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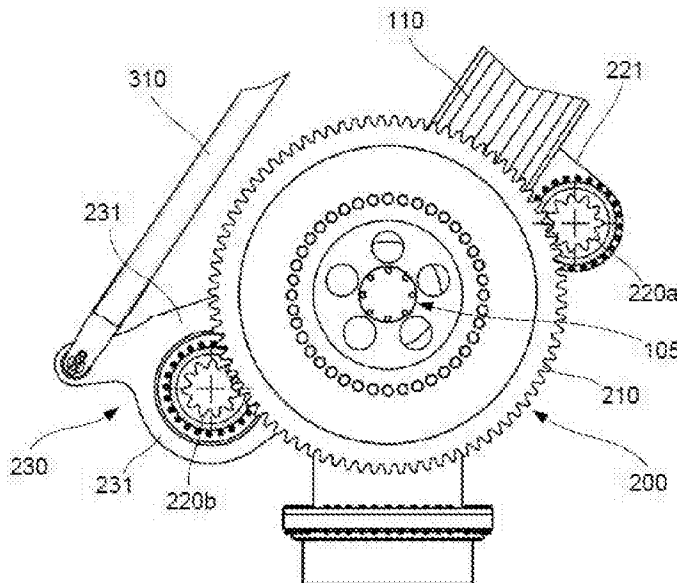
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(54)	Title	Arm actuator assembly for a crane
(56)	References	
	Cited:	US 4268214 A, EP 2374515 A1, DE 1260733 B, CN 202953754 U
(57)	Abstract	

Arm actuator assembly (200) for a crane (100) comprising at least a main arm (110) pivotally arranged to a support structure (101) at a lower end thereof by means of a pivoting connection (105), wherein the arm actuator assembly (200) comprising:

- at least one cogwheel (210) arranged with its circumference in a parallel vertical plane of the main arm (110) and fixed with its horizontal center axis corresponding with horizontal center axis of the pivoting connection (105) between the main arm (110) and support structure (101), and
- at least one main arm drive pinion gear (220a-c) arranged to the main arm (110) in engagement with the at least one fixed cogwheel (210), wherein operation of the at least one drive pinion gear (220a-c) in engagement with the at least one fixed cogwheel (210) elevate or lower the main arm (110) of the crane (100) in the vertical plane.



Arm actuator assembly for a crane

The present invention is related to an arm actuator assembly for a crane, according to the preamble of claim 1.

The present invention is especially related to an arm actuator assembly for a crane which can contribute to electrification and replace solutions of cranes where there are used hydraulic cylinders today.

Background

At present, there is great interest within the marine industry to develop environmentally friendly propulsion systems for marine vessels, where the main goal is to achieve zero emissions or close to zero emissions from the marine vessel. Electric and hybrid electric (electric and fuel) propulsion systems are increasingly being used. Such systems enable the marine vessel to be driven entirely or in part by electrical energy stored in energy storage devices. With this also follows the interest of developing equipment on the marine vessels that can utilize electrical energy stored in such energy storage devices. An example of such equipment is offshore cranes, which mainly use hydraulic cylinders for operation of the arms thereof. There however exist solutions, which utilize electrical motors for rotation of the crane structure.

In US 8123053 B2 (*EMS-Tech Inc.*) is described a slewing actuator system for horizontally rotating a boom structure by means of engagement with gearing means. The slewing actuator system comprises a rotatable cylindrical disc with exterior teeth that are in engagement with one or more fixed motor-driven (electrical) gearing means that impart rotational movement to cylindrical disc and thus the boom structure arranged thereto.

CN205709609 U (*BEIQI FONTON MOTOR CO LTD*) describes a similar solution to US8123053 B2 where a crane boom is arranged to a rotatable disc.

The operation of the crane arms in US 8123053 B2 and CN 205709609 U are however based on the use of hydraulic cylinders.

From US 4268214 A is known a front end mechanism for an excavating machine having a boom pivotally mounted at its foot and a dipper stick pivoted to the forward end of the boom that carries a dipper at its outer end. The mechanism includes a rotatable hoist member coaxial with the pivoted

boom foot that is in the form of either a gear or a lever arm, a hoist drive that alternately rotates the hoist member for effecting hoist and lower motions of the machine or that holds the hoist member stationary, a moment arm forming a part of the inner end of the dipper stick which is in the form of either a gear or a linear portion of the dipper stick, a coupling member interposed
5 between the hoist member and the dipper stick moment arm which is in the form of either an elongate strut tying the hoist member and moment arm together or an idler gear when both the hoist member and the moment arm are in the form of gears, and a crowd drive that can alternately pivot the boom with respect to the hoist member or hold these two elements fixed with respect to one another.

10 In EP 2374515 A1 is described a toy-front loader having a lifting arm, which is fixed at a play vehicle in a rotary manner. A dump body is fixed at the lifting arm in a rotary manner. A drive is provided for the lifting arm and another drive is provided for the dump body. The latter drive is operated independently from the former drive.

In DE 1260733 B is described a winch-operated crane where both load and the elbow arm are
15 operated by winches.

Use of hydraulic cylinders introduce a need for both hydraulic and electric technology. It is well known for a skilled person that a hydraulic solution is less efficient than an electric solution.

Further, contact with hydraulic oil is not healthy for personnel and leakage of hydraulic oil to the environment may give unwanted effects (especially for fish farmers).

20 There is accordingly a need for an arm actuator assembly enabling electrification and replacing hydraulic cylinders used for operating the arms of the crane.

It is further a need for an arm actuator assembly enabling an electrical solution that will improve issues regarding efficiency, health and environment.

25 **Object**

The main object of the present invention is to provide an arm actuator assembly for a crane partly or entirely solving the above-mentioned drawbacks of prior art.

It is further an object of the present invention to provide an arm actuator assembly for a crane enabling arms of the crane to be operated by electrical actuators, removing the need for hydraulic cylinders for operation of arms of the crane.

5 An object of the present invention is to provide an arm actuator assembly for a crane comprising at least one fixed cogwheel arranged in a parallel vertical plane of an arm of the crane and at least one arm drive pinion gear arranged to the arm and in engagement with the fixed cogwheel enabling elevation and lowering of the arm in the vertical plane by operation of the at least one arm drive pinion gear.

10 It is further an object of the present invention to provide an arm actuator assembly for a crane further comprising an upper elbow arm drive unit arranged for operating an upper elbow arm of the crane.

It is further an object of the present invention to provide an arm actuator assembly for a crane, which has low maintenance costs compared to prior art solution.

15 An object of the present invention is to provide an arm actuator assembly for a crane, which provides an environmentally friendly solution by that it does not use polluting fluids, such as hydraulic oil or similar, which can constitute a risk for the environment or personnel at breakdown or leakage.

Further objects of the present invention will appear from the following description, claims and attached drawings.

20

The invention

An arm actuator assembly for a crane according to the present invention is disclosed in claim 1. Preferable features of the arm actuator assembly are disclosed in the remaining claims.

25 Cranes comprise at least one main arm pivotally arranged to a support structure at a lower end thereof by means of a pivoting connection. Cranes further may comprise at least one elbow arm pivotally arranged to the upper end of the main arm, possibly via a connection link. Further, the support structure of the crane is typically formed by a tower (pedestal) and a base platform, where the base platform, which the main arm of the crane are connected to, typically is arranged to the

tower by means of a rotational interface (slew bearing), enabling the crane to rotate about the tower.

The present invention provides an arm actuator assembly for a crane where the main components are at least one fixed cogwheel and at least one arm drive pinion gear.

5 According to a first embodiment of the arm actuator assembly for a crane according to the present invention, the arm actuator assembly comprises at least one cogwheel arranged in a parallel vertical plane of the main arm and fixed to the support structure with its horizontal center axis corresponding with horizontal center axis of the pivoting connection between the main arm and support structure. According to the first embodiment of the arm actuator assembly further
10 comprises at least one main arm drive pinion gear arranged to the main arm and in engagement with the at least one fixed cogwheel. Accordingly, in the first embodiment of the arm actuator assembly for a crane according to the present invention, operation of the at least one main arm drive pinion gear in engagement with the at least one fixed cogwheel enable elevation or lowering of the main arm of the crane in the vertical plane. The at least one main arm drive pinion gear is
15 preferably driven by at least one electric power source (motor). If desired or necessary there can be arranged a gear exchange between the electric power source and the main arm drive pinion gear. According to the arm actuator assembly for a crane according to the present invention the at least one cogwheel exhibits a (considerably) larger diameter than the at least one main arm drive pinion gear. According to the present invention is preferably at least one main arm drive pinion gear
20 arranged at lower side of the main arm.

Accordingly, the arm actuator assembly for a crane according to the first embodiment of the present invention works by that operation of the at least one electrical power source results in that the at least one main arm drive pinion gear travels along the exterior circumference of the fixed cogwheel and in engagement therewith, resulting in that the main arm is elevated or lowered in the vertical
25 plane according to the rotational direction of the main arm drive pinion gear.

According to a second embodiment of the arm actuator assembly for a crane according to the present invention the arm actuator assembly further comprises an upper elbow arm drive unit for an elbow arm arranged for operating an upper elbow arm of the crane. According to the second embodiment of the arm actuator assembly for a crane according to the present invention the elbow
30 arm drive unit is arranged to the lower part of the main arm or the support structure for the crane.

According to the second embodiment of the arm actuator assembly for a crane according to the present invention, the elbow arm drive unit is formed by a torque arm pivotally arranged to lower

part of the main arm and further comprising a tension arm extending between the upper elbow arm and torque arm, wherein the tension arm is pivotally arranged to the upper elbow arm and main arm, respectively. According to the second embodiment of the arm actuator assembly for a crane, the torque arm is a single or double torque arm.

- 5 In an alternative embodiment of the second embodiment of the arm actuator assembly for a crane according to the present invention the torque arm is arranged with to pivot about a horizontal centre axis of a main arm drive pinion gear arranged at rear part of the main arm.

Accordingly, the arm actuator assembly for a crane according to the second embodiment of the present invention works by that, as the main arm is elevated or lowered in the vertical plane as
10 described above, the elbow arm will correspondingly move in the vertical plane due to the interaction of the tension arm.

In a further alternative embodiment of the arm actuator assembly for a crane according to the present invention, the elbow arm drive unit is formed by a tension winch, preferably an electrically driven winch, arranged to the support structure of the crane and a tension wire extending between
15 the tension winch and rear part of the elbow arm, alternatively rear part of a connection link connecting the main arm and elbow arm. By controlling the winch, the elbow arm can be controlled both in correspondence with the movement of the main arm and separately.

Accordingly, the arm actuator assembly for a crane according to the present invention provides a solution, which enables the crane to be driven by electrical power. Accordingly, there is no need for
20 hydraulic cylinders for operation of the arms of the crane.

Further, sufficient power/moment of the arm actuator assembly for a crane according to the present invention can be achieved by utilizing several main arm drive pinion gears in engagement with the at least one fixed cogwheel. Further, the diameter of the cogwheel can also be designed to achieve sufficient power/moment of the arm actuator assembly according to the present invention.

- 25 Further advantages with the present invention over prior art is that the arm actuator assembly according to the present invention removes the need for hydraulic reservoir, hydraulic pipes and hoses, as well as hydraulic pumps, which would provide free space at the deck of a marine vessel.

The present invention would further provide a more rapid/force/power effective controlling of the crane, as the there are no intermediate means transferring the power/force to the crane arm, as
30 the main arm drive pinion gears are directly connected to the main arm via the cogwheel.

A great advantage with the present invention is that there are low requirements for maintenance due to few moveable and force transferring parts.

Further, the present invention further provides a solution which is less exposed to wear, compared to prior art, due to few parts for transferring forces and that there is no requirement for a sealed
5 system as hydraulic systems.

Even though the present invention is mainly related to operation of the main arm by means of the fixed cogwheel and the main arm drive pinion gears, the same principle can also be used for operation of the elbow arm in relation to the main arm by arranging a fixed cogwheel to upper end portion of the main arm, with its center in the pivoting connection between the main arm and the
10 elbow arm, and further arrange at least one elbow arm drive pinion gear to the elbow arm.

Further preferable features and advantageous details of the present invention will appear from the following example description, claims and attached drawings.

Example

15 The present invention will below be described in further detail with references to the attached drawing where:

Fig. 1 is a principle drawing of a crane according to prior art,

Fig. 2a-c are principle drawings of a crane provided with an arm actuator assembly according to a first embodiment of the present invention,

20 Fig. 3a-b are principle drawings of a torque arm for the arm actuator assembly according to the first embodiment of the present invention, and

Fig. 4a-b are principle drawings of a crane provided with an arm actuator assembly according to a second embodiment of the present invention,

25 Reference is now made to Figure 1 which is a principle drawing of a crane 100, in the form of a deck crane, according to prior art. The crane 100 has a support structure 101 formed by a base platform

102 rotatably arranged on upper end of a tower 103 (pedestal) via a rotational interface 104 (slew bearing), which is well known in prior art and needs no further description herein.

The crane 100 further comprises a main arm 110 having a lower end pivotally mounted on the base platform 102 by means of a pivoting connection 105, e.g. formed by a shaft 106 and attachment
5 lugs 107. The main arm 110 can be raised and lowered by actuation of at least one hydraulic cylinder 111 having its lower end arranged to the base platform 102 and upper end arranged to an intermediate location along the length of the main arm 110.

The crane 100 also comprises an upper elbow arm 120 having a lower end pivotally arranged to the upper end portion of the main arm 110. The upper elbow arm 120 is pivotally connected relative to
10 the main arm 110 by at least one hydraulic cylinder 121 having lower end portion pivotally arranged to an intermediate location along the main arm 110 and upper end portion pivotally arranged an intermediate location along the length of the upper elbow arm 120.

Operation of the hydraulic cylinders 111 and 121 enables the crane 100 to be raised and lowered as well as to be extended and retracted, and the rotational interface 104 enables the crane 100 to be
15 rotated about the tower 103.

The crane 100 further includes a main load winch 130 mounted on the lower end portion of the main arm 110 or the base platform 102 to pay out or reel in a main load wire 131 which is wound about a spool 132. A hook 133 is attached to the distal end of the wire 131. Between the spool 132 and hook 133, the wire 131 extends over a guide sheave 134 mounted on the distal end of the main
20 arm 110, a further guide sheave 135 mounted on the lower or proximal end of elbow arm 120, and a distal sheave 136 mounted on the distal end portion of the elbow arm 120.

Accordingly, above is described a typical crane 100 which are used for offshore applications. The same principle as described above also applies for larger offshore cranes.

The present invention is related to an arm actuator assembly enabling such cranes, especially
25 offshore/maritime cranes, to be operated without the use of hydraulic cylinders, at least minimizing the use of hydraulic cylinders for operation thereof.

Reference is now made to Figures 2a-c which is a principle drawing of a crane 100 provided with an arm actuator assembly 200 for a crane according to a first embodiment of the present invention. The crane 100 comprises as described above a support structure 101 comprising a base platform
30 102 rotatably arranged to a tower 103 by means of a rotational interface 104. The main arm 110 is

pivotably arranged to the base platform 102 by that the base platform 102 is provided with a pivoting connection 105. The pivoting connection 105 can e.g. be formed by two attachment lugs 107 adapted to receive and accommodate the lower end of the main arm 110, and wherein the attachment lugs 107 and the main arm 110 at lower part thereof is provided with corresponding
 5 through holes for receiving and accommodating a shaft 106 arranging the lower end of the main arm 110 pivotally to the attachment lugs 107/base platform 102. Accordingly, the longitudinal centre axis of the shaft 106 forms a pivoting centre axis, which the main arm 110 pivots about.

The present invention provides, as mentioned, an arm actuator assembly 200 which removes the need for hydraulic cylinders 111 and 121 for operation of the main arm 110 and/or elbow arm 120.
 10 The main component of the arm actuator assembly 200 according to the present invention is at least one cogwheel 210, wherein the at least one cogwheel 210, with its circumference, is arranged in a parallel vertical plane with the main arm 110 and fixed to the support structure 100, i.e. the base platform 102 with its horizontal center axis corresponding with the pivoting centre axis of the main arm 110, i.e. the horizontal center axis of the pivoting connection 105/shaft 106.

15 The arm actuator assembly 200 according to the present invention further comprises at least one main arm drive pinion gear 220a-b arranged to the main arm 110 and in engagement with the fixed cogwheel 210. According to the arm actuator assembly 200 for a crane 100 according to the present invention the at least one cogwheel 210 exhibits a (considerably) larger diameter than the at least one main arm drive pinion gear 220a-b.

20 In the shown example, the arm actuator assembly 200 according to the present invention comprises a main arm drive pinion gear 220a, arranged to the main arm 110 at a distance from the lower end of the main arm 110 corresponding to the exterior circumference of and in engagement with the cogwheel 210 by means of an attachment device 221, wherein the main arm drive pinion gear 220a is arranged at a lower side of the main arm 110. The arm actuator assembly 200 in the shown
 25 example further comprises a main arm drive pinion gear 220b arranged to the main arm 110 at rear part thereof and in engagement with the fixed cogwheel 210 by means of an attachment device 222, wherein the main arm drive pinion gear 220b is arranged at an upper side of the main arm 110.

The at least one main arm drive pinion gear 220a-b is arranged to at least one electrical power source 225, such as an electric motor, capable of providing the necessary driving torque for the at
 30 least one main arm drive pinion gear 220a-b to operate the main arm 110 in the vertical plane directly or via a gear exchange.

Accordingly, as the at least one main arm drive pinion gear 220a-b travels along the exterior circumference of the fixed cogwheel 210 and in engagement therewith, being powered by the at least one electrical power source 225, the main arm 110 is elevated or lowered in the vertical plane.

In the example shown in Figure 2a, the upper elbow arm 120 is pivotally connected to the main arm 110 via a connection link 300, wherein the connection link 300 connects the upper elbow arm 120 and main arm 110 at one end and provides a connection point 301 at the other end for a tension arm 310. The upper elbow arm 120 can alternatively be pivotally connected to the main arm 110, as shown in Figure 4a.

According to the arm actuator assembly 200 of the first embodiment, the arm actuator assembly 200 further comprises an elbow drive unit 230 arranged at lower part of the main arm 110 and which is arranged for connection to the tension arm 310, such that the tension arm 310 is arranged extending between the elbow drive unit 230 and the connection link 300. In an alternative embodiment, the tension arm 310 is connected to a rear end of the elbow arm 120 as shown for a tension wire 311 in Figure 4a.

In the shown example the elbow drive unit 230 is formed by a single or double torque arm 231, as shown in Figures 3a-b, respectively. In the shown example the single or double torque arm 231 is rotatably connected at a center axis of the main arm drive pinion gear 220b, wherein the torque arm 231 has a longitudinal extension longer than the exterior circumference of the main arm drive pinion gear 220b allowing it to pivot freely about the main arm drive pinion gear 220b.

Accordingly, as the main arm 110 is elevated or lowered in the vertical plane as described above, the elbow arm 120 will correspondingly move in the vertical plane due to the interaction of the tension arm 310 which is pivotally connected to the elbow drive unit 230 at one end and to the connection link 300 or rear part of the elbow arm 120 at the other end.

This is only an example, and the elbow drive unit 230 can e.g. be arranged to a separate attachment lug arranged to the lower part of the main arm 110.

Reference is now made to Figures 4a-b, which are principle drawings of a second embodiment of the arm actuator assembly 200 according to the present invention, arranged to a knuckle jib crane 100. In this example, the elbow arm 120 is pivotally connected to the main arm 110 at a distance from the end of the elbow arm 120, such that the elbow arm 120 exhibits overhang 122 at rear end thereof. The arm actuator assembly 200 according to the second embodiment comprises three main arm drive pinion gears 220a-c providing a higher moment which is required for a larger crane,

compared to the first embodiment, arranged to the main arm 110 by means of separate attachment devices or where two or more pinion gears 220a-c are arranged to a common attachment device, as described in the first embodiment. In the embodiment shown in Figures 4a-b the main arm drive pinion gears 220a-c are arranged at lower part and lower end of the main arm 110, and the main arm drive pinion gears 220a-c are distributed along the circumference of the cogwheel 210.

In this embodiment the arm actuator assembly 200 for operation of the elbow arm 120 comprises a controllable tension winch 240 arranged to the base platform 102 for controlling a tension wire 311 arranged fixed to the overhang 122 at one end, alternatively rear end of a connection link 300 connecting the main arm 110 and elbow arm 120, and running over a pulley 241 and is arranged to the tension winch 240 at the other end. In this way, the arm actuator assembly 200 in the second embodiment according to the present invention is capable of operation of both the main arm 110 and elbow arm 120. The tension winch 240 can be controlled to move the elbow arm 120 both in correspondence with the movement of the main arm 110 and separately.

Even though it in the examples there are shown cranes 100 which comprise both main arm 110 and elbow arm 120 it is obvious for a skilled person that the main principle of the present invention can be use on cranes comprising only one arm or more than two arms. Any crane 100, which would require elevation or lowering movement in the vertical plane of an arm 110 pivotally arranged to a base platform 102 at one end can utilize the fixed cogwheel 210 and drive pinion gear(s) 220a-c for operation thereof.

Further, the arm actuator assembly 200 according to the present invention can comprise only one drive pinion gear 220a-c or several drive pinion gears 220a-c depending on the size/requirements of the crane 100. Further, gear exchanges can be used in connection with the arm drive pinion gear 220a-c if required or desired.

It will further be preferable that the arm actuator assembly 200 according to the present invention is provided with safety devices, which will lock the arm drive pinion gear(s) 220a-c at loss of power or fail function. Alternatively that the main arm 120 is provided with a safety mechanism that locks the main arm 110 to the fixed cogwheel 210.

Further, the features of the above described example embodiments can be combined to form further embodiments within the scope of the attached claims.

A crane provided with the arm actuator assembly according to the present invention will have a more horizontal load path than conventional cranes and due to that it can be electrically controlled.

Further, a crane provided with the arm actuator system according to the present invention will be easier and safer to use within automatic operations. A crane provided with the arm actuator assembly according to the present invention will provide enhanced monitoring and improved precise control compared to hydraulically operated cranes.

- 5 By enabling a crane to be operated electrically, features as remote, automatic, robotic operations can easily be added.

Remote monitoring of an electrically driven crane provides more accurate state of the crane than hydraulic cranes. This will be beneficial for cranes arranged on unmanned offshore installations. When e.g. a platform is to be manned, one can better predict if the crane is operational or not.

Claims

1. Arm actuator assembly (200) for a crane (100) comprising at least a main arm (110) pivotally arranged to a support structure (101) at a lower end thereof by means of a pivoting connection (105), and an upper elbow arm (120) pivotally connected to the main arm (110) controllable by an elbow arm drive unit (230), the arm actuator assembly (200) comprising at least one cogwheel (210) arranged with its circumference in a parallel vertical plane of the main arm (110) and with its horizontal center axis corresponding with horizontal center axis of the pivoting connection (105) between the main arm (110) and support structure (101), and at least one main arm drive pinion gear (220a-c) arranged to the main arm (110) in engagement with the at least one cogwheel (210), wherein operation of the at least one drive pinion gear (220a-c) in engagement with the at least one cogwheel (210) elevate or lower the main arm (110) of the crane (100) in the vertical plane, **characterized in that:**

- the at least one cogwheel (210) is fixed with its horizontal center axis corresponding with horizontal center axis of the pivoting connection (105) between the main arm (110) and support structure (101), and

- the elbow arm drive unit (230) is arranged to the lower part of the main arm (110) and is formed by a torque arm (231) pivotally arranged to lower part of the main arm (110) and further comprising a tension arm (310) extending between the upper elbow arm (120) and torque arm (231), wherein the tension arm (310) is pivotally arranged to the upper elbow arm (120) and main arm (110), respectively.

2. Arm actuator assembly according to claim 1, **characterized in** that the torque arm (231) is a single or double torque arm (231).

3. Arm actuator assembly according to claim 2, **characterized in** that the torque arm (231) is pivotally arranged to a horizontal center axis of a main arm drive pinion gear (220b) arranged at rear part of the main arm (110).

4. Arm actuator assembly according to claim 1, **characterized in** that the at least one cogwheel (210) exhibits a larger diameter than the at least one main arm drive pinion gear (220a-c).

5. Arm actuator assembly according to claim 1, **characterized in** that the at least one main arm drive pinion gear (220a-c) is arranged to an electrical power source (225).

6. Arm actuator assembly according to claim 5, **characterized in** that a gear exchange is arranged between the electrical power source (225) and the main arm drive pinion gear (220a-c).

7. Arm actuator assembly according to claim 1, **characterized in** that at least one main arm drive pinion gear (220a) is arranged at lower side of the main arm (110).

Patentkrav

1. Armaktuatorsammenstilling (200) for en kran (100) omfattende minst en hovedarm (110) dreibart innrettet til en støttestruktur (101) ved en nedre ende derav ved hjelp av minst en dreibar kobling (105), og en øvre albuearm (120) dreibart koblet til hovedarmen (110) og styrbar av en albuearm-drivenhet (230), hvilken armaktuatorsammenstilling (200) omfatter minst ett tannhjul (210) innrettet med sin omkrets i et parallelt vertikalt plan av hovedarmen (110) og med sin horisontale senterakse samsvarende med horisontal senterakse for den dreibare koblingen (105) mellom hovedarmen (110) og støttestrukturen (101), og minst ett hovedarm-drivtannhjul (220a-c) innrettet i inngripen med det minst ene tannhjulet (210), hvori drift av det minst ene hovedarm-drivtannhjulet (220a-c) i inngripen med det minst ene tannhjulet (210) hever eller senker hovedarmen (110) av kranen (100) i vertikalplanet, **karakterisert ved** at:

- det minst ene tannhjulet (210) er fast med sin horisontale senterakse samsvarende med den horisontale senteraksen til den dreibare koblingen (105) mellom hovedarmen (110) og støttestrukturen (101), og

- albuearm-drivenheten (230) er innrettet til den nedre delen av hovedarmen (110) og er dannet av en momentarm (231) dreibart innrettet til nedre del av hovedarmen (110) og videre omfatter en spennarm (310) hvilken strekker seg mellom den øvre albuearmen (120) og momentarmen (231), hvori spennarmen (310) er dreibart innrettet til den øvre albuearmen (120) og henholdsvis hovedarmen (110).

2. Armaktuatorsammenstilling i samsvar med krav 1, **karakterisert ved** at momentarmen (231) er en singel eller dobbelt momentarm (231).

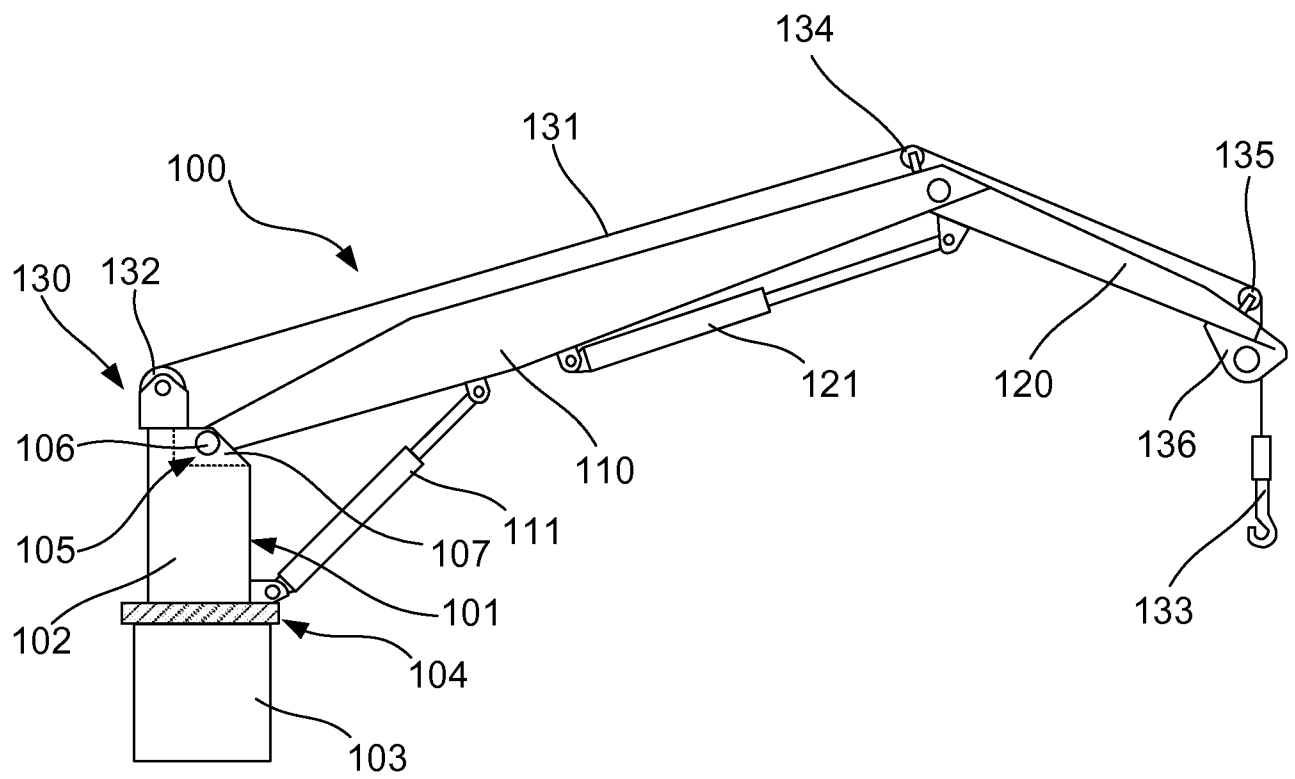
3. Armaktuatorsammenstilling i samsvar med krav 2, **karakterisert ved** at momentarmen (231) er dreibart innrettet til en horisontal senterakse av et hovedarm-drivtannhjul (220b) innrettet ved bakre del av hovedarmen (110).

4. Armaktuatorsammenstilling i samsvar med krav 1, **karakterisert ved** at det minst ene tannhjulet (210) oppviser en større diameter enn det minst ene hovedarm-drivtannhjulet (220a-c).

5. Armaktuatorsammenstilling i samsvar med krav 1, **karakterisert ved** at det minst ene hovedarm-drivtannhjulet (220a-c) er innrettet til en elektrisk kraftkilde (225).

6. Armaktuatorsammenstilling i samsvar med krav 5, **karakterisert ved** at en girutveksling er innrettet mellom den elektriske kraftkilden (225) og hovedarm-drivtannhjulet (220a-c).
7. Armaktuatorsammenstilling i samsvar med krav 1, **karakterisert ved** at minst ett hovedarm-drivtannhjul (220a) er innrettet ved nedre side av hovedarmen (110).

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**Fig. 1.**

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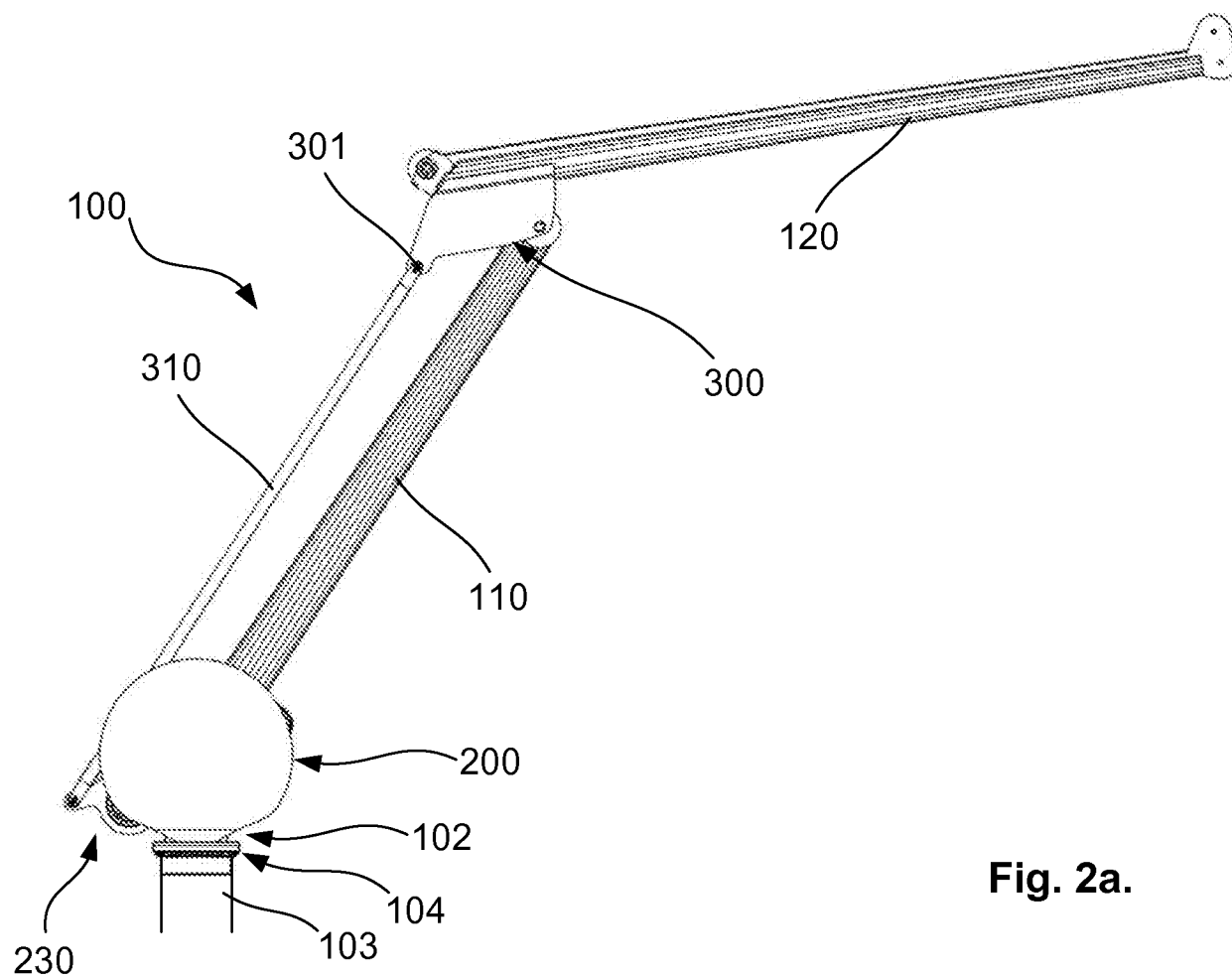


Fig. 2a.

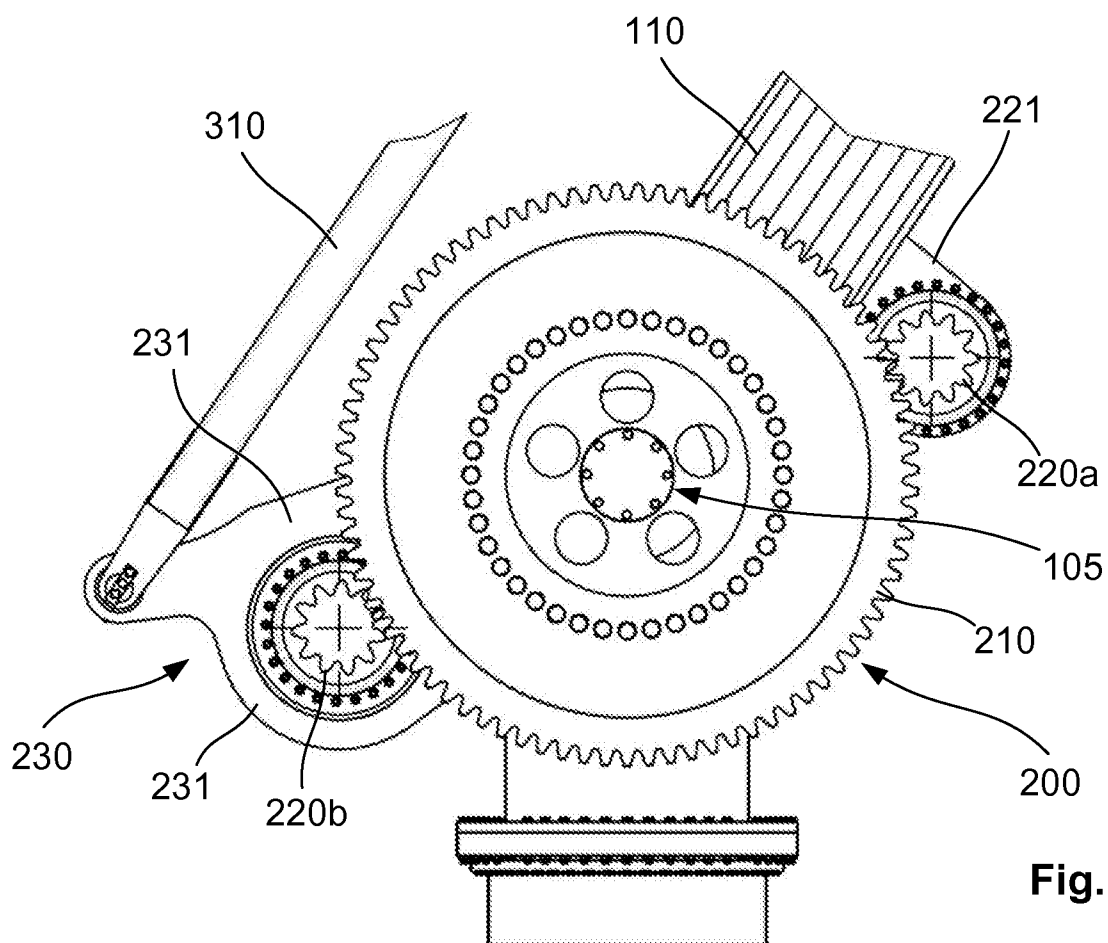
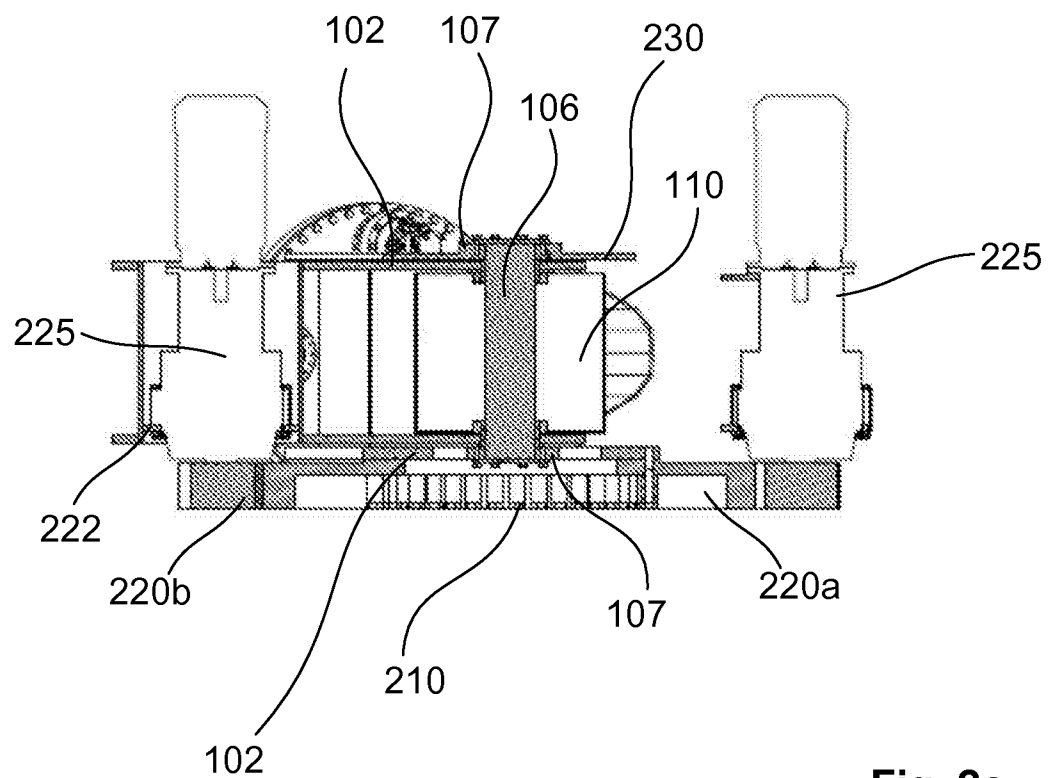
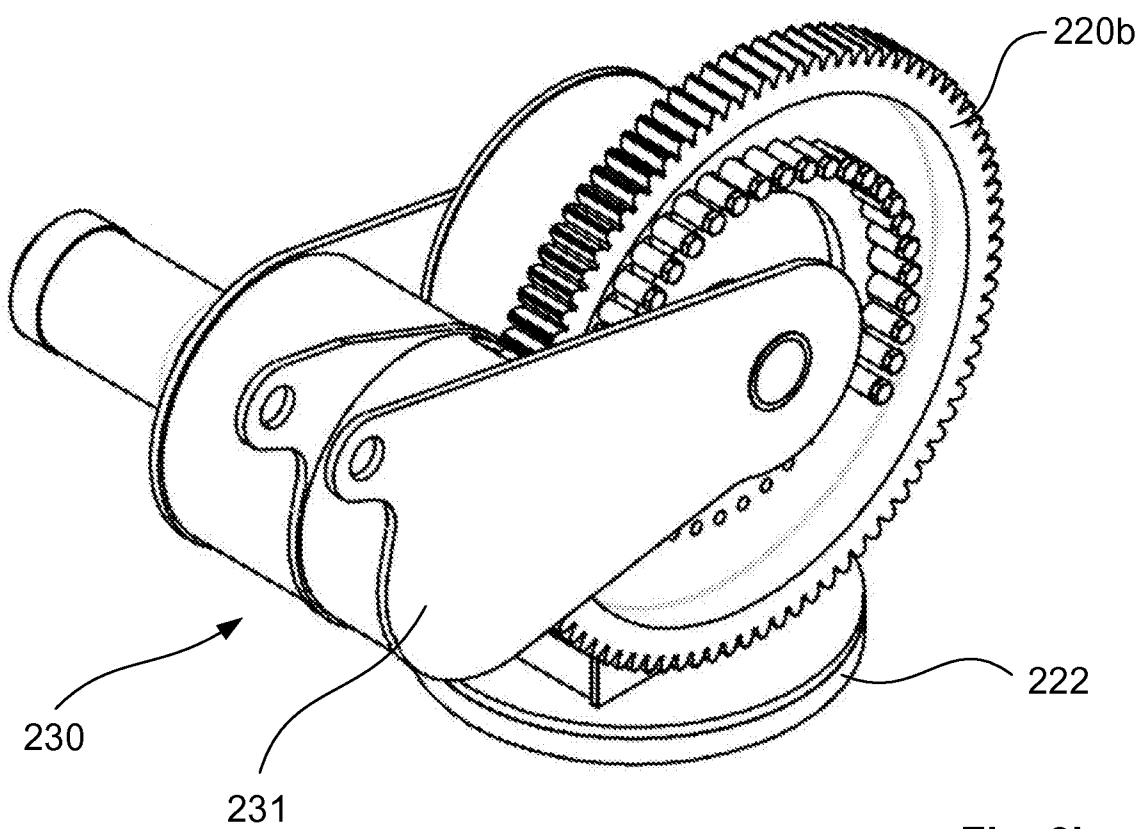
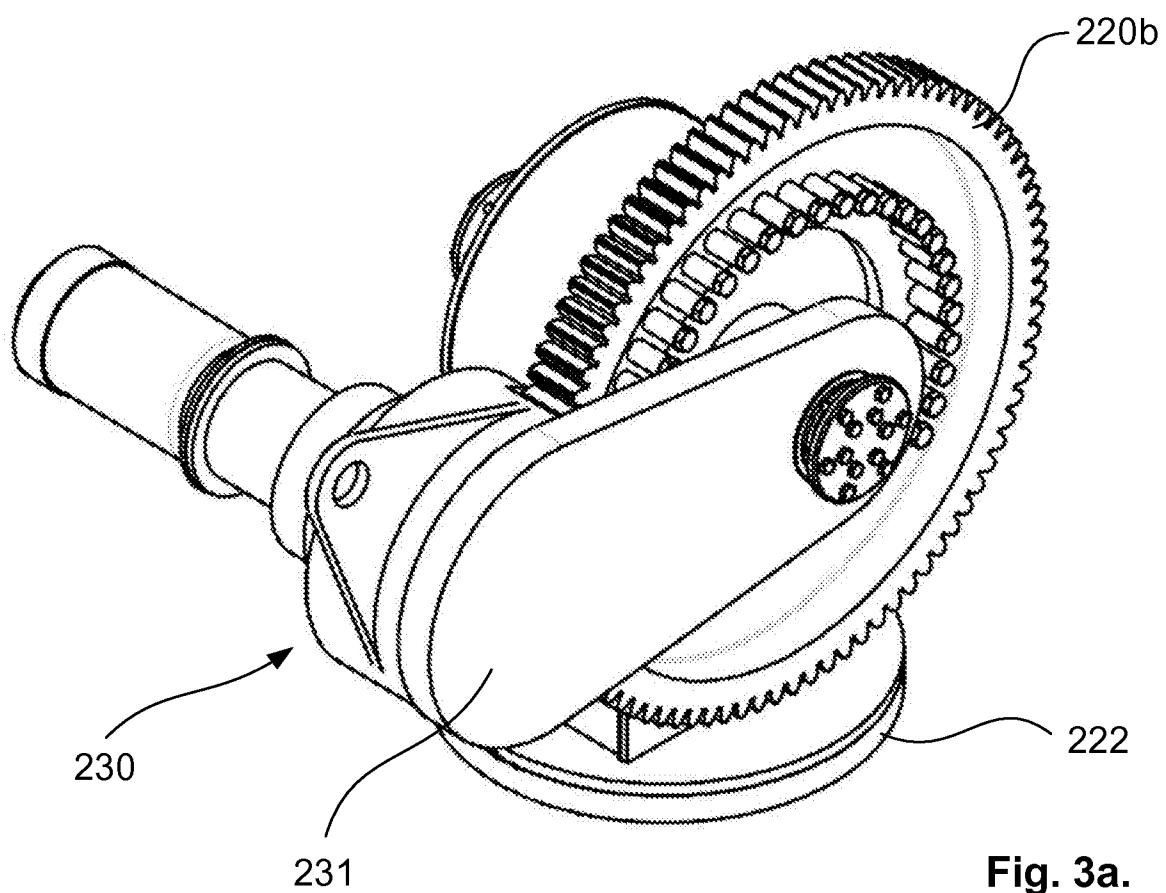


Fig. 2b.

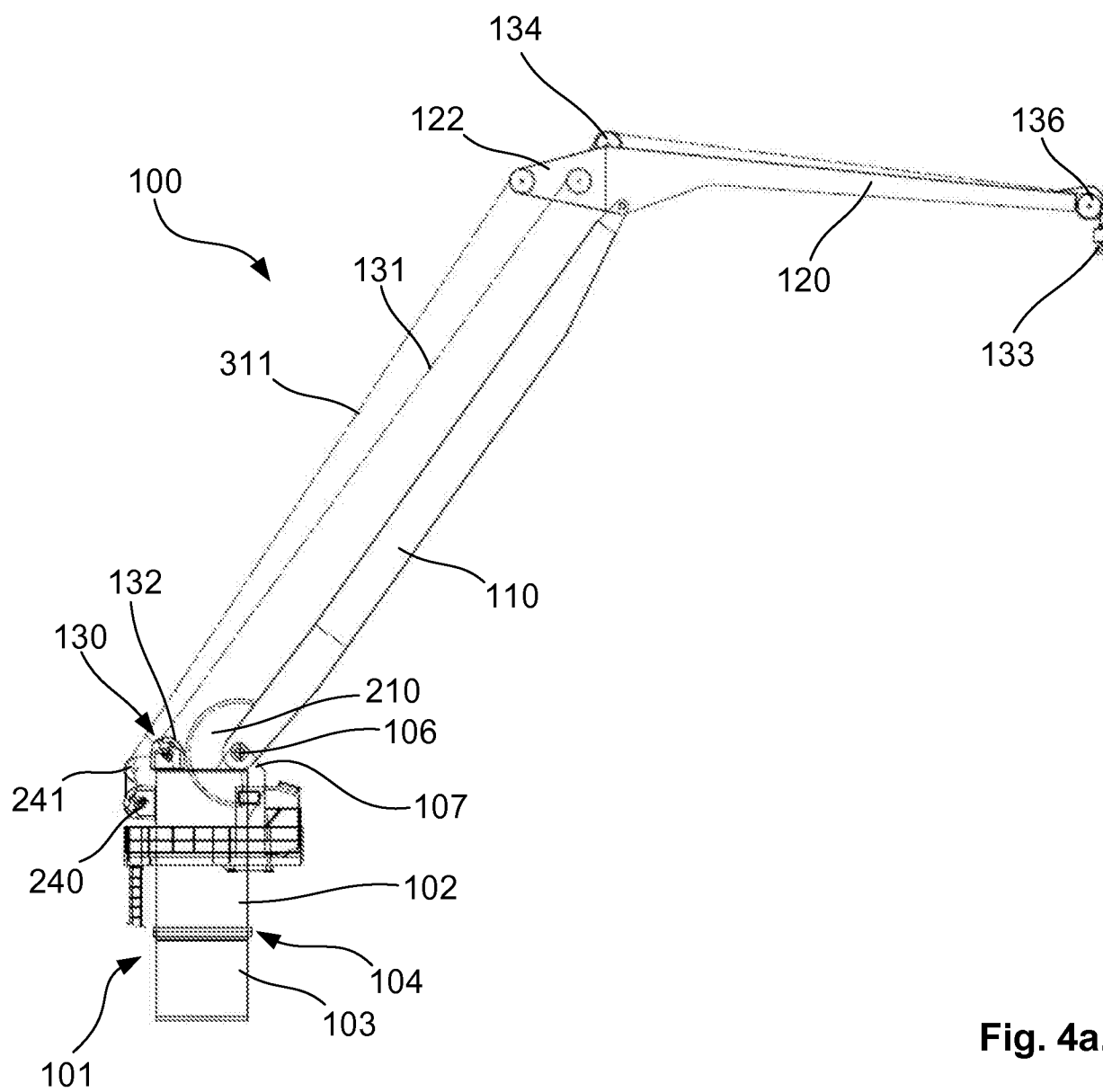
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**Fig. 2c.**

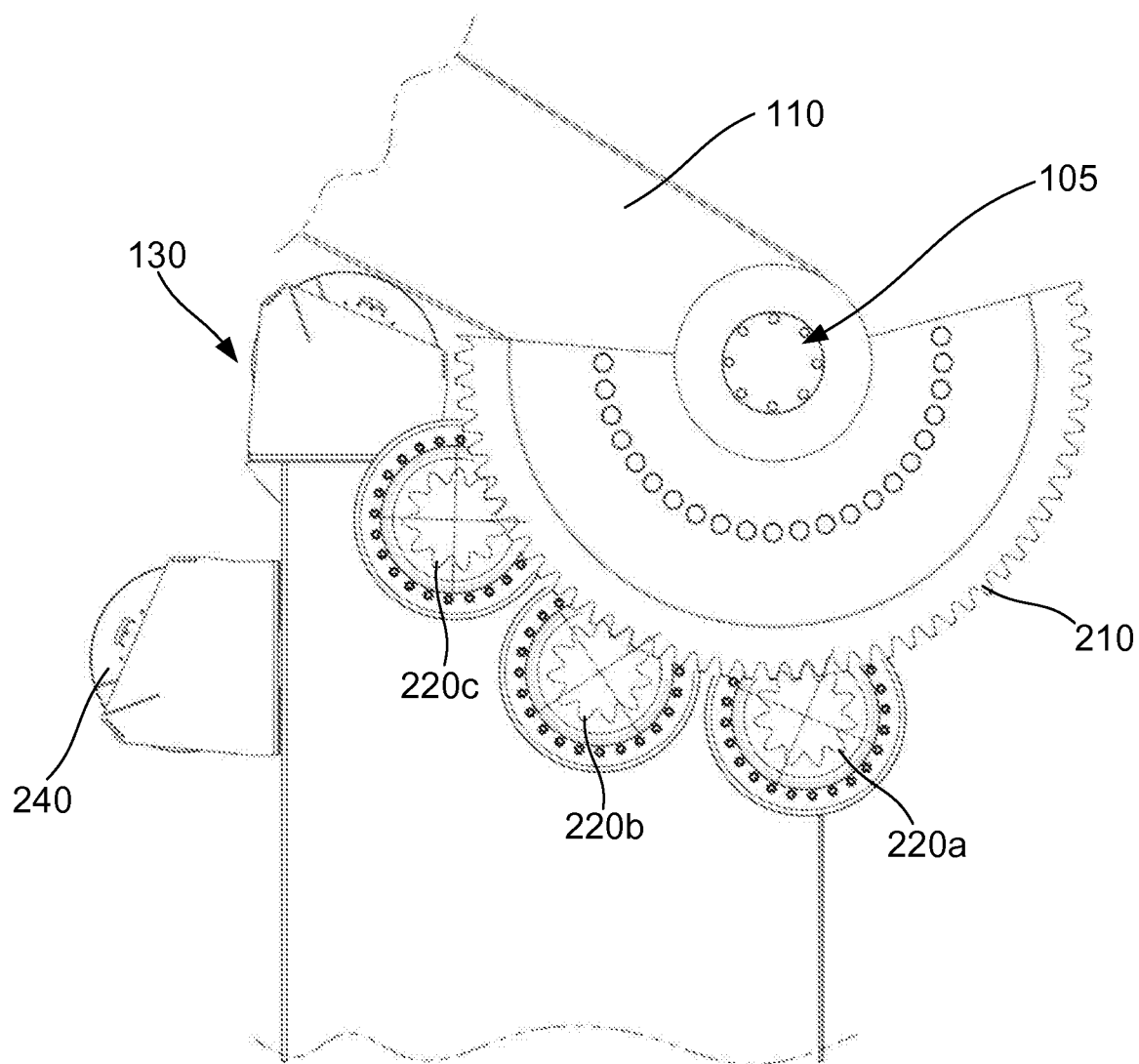
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**Fig. 4a.**

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**Fig. 4b.**