3

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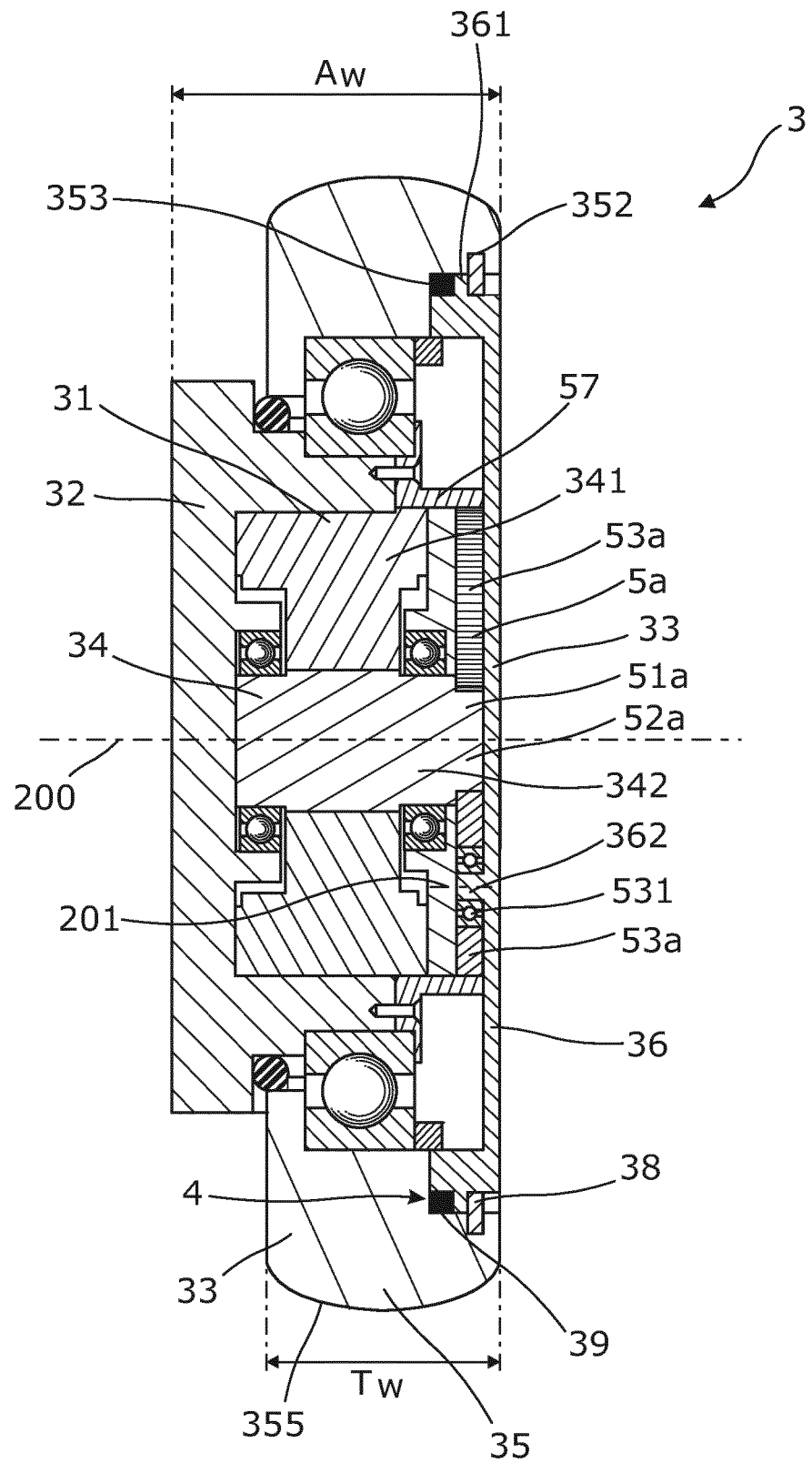


Fig. 4

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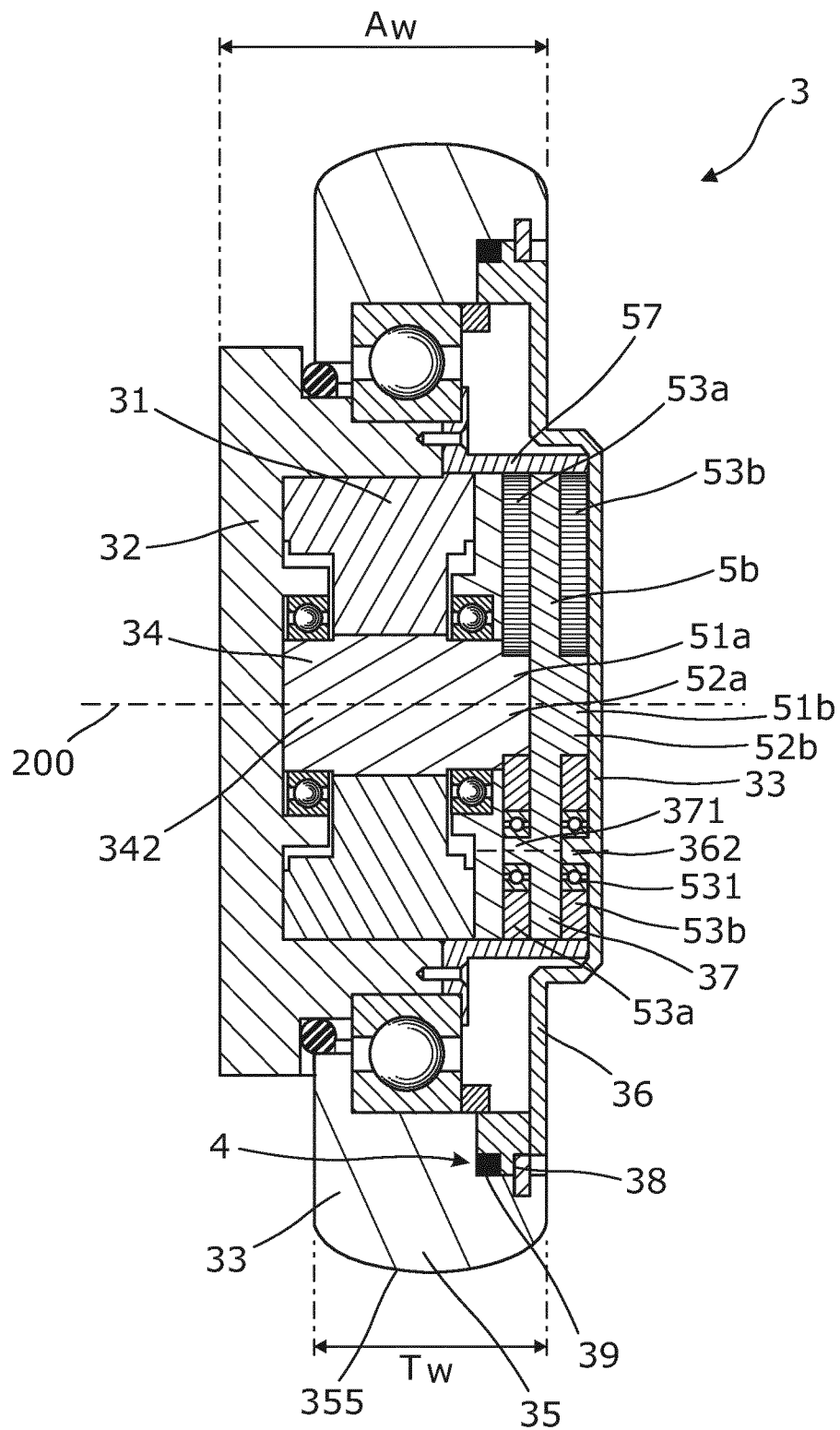


Fig. 5

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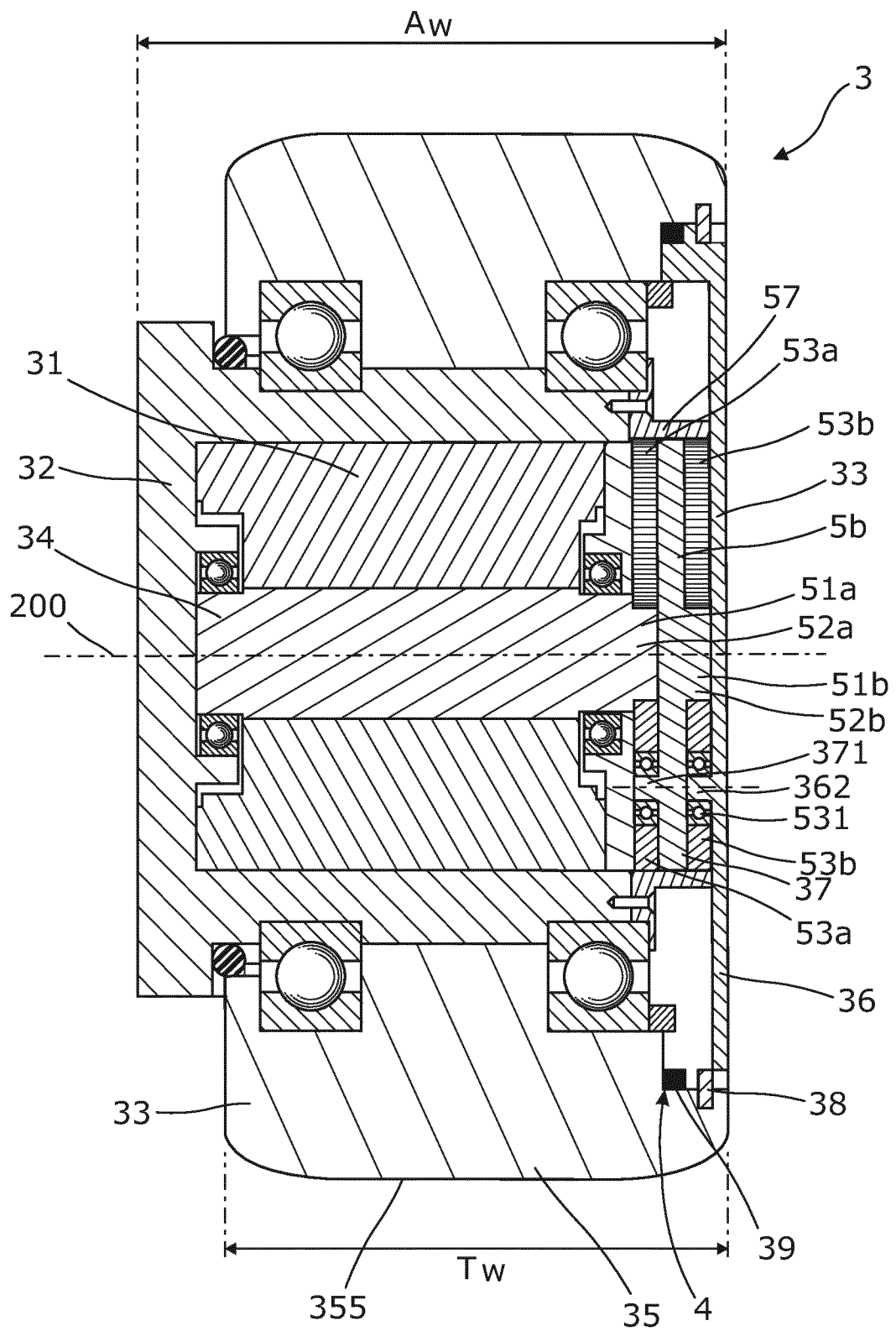


Fig. 6

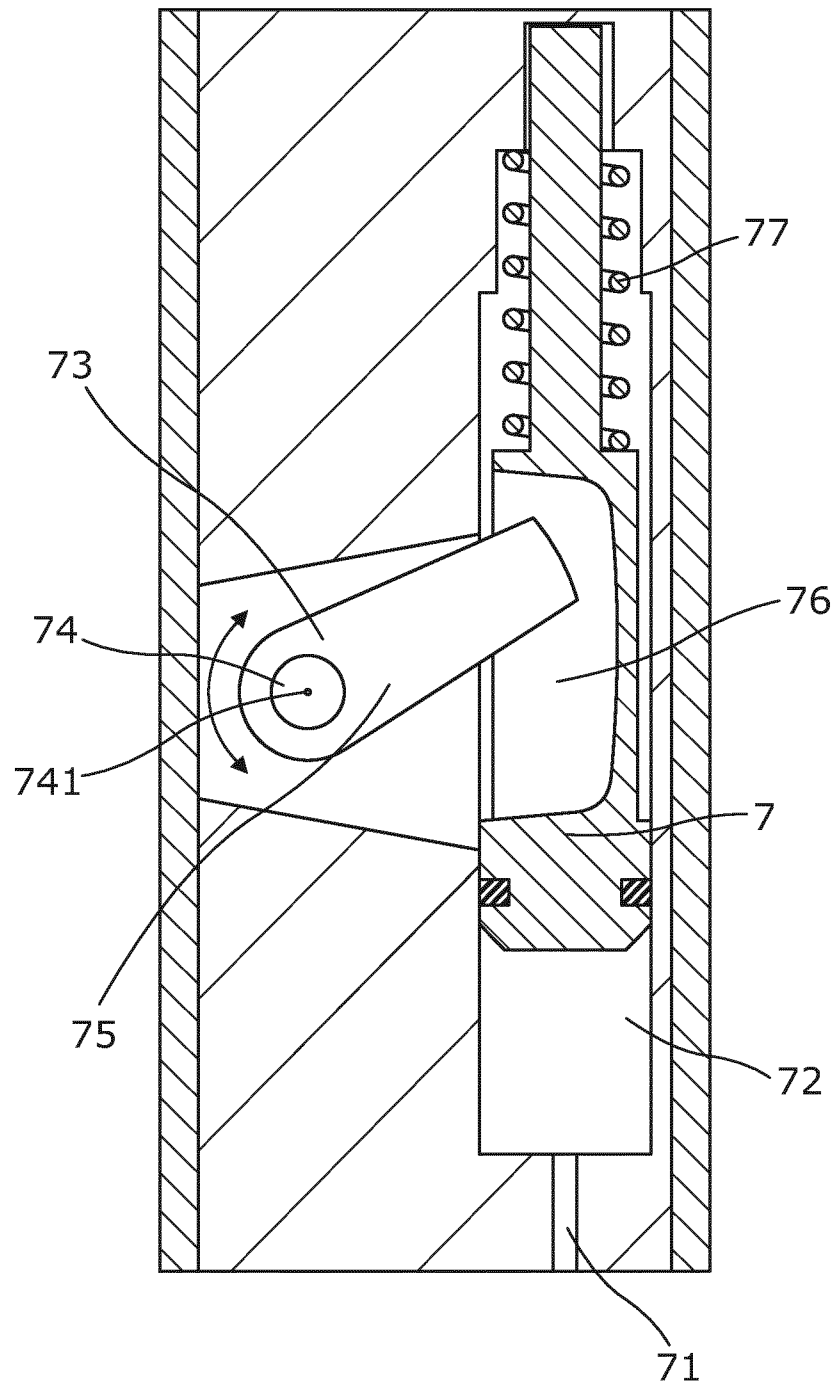


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/053434

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B23/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 6 273 189 B1 (GISSLER ROBERT W [US] ET AL) 14 August 2001 (2001-08-14) column 3, line 20 - line 38 column 5, line 15 - line 23 column 5, line 47 - line 50 column 12, line 44 - column 13, line 37 column 13, line 56 - line 58 column 14, line 10 - line 12 figures 1,4,5,6,7,10-13	1-18
Y	WO 2012/130938 A1 (WELLTEC AS [DK]; HALLUNDBAEK JOERGEN [DK]) 4 October 2012 (2012-10-04) page 14, line 7 - page 15, line 5 figures 5A,5B,8A,8B ----- -/--	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

13 May 2014

Date of mailing of the international search report

22/05/2014

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/053434

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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