



(51) International Patent Classification:

B65H 59/18 (2006.01) *B65H 59/40* (2006.01)
B65H 59/20 (2006.01) *B65H 75/42* (2006.01)

(21) International Application Number:

PCT/SE2023/050593

(22) International Filing Date:

13 June 2023 (13.06.2023)

(25) Filing Language:

English

(26) Publication Language:

English

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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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, 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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,

(54) Title: SYSTEM, MACHINE, CONTROL UNIT AND METHOD THEREIN FOR HANDLING A CABLE AND/OR HOSE

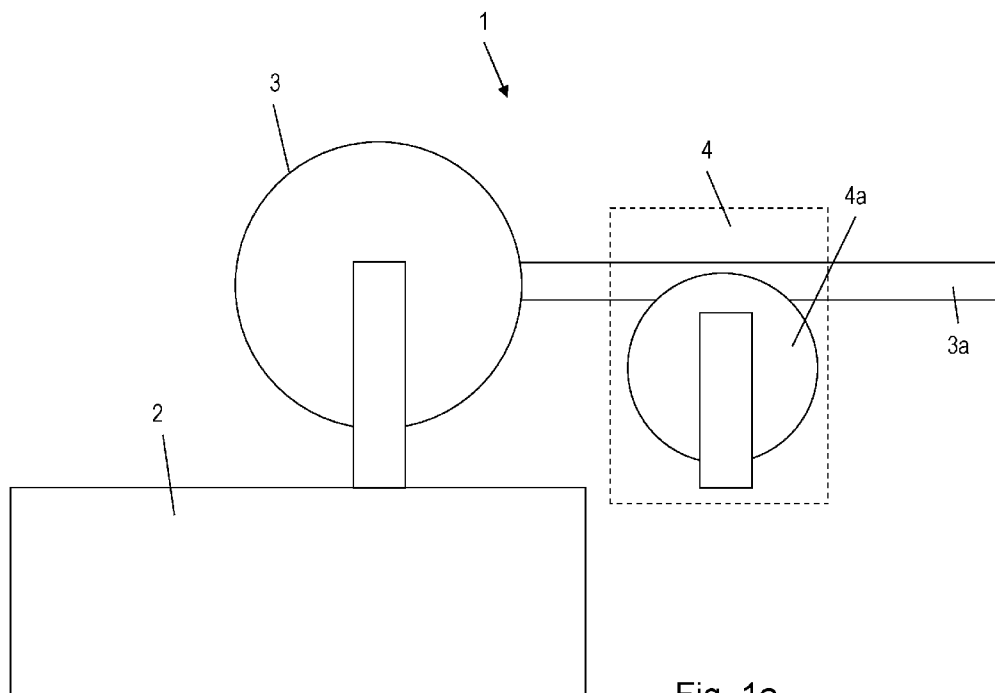


Fig. 1a

(57) Abstract: A cable handling system (1) at a mining and/or construction machine (2) is provided. The system (1) comprising: a cable reel (3) mounted on the mining and/or construction machine (2), a cable (3a) arranged to be wound onto or unwound from the cable reel (3), a cable tension assembly (4) that includes at least one wheel, belt and/or roller (4a), the cable tension assembly (4) arranged in proximity to a portion of the cable reel (3) where the cable (3a) is wound onto or unwound from the cable (3), wherein the cable (3a) is arranged to be in contact with the at least one wheel, belt and/or roller (4a) such that the at least one wheel, belt and/or rollers (4a) provides a tensioning of the cable (3a) while winding out the cable (3a) from the cable reel (3).

SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

SYSTEM, MACHINE, CONTROL UNIT AND METHOD THEREIN FOR HANDLING A CABLE AND/OR HOSE

TECHNICAL FIELD

5 Embodiments herein relate to a system, machine, control unit and method for handling a cable and/or hose stored on a cable and/or hose reel.

BACKGROUND OF THE INVENTION

 When using a cable and/or hose reel, or drum, together with a cable and/or hose
10 arm, the cable and/or hose may, when there is too much friction between the reel or drum and the cable outlet on the arm, raise up from the cable and/or hose reel, or drum, instead of being feed out to the ground when winding out cable and/or hose. This may increase the risk of tangling and/or destroyed or damage to the unwound cable and/hose.

15 Consequently, there is a need for improvements of the cable and/or hose handling.

SUMMARY OF THE INVENTION

 As part of developing embodiments herein a problem has been identified and will
20 first be discussed.

 With a cable and/or hose, there is always a risk of the cable and/or hose rising above the cable and/or hose reel or drum due to a lack of cable and/or hose tension. This may result in cable and/or hose tangling. Further, the lack of tension when unwinding the
25 cable and/or hose, increases the risk of damage or destruction of the cable and/or hose. This because the cable and/or hose may wear against parts of the cable and/or hose reel or drum, or other parts of a machine the cable and/or hose reel or drum is mounted on.

 An object of embodiments herein is to provide a mechanism that improves the
30 cable and/or hose handling, such as unwinding the cable and/or hose, by providing a tension to the cable and/or hose. The object is achieved by the independent claims.

According to a first aspect, a cable handling system at a mining or construction machine is provided. The system comprises:

- A cable reel mounted on the mining and/or construction machine,
- a cable arranged to be wound onto or unwound from the cable reel,
- 5 - a cable tension assembly that includes at least one wheel, belt and/or roller, the cable tension assembly arranged in proximity to a portion of the cable reel where the cable is wound onto or unwound from the cable reel;

wherein the cable is arranged to be in contact with the at least one wheel, belt and/or roller such that the at least one wheel, belt and/or roller provides a tensioning of the cable while winding out the cable from the cable reel. By provision of the cable handling system as disclosed herein, an improved cable handling system is provided, for which a cable is arranged to be in contact with at least one wheel, belt and/or roller in a cable tension assembly, the at least one wheel, belt and/or roller providing a tensioning of the cable when the cable is unwound from a cable reel. In particular, it has been realized that by providing a tensioning of the cable when unwinding said cable from the cable reel, the risk of the cable rising up above the cable reel is reduced. Thereby, as cable tangle and/or damage to the cable, e.g., due to the cable wearing against on or outside the cable reel, may be avoided, a more robust and reliable cable handling system is achieved in a cost-effective manner. By "a tensioning" of the cable as used herein is meant a tensioning force of the cable, such that the cable is tensioned between the cable reel and the cable tensioning assembly. Thus, by providing a tensioning of the cable, the tension of the cable, such as between the cable reel and the cable tensioning assembly, may be controlled. In other words, the cable handling system controls the tension of the cable by providing a tensioning, such as e.g., a tensioning force, to the cable. By providing a tensioning of the cable between the cable reel and the cable tension assembly, the risk of cable tangle and/or damage may be avoided. This e.g., since the cable is prevented from rising up above the cable reel. Further, by providing the tensioning of the cable, the cable may stay in the correct pattern when winding out the cable. By arranged in proximity to a portion of the cable reel where the cable is wound onto or unwound from the cable reel as used herein, is meant that the cable tension assembly is positioned in a location such that the cable may be arranged between the at least two wheels and/or rollers before entering the cable reel. The cable may in some examples be a hose, and the cable reel may in these examples be hose reel.

According to some exemplary embodiments, the tensioning of the cable is provided to a part of the cable that is arranged between the cable tension assembly and the cable reel.

5 According to some exemplary embodiments, the at least one wheel, belt and/or roller 4a comprises at least two wheels, belts or rollers. The cable is arranged between the at least two wheels, belts or rollers such that the at least two wheels, belts or rollers 4a provides a tensioning of the cable when the cable is unwound from the cable reel 3. The at least two wheels, belts and/or rollers may be provided in any combination, such as
10 one wheel and one roller, two wheels, two rollers, two belts, one belt and one roller, or one belt and one wheel. This example was with two wheels, belts and/or rollers, but any combination of more than two wheels, belts and/or rollers is also possible

According to some exemplary embodiments, the at least one wheel, belt and/or roller may provide a tensioning of the cable by applying a pushing force against the cable.

15 The pushing force may be applied by e.g., one of the at least one wheel, belt and/or roller pushing against the cable such that a tensioning of the cable is increased. In other words, the pushing force may be applied against the cable in a direction towards the cable.

According to some exemplary embodiments, the pushing force may be at least
20 one out of spring controlled, hydraulic controlled, or electric controlled. In some examples, a combination of two or of the above may be used to control the pushing force.

According to some exemplary embodiments, the at least one wheel, belt and/or roller may provide a tensioning of the cable by applying a rotating torque to the cable. The rotating torque may be applied by one or more of the at least one wheel, belt and/or roller.

25 E.g., the rotating torque may be applied by rotating at least one of the at least one wheel, belt and/or roller such that a pulling force is applied on the cable when the cable is unwound from the cable reel. This way, the cable may be tensioned, such as a tensioning is applied to the cable, between the cable and the cable reel.

According to some exemplary embodiments, the cable tension assembly may
30 include an actuator driving at least one of the at least one wheel, belt and/or roller to apply a rotating torque to the cable. The actuator may e.g., be an electrically or hydraulically controlled actuator. The actuator may be used to apply the rotating torque to the cable. The rotating torque may be a variable rotating torque, which may be controlled by controlling the actuator. Thus, the amount of tension may be controlled by the amount
35 of rotating torque.

According to some exemplary embodiments, the cable tension assembly may be arranged to release and/or reduce the tensioning of the cable when the tension of the cable is above an upper threshold and/or when the cable is wound in onto the cable reel.

According to some exemplary embodiments, the tension may be released and/or
5 reduced by retracting at least one of the at least two wheels or rollers.

This may release, or reduce, the tension of the cable by removing, or reducing, the pushing force applied to the cable.

According to some exemplary embodiments, the tension may be released and/or reduced by stopping the rotating torque to be applied.

10 This may release, or reduce, the tension of the cable by removing, or reducing, the rotating torque applied to the cable. In some examples, the tensioning may be released, or reduced, by a combination of releasing, or reducing, the pushing force and the rotating torque.

According to a second aspect, a method performed by a control unit for controlling
15 a tensioning of a cable while winding out the cable from a cable reel is provided. The tensioning of the cable is provided by a cable tension assembly arranged in proximity to a portion of the cable reel where the cable is wound onto or unwound from the cable reel.

The control unit monitors sensor data obtained from one or more sensors. The sensor data is related to one or more characteristics associated to one or more out of the
20 cable tension assembly, the cable reel and of the cable.

The control unit determines, based on the one or more characteristics, one or more parameters for controlling the tensioning of the cable.

The control unit controls the tensioning of the cable by applying the determined one or more parameters to the cable tension assembly.

25 According to some exemplary embodiments, the one or more sensors comprises any one or more out of:

- a tension sensor,
- a torque sensor,
- a pushing force sensor,
- 30 - a speed sensor,
- a flow sensor, and
- a pressure sensor.

According to some exemplary embodiments, the control unit may control the tensioning of the cable by any one out of:

- 35 - increasing the tension of the cable,

- reducing the tension of the cable, or
- releasing the tension of the cable..

According to some exemplary embodiments, the control unit may control the tensioning of the cable by any one or more out of:

- 5 - controlling a pushing force applied to, or to be applied to, the cable by the cable tension assembly, and
- controlling a rotational torque applied to, or to be applied to, the cable by the cable tension assembly.

The pushing force and/or the rotational torque may be controlled by applying the
10 one or more parameters.

According to some exemplary embodiments, the control unit may determine the one or more parameters by determining a current tension value of the cable, and comparing the current tension of the cable with a configured tension value, and determine whether current tension value is within a threshold of the configured tension value.

- 15 According to some exemplary embodiments, when determined that the current tension value is not within the threshold of the configured tension value, the control unit may determine the one or more parameters such that the tension of the cable is increased, reduced and/or released.

According to a third aspect, a control unit configured to control a tensioning of a
20 cable while winding out the cable from a cable reel is provided. The tensioning of the cable is adapted to be provided by a cable tension assembly arranged in proximity to a portion of the cable reel where the cable is wound onto or unwound from the cable reel. The control unit is further configured to:

- Monitor sensor data adapted to be obtained from one or more sensor, wherein
25 the sensor data is adapted to be related to one or more characteristics associated to one or more out of the cable tension assembly, the cable reel and of the cable,
- determine, based on the one or more characteristics, one or more parameters for controlling the tensioning of the cable, and
- control the tensioning of the cable by applying the determined one or more
30 parameters to the cable tension assembly.

According to a third aspect, a mining and/or construction machine comprising a cable arranged to be wound onto or unwound from a cable reel mounted on the machine is provided. The machine further comprises a cable handling system and a control unit according to embodiments herein, and one or more sensors for providing sensor data to
35 the control unit.

According to a fourth aspect it is furthermore provided herein a computer program comprising instructions, which, when executed by a processing circuitry, causes the processing circuitry to perform method above, as performed by the control unit.

5 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will hereinafter be further explained by means of non-limiting examples with reference to the appended schematic figures where;

- Fig. 1a shows a schematic view of a cable handling system according to
10 embodiments herein;
- Fig. 1b shows a schematic view of a cable handling system according to
embodiments herein;
- 15 Figs. 2a-d show schematic views of a cable tension assembly according to
embodiments herein;
- Fig. 3a shows a schematic view of a cable tension assembly according to
embodiments herein;
- 20 Figs. 3b-d show a schematic views of a pushing according to embodiments herein;
- Fig. 3e shows a schematic view of a cable tension assembly according to
embodiments herein;
- 25 Fig. 4a shows a schematic view of a cable tension assembly according to
embodiments herein;
- Fig. 4b shows a schematic view of a cable tension assembly according to
30 embodiments herein;
- Fig. 5 shows a schematic view of a cable tension assembly according to
embodiments herein;

- Fig. 6a shows a schematic view of a cable tension assembly according to embodiments herein;
- 5 Fig. 6b shows a schematic view of a cable tension assembly according to embodiments herein;
- Fig. 7 shows a schematic view of a cable handling system according to embodiments herein;
- 10 Fig. 8 shows a flowchart depicting embodiments of a method in a control unit;
- Fig. 9 shows a schematic view of a machine according to embodiments herein;
- 15 Figs. 10a-b shows schematic block diagrams illustrating embodiments of a control unit.

It should be noted that the drawings have not necessarily been drawn to scale and that the dimensions of certain features may have been exaggerated for the sake of clarity. Like reference signs in the drawings refer to the same or similar element, unless expressed
20 otherwise.

DETAILED DESCRIPTION OF EMBODIMENTS

An object of embodiments herein is to provide a mechanism that improves the cable and/or hose handling, such as unwinding the cable and/or hose, by providing a
25 tension to the cable and/or hose.

Embodiments herein may bring the advantage of an improved cable and/or hose handling. This may be achieved by, as mentioned above, making it possible to provide a tensioning of cable and/or hose when the cable and/or hose is unwound from cable reel or
30 drum, resulting in an improved cable and/or hose handling and e.g., keeping the tension of the cable and/or hose at suitable level. Further, embodiments herein may bring the advantage of reducing the risk of the cable and/or hose rising up above or outside the cable and/or hose reel or drum, resulting in less cable and/or hose tangling, reduced risk of cable and/or hose damage and improved cable and/or hose management by the cable
35 and/or hose staying in the correct pattern during unwinding.

Fig. 1a depicts a schematic view of a **cable handling system 1** according to example embodiments of the present invention. The system 1 comprises a **cable tension assembly 4**, a **cable reel 3** and a **cable 3a**. The cable handling system 1 is arranged at a **mining and/or construction machine 2**. The cable 3a is arranged to be wound onto or unwound from the cable reel 3. The cable tension assembly 4 includes, such as comprises, at least one wheel, belt and/or roller 4a. The cable 3a is arranged to be in contact with the at least one wheel, belt and/or roller 4a such that the cable tension assembly 4 provides a tensioning of the cable 3a when the cable 3a is unwound from the cable reel 3. The cable handling system 1 may provide tensioning of the cable 3a between the cable reel 3 and the cable tension assembly 4.

Fig. 1b depicts a schematic view of the cable handling system 1 according to further example embodiments of the present invention. The system 1 comprises the cable tension assembly 4, the cable reel 3, the cable 3a. The cable handling system 1 is arranged at the mining and/or construction machine 2. The cable 3a is arranged to be wound onto or unwound from the cable reel 3. The cable tension assembly 4 includes, such as comprises, at least two wheels and/or rollers 4a. The cable 3a is arranged between the at least two wheels and/or rollers such that the cable tension assembly 4 provides a tensioning of the cable 3a when the cable 3a is unwound from the cable reel 3. The cable handling system 1 may provide tensioning of the cable 3a between the cable reel 3 and the cable tension assembly 4.

Figs. 2a and 2b depict schematic views of the cable tension assembly 4 from two angles according to example embodiments of the present invention. In this example, the cable tension assembly 4 comprises one wheel, belt and/or roller 4a. Here, the cable 3a is arranged to be in contact with the at least one wheel, belt and/or roller 4a such that the cable tension assembly 4 provides a tensioning of the cable 3a when the cable 3a is unwound from a cable reel (not shown). E.g., the tensioning of the cable 3a is provided between the cable reel 3 and the cable tension assembly 4. Here, the cable tension assembly 4 comprises a **supporting structure 4c** to which the at least one wheel, belt and/or roller 4a is fastened. The at least one wheel, belt and/or roller 4a may be fastened to the supporting structure 4c such that they may rotate freely. The supporting structure 4c is depicted comprising four parts, though this is only for illustrative purposes, the supporting structure 4c may be arranged in any other suitable way. The shape of the at

least one wheel, belt and/or roller 4a as depicted in Figs 2a and 2b is only for illustrative purposes, and may be shaped in any suitable way.

Figs. 2c and 2d depict schematic views of the cable tension assembly 4 from two angles according to example embodiments of the present invention. In this example, the cable tension assembly 4 comprises two wheels, belts and/or rollers 4a. Here, the cable 3a is arranged between the at least two wheels and/or rollers 4a such that the cable tension assembly 4 provides a tensioning of the cable 3a when the cable 3a is unwound from a cable reel (not shown). E.g., the tensioning of the cable 3a is provided between the cable reel 3 and the cable tension assembly 4. Here, the cable tension assembly 4 comprises a **supporting structure 4c** to which the wheels and/or rollers 4a are fastened. The at least two wheels and/or rollers 4a may be fastened to the supporting structure 4c such that they may rotate freely. The supporting structure 4c is depicted comprising four parts, though this is only for illustrative purposes, the supporting structure 4c may be arranged in any other suitable way. The shape of the at least two wheels and/or rollers 4a as depicted in Figs 2a and 2b is only for illustrative purposes, and may be shaped in any suitable way.

Figs. 3a depicts a schematic view of the cable tension assembly according to example of embodiments of the present invention. In this example, the cable tension assembly 4 comprises one wheel, belt and/or roller 4a. Here, the cable tension assembly 4 provides a tensioning of the cable by applying a pushing force against the cable 3a. The pushing force is applied by the wheel, belt and/or roller 4a pushing against the cable 3a in a direction towards the cable 3a. The pushing force may be applied by a **pushing mechanism 4d** that pushes the wheel, belt and/or roller 4a in a direction towards the cable 3a. Fig 3 is exemplified with two pushing mechanisms 4d, one on each side of the wheel, belt and/or roller 4a. In other examples of embodiments, one or more than two pushing mechanisms 4d may be used. By controlling the pushing force applied to the cable 3a, the tension of the cable 3a may be adapted to stay within two or more predefined thresholds.

The pushing force may e.g., be spring controlled, hydraulic controlled, or electrically controlled, e.g., as shown in **Figs 3b-d**. As mentioned above, the pushing force may be applied by using the pushing mechanism 4d.

Fig. 3b depicts a spring controlled pushing mechanism 4d where the pushing force is applied by using a **spring 4d'** that pushes the wheel, belt and/or roller 4a in the direction towards the cable 3a.

Fig. 3c depicts a hydraulic controlled pushing mechanism 4d where the pushing
5 force is applied by using a **hydraulic member 4d''** that pushes the wheel, belt and/or roller 4a in the direction towards the cable 3a.

Fig. 3d depicts an electrically controlled pushing mechanism 4d where the pushing force is applied by using e.g., an **electric actuator 4d'''** that pushes the wheel, belt and/or roller 4a in the direction towards cable 3a.

10

Figs. 3e depicts a schematic view of the cable tension assembly according to example of embodiments of the present invention. In this example, the cable tension assembly 4 comprises two wheels, belts and/or rollers 4a. Here, the cable tension assembly 4 provides a tensioning of the cable by applying a pushing force against the
15 cable 3a. The pushing force is applied by the lower wheel, belt and/or roller 4a pushing against the cable 3a in a direction towards the upper wheel or roller 4a. The pushing force may be applied by a pushing mechanism 4d that pushes the lower wheel, belt and/or roller 4a in a direction towards the upper wheel, belt and/or roller 4a. Fig 3e is exemplified with two pushing mechanisms 4d, one on each side of the lower wheel, belt and/or roller
20 4a. In other examples of embodiments, one or more than two pushing mechanisms 4d may be used. E.g., a pushing mechanism 4d may be used on the upper wheel, belt and/or roller 4a, either instead of or in addition to the pushing mechanism 4d used on the lower wheel, belt and/or roller 4a. A pushing mechanism 4d used on the upper wheel, belt and/or roller 4a may in such an example apply the pushing force by pushing against the
25 cable 3a in a direction towards the upper wheel, belt and/or roller 4a. By controlling the pushing force applied to the cable 3a, the tension of the cable 3a may be adapted to stay within two or more predefined thresholds.

Fig. 4a depicts a schematic view of the cable tension assembly according to
30 example of embodiments of the present invention. Here, the cable tension assembly 4 comprises an **actuator 4b**. The actuator 4b is connected to at least one of the at least one wheel, belt and/or roller 4a such that the actuator 4b may drive the at least one wheel or roller 4a to apply a rotating torque to the cable 3a. The rotating torque applied to the cable 3a provides a tensioning of the cable 3a. E.g., the rotating torque may be applied by
35 rotating the at least one wheel, belt and/or roller 4a such that a pulling force is applied on

the cable 3a when the cable is unwound from the cable reel 3. This way, the cable 3a may be tensioned, such as a tensioning is applied to the cable 3a, between the cable 3a and the cable reel 3. The actuator may e.g., be an electrically or hydraulically controlled actuator. By controlling the rotating torque applied by the actuator 4b, the tension of the
5 cable 3a may be adapted to stay within two or more predefined thresholds. Fig. 4a shows an example with one wheel, belt and/or roller 4a. This is only an example and should not be seen as limiting to the scope. The cable tension assembly 4 may comprise more than one wheel, belt and/or roller 4a.

10 In some examples, the actuator 4b is connected to more than one wheel, belt and/or roller 4a, as depicted in **Fig. 4b**. Here, the actuator 4b is connected to the both the upper and the lower wheel, belt and/or roller 4a. The cable tension assembly 4 provides a tensioning of the cable 3a by the actuator 4b driving the upper and lower wheel, belt and/or roller 4a to apply a rotating torque to the cable 3a. In other words, rotating torque is
15 applied by the actuator 4b rotating the upper and lower wheels, belts and/or rollers 4a such that a pulling force is applied on the cable 3a when the cable is unwound from the cable reel 3. The upper and lower wheels, belts and/or rollers 4a must be rotated in opposite directions. Therefore, the actuator 4b in this example is connected to upper and lower wheels, belts and/or rollers 4a through gearing such that the wheels, belts and/or
20 rollers 4a rotate in the correct direction, i.e., opposite to each other.

Fig. 5 depicts a schematic view of the cable tension assembly according to example of embodiments of the present invention. Here, the cable tension assembly 4 provides a tensioning of the cable 3a by applying a pushing force against the cable 3a
25 and further by applying a rotating torque to the cable 3a. Thus, this may be seen as a combination of examples of embodiments as described above in relation to any Figs. 3a-e and any of Figs. 4a-b. The pushing force may, as described above, be hydraulically, electrically or spring controlled, e.g., by using the pushing mechanism 4d. The cable tension assembly 4 provides tensioning to the cable 3a by pushing the wheel, belt and/or
30 roller 4a in a direction towards the cable 3a, thereby applying a pushing force against the cable 3a. Additionally, the cable tension assembly 4 provides a tensioning of the cable 3a by applying a rotating torque to the cable 3a. In this example, the rotating torque is applied cable 3a by the actuator 4d driving, such as rotating, the wheel, belt and/or roller 4a. By the combination of a pushing force a rotating torque, the tension of the cable 3a
35 may be more efficiently and accurately controlled. Further, the rotating torque may be

used to unwind the cable 3a from the cable reel 3 while maintaining the tension of the cable 3a. Fig. 5 shows an example with one wheel, belt and/or roller 4a. This is only an example and should not be seen as limiting to the scope. The cable tension assembly 4 may comprise more than one wheel, belt and/or roller 4a.

5

Fig. 6a depicts a schematic view of the cable tension assembly 4 according to example of embodiments of the present invention. Here, the cable tension assembly 4 releases, or at least reduces, the tension of the cable 3a. The current tensioning of the cable 3a is provided by a pushing force applied by at least one of the at least one wheel, belt and/or roller 4a. In order to release, or reduce, the tensioning of the cable 3a, the pushing force is released or reduced. This may be performed by e.g., retracting the at least one wheel, belt and/or roller 4a that applies the pushing force. E.g., the pushing mechanism 4d may be deactivated, meaning that the action performed to apply the pushing force is stopped. E.g., if the pushing force is spring controlled, the load to spring may be reduced, or removed, such that the at least one wheel, belt and/or roller 4a does not provide a pushing force. Alternatively, or additionally, the pushing force may be hydraulically or electrically controlled, in which case the at least one wheel or roller 4a may be moved in direction away from the cable 3a. Fig. 6a shows an example with one wheel, belt and/or roller 4a. This is only an example and should not be seen as limiting to the scope. The cable tension assembly 4 may comprise more than one wheel, belt and/or roller 4a.

Fig. 6b depicts a schematic view of the cable tension assembly 4 according to example of embodiments of the present invention. Here, the cable tension assembly 4 releases, or at least reduces, the tension of the cable 3a. The current tensioning of the cable 3a is provided by a rotating torque applied by at least one of the at least one wheel, belt and/or roller 4a. In order to release, or reduce, the tensioning of the cable 3a, the rotating torque is released or reduced. E.g., the actuator 4d may be deactivated, meaning that the action performed to apply the pushing force is stopped. E.g., if the actuator drives the at least one wheel, belt and/or roller 4a that provides the rotating torque to the cable 3a, the actuator may stop or reduce speed by which it is driving the at least one wheel, belt and/or roller 4a. Fig. 6b shows an example with one wheel, belt and/or roller 4a. This is only an example and should not be seen as limiting to the scope. The cable tension assembly 4 may comprise more than one wheel, belt and/or roller 4a.

35

Fig. 7 depicts a schematic view of the cable handling system 1 according to example of embodiments of the present invention. The system 1 comprises the cable tension assembly 4, the cable reel 3, and the cable 3a. The cable reel 3 is mounted on the mining and/or construction machine 2. The cable 3 is arranged to be wound onto or
5 unwound from the cable reel 3. In this example, the cable tension assembly 4 includes, such as comprises, at least two wheels, belts and/or rollers 4a. The cable 3a is arranged between the at least two wheels, belts and/or rollers 4a such that the cable tension assembly 4 provides a tensioning of the cable 3a when the cable 3a is unwound from the cable reel 3. The cable handling system 1 further comprises an optional **arm member 5**
10 with a **first end 5a** attached to the machine 2. An optional **cable guide mechanism 6** is attached to a **second end 5b** of the arm member 5. The cable tension assembly 4 is arranged on optional the arm member 5 between the first end 5a and the second end 5b. The optional cable guide mechanism 6 is arranged to guide the unwound cable 3a in the correct direction such that the cable 3a avoids wearing against parts of the machine 2.
15 **Fig. 7** shows an example with at least two wheels, belts and/or rollers 4a. This is only an example and should not be seen as limiting to the scope. The cable tension assembly 4 may comprise more only one wheel, belt and/or roller 4a.

Fig. 8 shows an example embodiment of a method performed by a method
20 performed by a control unit 10 for controlling a tensioning of the cable 3a while winding out the cable 3a from the cable reel 3. The tensioning of the cable 3a is provided by the cable tension assembly 4 arranged in proximity to a portion of the cable reel 3 where the cable 3a is wound onto or unwound from the cable reel 3. The method comprises the following actions, which may be taken in any suitable order. Optional actions are referred
25 to as dashed boxes in **Fig. 8**.

Action 801

In some embodiments, the control unit 10 obtains sensor data from the one or more sensors 11. The sensor data is related to one or more characteristics associated to one or more out of the cable tension assembly 4, the cable reel 3 and of the cable 3a.

30 The one or more sensors 11 may comprise any one or more out of: A tension sensor, a torque sensor, a pushing force sensor, a speed sensor, a flow sensor, and a pressure sensor.

The tension sensor may e.g., provide sensor data related the tension of the cable 3a.

The torque sensor may e.g., provide sensor data related to the rotational torque provided to the cable 3a by the cable tension assembly 4. Alternatively, or additionally, the torque sensor may e.g., provide sensor data related to the torque of the cable reel 3, an electric motor driving the cable reel 3, and/or an electric motor, such as the actuator 4b, driving at least one of the at least one wheel, belt or roller 4a of the tension assembly 4.

The pushing force sensor may e.g., provide sensor data related to the pushing force provided to the cable 3a by the cable tension assembly 4.

The speed sensor may e.g., provide sensor data related to the speed of at least one of the at least one wheel, belt or roller 4a of the tension assembly 4. Alternatively, or additionally, the speed sensor may e.g., provide sensor data related to a speed of the cable reel 3, an electric and/or hydraulic motor driving the cable reel 3, at least one of the at least one wheel, belt and/or roller 4a, and/or an electric and/or hydraulic motor, such as the actuator 4b, driving at least one of the at least one wheel, belt or roller 4a of the tension assembly 4.

The flow sensor may e.g., provide sensor data related to an oil flow in a hydraulic system, such as a hydraulic pump and/or hydraulic motor, e.g., the actuator 4b, driving at least one of the at least one wheel, belt and/or roller 4a, and/or a hydraulic system, such as a hydraulic pump and/or hydraulic motor, driving the cable reel 3.

The pressure sensor may e.g., provide sensor data related to an oil pressure in a hydraulic system, such as a hydraulic pump and/or hydraulic motor, e.g., the actuator 4b, driving at least one of the at least one wheel, belt and/or roller 4a, and/or a hydraulic system, such as a hydraulic pump and/or hydraulic motor, driving the cable reel 3.

Action 802

The control unit 10 monitors sensor data obtained from the one or more sensor 11. The sensor data is related to one or more characteristics associated to one or more out of the cable tension assembly 4, the cable reel 3 and of the cable 3a. The one or more characteristics may e.g., comprise a tension of the cable 3a, an oil flow and/or pressure in a hydraulic system, such as a hydraulic pump and/or hydraulic motor, an electric motor rotational speed and/or torque, a cable reel rotational speed and/or torque, a pushing force applied to the cable 3a, and/or a rotational torque applied to the cable 3a.

The one or more sensor 11 may be connected to the control unit 10 wirelessly, or there may be a wired connection between the one or more sensors 11 and the control unit 11. In some examples, there may be combination of wired and wirelessly connected sensors 11 connected to the control unit 10. Examples of the wireless connection may

(but not limited to) be a Bluetooth connection, a WIFI connection, a cellular connection, such as a GSM, GPRS, EDGE, WCDMA, LTE and/or 5G cellular connection.

Action 803

The control unit 10 determines, based on the one or more characteristics, one or
5 more parameters for controlling the tensioning of the cable 3a.

The one or more parameters may e.g., comprise a parameter related to a pushing force to be applied to the cable 3a, and/or a parameter related to a rotational torque to be applied to the cable 3a.

A parameter related to the pushing force to be applied to the cable 3a may e.g.,
10 comprise a position of at least one of the at least one wheel, belt and/or roller 4a. Depending on the position of a wheel, belt and/or roller 4a, the pushing force on the cable 3a may be increased or reduced. Thus, by changing the position of a wheel, belt and/or roller 4a, the pushing force applied to the cable 3a may be adapted, resulting in that the tensioning of the cable 3a may be adapted, such as controlled.

15 A parameter related to the rotational to be applied to the cable 3a may e.g., comprise a speed of the wheel, belt and/or roller 4a, such as a rotational speed, and/or a speed of an electrical motor and/or hydraulic motor, such as the actuator 4b, driving at least one or the at least one wheel, belt and/or roller 4a.

Depending on the speed of a wheel, belt and/or roller 4a, and/or an electrical
20 motor and/or hydraulic motor, such as the actuator 4b, driving at least one or the at least one wheel, belt and/or roller 4a, the rotational torque applied to the cable 3a may be increased or reduced. Thus, by changing the position of a wheel, belt and/or roller 4a, the speed of a wheel, belt and/or roller 4a, and/or an electrical motor and/or hydraulic motor, such as the actuator 4b, driving at least one or the at least one wheel, belt and/or roller
25 4a, may be adapted, resulting in that the tensioning of the cable 3a may be adapted, such as controlled.

By combining parameters related to the pushing force and the rotational torque, an increased control of the tensioning of the cable 3a may be achieved, compared to using only one of the parameters. This since tensioning of the cable 3a may be more accurately
30 controlled by adapting both the pushing force and the rotational torque.

In some embodiments, the control unit 10 determines the one or more parameters by determining a current tension value of the cable 3a, and comparing the current tension of the cable 3a with a configured tension value. The control unit 10 determines whether the current tension value is within a threshold of the configured tension value. Being within
35 a threshold of the configured tension value may e.g., mean that the current tension value

is above a lower threshold that is lower the configured tension value and below an upper threshold that is higher than the configured tension value. The lower and upper thresholds may be configured in the control unit 10. The control unit 10 may be configured with more than one configured tension value. The configured tension value to use may be selected
5 by the control unit 10 and/or an operator, e.g., depending on the 3a, such as the dimension, stiffness, flexibility, and/or strength of the cable 3a.

When determined that the current tension value is not within the threshold of the configured tension value, the control unit 10 may determine the one or more parameters such that the tension of the cable 3a is increased, reduced and/or released.

10 For example, when the tension of the cable 3a is too low, such as the current tension value is below the lower threshold, the one or more parameters may be determined such that the tension of the cable 3a is increased. as a another example, when the tension of the cable 3a is to high, such as the current tension value is above the upper threshold, the one or more parameters may be determined such that the tension of
15 the cable 3a is reduced and/or released. Releasing the tension of the cable 3a may e.g., mean that no pushing force and/or rotational torque is applied to the cable 3a. This may e.g., be the case when the configured tension value is zero, i.e., no tensioning of the cable 3a is to be provided to the cable 3a by the cable tension assembly 4.

Action 804

20 The control unit 10 controls the tensioning of the cable 3a by applying the determined one or more parameters to the cable tension assembly 4. This enables the control unit 10 to control the tensioning of the cable 3a, since by applying the one or more parameters to the cable tension assembly 4, the cable tension assembly 4 may provide a tensioning of the cable 3a according to the applied one or more parameters.

25 Applying the one or more parameters may e.g., mean controlling the cable tension assembly 4 such that the cable tension assembly 4 operates according to the determined parameters.

In some embodiments, controlling the tensioning of the cable 3a may comprise any one out of: Increasing the tension of the cable 3a, reducing the tension of the cable
30 3a, or releasing the tension of the cable 3a. As mentioned above, the control unit 10 may increase the tension of the cable 3a when the current tension is too low, such as when the current tension is below the lower threshold. Correspondingly, the control unit 10 may decrease the tension of the cable 3a when the current tension is too high, such as when the current tension is above the upper threshold. Further, also as mentioned above, the

control unit 10 may release the tension of the cable 3a, e.g., when the configured tension value is zero.

In some embodiments, the control unit 10 controls the tensioning of the cable 3a by any one or more out of: Controlling a pushing force applied to the cable 3a by the cable
5 tension assembly 4, and controlling a rotational torque to applied to the cable 3a by the cable tension assembly 4. The pushing force and/or the rotational torque may be controlled by applying the one or more parameters.

For example, the control unit 10 may control the pushing force by increasing or reducing the pushing force. By increasing the pushing force, the tensioning of the cable
10 3a may be increased. Correspondingly, the tensioning of the cable 3a may be decreased by reducing the pushing force, or the tensioning may be released by stopping the pushing force. Alternatively, or additionally, the control unit 10 may control the rotational torque. By increasing the rotational torque, the tensioning of the cable 3a may be increased. Correspondingly, the tensioning of the cable 3a may be decreased by reducing the
15 rotational torque, the tensioning may be released by stopping the rotational torque.

Fig. 9 depicts a schematic view of the mining or construction machine 2 according to example of embodiments of the present invention. In Fig. 9, the mining and/or construction machine 2 is depicted as a drill rig. This should not be seen as limiting to the
20 scope, but is merely shown as an example of a mining and/or construction machine 2. The mining and/or construction machine 2 may be any other type of mining and/or construction machine 2. The mining and/or construction machine 2 comprises the cable handling system 1 according to examples of embodiments herein. The cable handling system 1 comprises the cable reel 3, the cable 3a and the cable tension assembly 4. The
25 cable reel 3 is mounted on the machine 2. In this example, the cable tension assembly 4 is arranged on the optional arm member 5, though in other examples the cable tension assembly 4 may be mounted directly on the mining and/or construction machine 2. Fig. 9 further shows the optional cable guide mechanism 6 attached to the second end 5b of the arm member 5, though in other examples the optional cable guide mechanism 6 is not
30 present. The mining and/or construction machine 2 in this example further comprises the control unit 10 and the one or more sensors 11. In other examples, the mining and/or construction machine 2 does not comprise the control unit 10 and/or the one or more sensors 11.

Fig. 10a discloses an example configuration of the control unit 10 configured to control a tensioning of the cable 3a while winding out the cable 3a from the cable reel 3. The tensioning of the cable 3a is adapted to be provided by the cable tension assembly 4 arranged in proximity to a portion of the cable reel 3 where the cable 3a is wound onto or
5 unwound from the cable reel 3. The control unit 10 comprises a memory 1060 operable to store instructions and processing circuitry 1050 operable to execute the instructions.

The controller unit 10 may comprise **an input and output interface 1000** configured to communicate with, e.g., the one or more sensors 11.

10 **Fig. 10b** also discloses an example configuration of processing circuitry for a control unit 10, e.g., the processing circuitry 1050 disclosed in Fig. 10a. The processing circuitry may comprise a **determining unit 1010**, a **monitoring unit 1020**, a **controlling unit 1030** and an **obtaining unit 1040** configured to perform the methods above.

The embodiments herein may be implemented through the processing circuitry
15 1050 in the control unit 10 depicted in Figure 10a, together with respective computer program code for performing the functions and actions of the embodiments herein. The processing circuitry 1050 may comprise one or more processors and one or more memory units. The memory units may be the memory 1060. The program code mentioned above may also be provided as a computer program product, for instance in the form of a
20 data carrier carrying computer program code for performing the embodiments herein when being loaded into the control unit 10. One such carrier may be in the form of a CD ROM disc, a USB flash drive, and/or an Over-the-Air (OTA) carrier. It is however feasible with other data carriers such as a memory stick. The computer program code may furthermore be provided as pure program code on a server and downloaded to the control
25 unit 10.

The memory 1060 of the control unit 10 may further comprise one or more memory units. The memory 1060 is configured to store instructions executable by the processing circuitry 1050. The memory 1060 is arranged to be used to store e.g., information, messages, indications, configurations, unwinding speed, rotational speed,
30 sensor data, characteristics, parameters, thresholds, tension values, pushing forces, rotational torques, measurements, locations, positions, and applications to perform the methods herein when being executed in the control unit 10.

The control unit 10 is configured to control a tensioning of the cable 3a when the cable 3a is unwound from the cable reel 3. The tensioning of the cable 3a is adapted to be

provided by the cable tension assembly 4 arranged in proximity to a portion of the cable reel 3 where the cable 3a is wound onto or unwound from the cable reel 3.

The control unit 10 monitors sensor data adapted to be obtained from one or more sensor 11. The sensor data is adapted to be related to one or more characteristics
5 associated to one or more out of the cable tension assembly 4, the cable reel 3 and of the cable 3a.

The control unit 10 determines, based on the one or more characteristics, one or more parameters for controlling the tensioning of the cable 3a.

The control unit 10 controls the tensioning of the cable 3a by applying the
10 determined one or more parameters to the cable tension assembly 4.

In some embodiments, a computer program 1070 comprises instructions, which when executed by the processing circuitry 1050, e.g., of the respective at least one processor of the processing circuitry 1050, cause the processing circuitry 1050 of the control unit 10 to perform the actions above.

15 In some embodiments, a respective carrier 1080 comprises the respective computer program 1070, wherein the carrier 1080 is one of an electronic signal, an optical signal, an electromagnetic signal, a magnetic signal, an electric signal, a radio signal, a microwave signal, or a computer-readable storage medium.

Those skilled in the art will appreciate that the units in the control unit 10 described
20 above may refer to a combination of analogue and digital circuits, and/or one or more processors configured with software and/or firmware, e.g., stored in the control unit 10, that when executed by the respective one or more processors such as the processors described above. One or more of these processors, as well as the other digital hardware, may be included in a single Application-Specific Integrated Circuitry (ASIC), or several
25 processors and various digital hardware may be distributed among several separate components, whether individually packaged or assembled into a system-on-a-chip (SoC).

It will be appreciated that the foregoing description and the accompanying
30 drawings represent non-limiting examples of the methods and apparatus taught herein. As such, the apparatus and techniques taught herein are not limited by the foregoing description and accompanying drawings. Instead, the embodiments herein are limited only by the following claims and their legal equivalents.

CLAIMS

1. A cable handling system (1) at a mining and/or construction machine (2), the system (1) comprising:
- a cable reel (3) mounted on the mining and/or construction machine (2),
 - 5 - a cable (3a) arranged to be wound onto or unwound from the cable reel (3),
 - a cable tension assembly (4) that includes at least one wheel, belt and/or roller (4a), the cable tension assembly (4) arranged in proximity to a portion of the cable reel (3) where the cable (3a) is wound onto or unwound from the cable reel (3),
 - wherein
 - 10 the cable (3a) is arranged to be in contact with the at least one wheel, belt and/or roller (4a) such that the at least one wheel, belt and/or roller (4a) provides a tensioning of the cable (3a) while winding out the cable (3a) from the cable reel (3).
- 15 2. The system (1) according to claim 1, wherein the tensioning of the cable (3a) is provided to a part of the cable (3a) that is arranged between the cable tension assembly (4) and the cable reel (3).
3. The system (1) according to any of claims 1-2, wherein the at least one wheel, belt
- 20 and/or roller (4a) provides a tensioning of the cable (3a) by applying a pushing force against the cable (3a).
4. The system according to claim 3, where the pushing force is at least one out of:
- spring controlled,
 - 25 - hydraulic controlled, or
 - electric controlled.
5. The system (1) according to any of claims 1-4, wherein the at least one wheel, belt and/or roller (4a) provides a tensioning of the cable (3a) by applying a rotating torque to
- 30 the cable (3a).
6. The system (1) according to any of claims 1-5, wherein the cable tension assembly includes an actuator (4b) driving at least one of the at least one wheel, belt and/or roller (4a) to apply a rotating torque to the cable (3a).

7. The system (1) according to any of claims 1-6, wherein the cable tension assembly (4) is arranged to release and/or reduce the tensioning of the cable (3a) when the tension of the cable (3a) above an upper threshold and/or when the cable (3a) is wound in onto the cable reel (3).

5

8. The system (1) according to any of claim 7, wherein the tension is released and/or reduced by retracting at least one of the at least one wheel, belt and/or roller (4a).

9. The system (1) according to any of claims 7-8, wherein the tension is released
10 and/or reduced by stopping the rotating torque to be applied.

10. The system (1) according to any of claims 1-9, wherein the at least one wheel, belt and/or roller (4a) comprises at least two wheels, belts or rollers (4a), and wherein the cable (3a) is arranged between the at least two wheels, belts and/or rollers (4a) such that
15 the at least two wheels, belts and/or rollers (4a) provides a tensioning of the cable (3a) when the cable (3a) is unwound from the cable reel (3).

11. A method performed by a control unit (10) for controlling a tensioning of a cable (3a) while winding out the cable (3a) from a cable reel (3), wherein the tensioning of the
20 cable (3a) is provided by a cable tension assembly (4) arranged in proximity to a portion of the cable reel (3) where the cable (3a) is wound onto or unwound from the cable reel (3), the method comprising:

monitoring (801) sensor data obtained from one or more sensor (11), wherein the sensor data is related to one or more characteristics associated to one or more out of the
25 cable tension assembly (4), the cable reel (3) and of the cable (3a),

determining (802), based on the one or more characteristics, one or more parameters for controlling the tensioning of the cable (3a), and

controlling (803) the tensioning of the cable (3a) by applying the determined one or more parameters to the cable tension assembly (4).

30

12. The method according to claim 11, wherein the one or more sensors comprises any one or more out of:

- a tension sensor,
- a torque sensor,
- 35 - a pushing force sensor,

- a speed sensor,
- a flow sensor, and
- a pressure sensor.

5 13. The method according to any of claims 11-12, wherein *controlling* (803) the tensioning of the cable (3a) comprises any one out of:

- increasing the tension of the cable (3a),
- reducing the tension of the cable (3a), or
- releasing the tension of the cable (3a).

10

14. The method according to any of claims 11-13, wherein *controlling* (803) the tensioning of the cable (3a) comprises any one or more out of:

- controlling a pushing force applied to the cable (3a) by the cable tension assembly (4), and

15 - controlling a rotational torque to applied to the cable (3a) by the cable tension assembly (4),

wherein the pushing force and/or the rotational torque is controlled by applying the one or more parameters.

20 15. The method according to any of claims 11-14, wherein *determining* (802) the one or more parameters comprises determining a current tension value of the cable (3a), and comparing the current tension of the cable (3a) with a configured tension value, and determining whether current tension value is within a threshold of the configured tension value.

25

16. The method according to claim 15, wherein when determined that the current tension value is not within the threshold of the configured tension value, determining the one or more parameters such that the tension of the cable (3a) is increased, reduced and/or released.

30

17. A computer program (970) comprising instructions, which when executed by a processing circuitry (950), causes the processing circuitry (950) to perform actions according to any of the claims 11-16.

18. A control unit (10) configured to control a tensioning of a cable (3a) when the cable (3a) is unwound from a cable reel (3), wherein the tensioning of the cable (3a) is adapted to be provided by a cable tension assembly (4) arranged in proximity to a portion of the cable reel (3) where the cable (3a) is wound onto or unwound from the cable reel (3), the
5 control unit (10) further being configured to:

monitor sensor data adapted to be obtained from one or more sensor (11), wherein the sensor data is adapted to be related to one or more characteristics associated to one or more out of the cable tension assembly (4), the cable reel (3) and of the cable (3a),

10 *determine*, based on the one or more characteristics, one or more parameters for controlling the tensioning of the cable (3a), and

control the tensioning of the cable (3a) by applying the determined one or more parameters to the cable tension assembly (4).

15 19. The control unit (10) according to claim 18, wherein the control unit (10) is further configured to perform the method according to any of claims 12-16.

20. A mining and/or construction machine (2) comprising a cable handling system (1) according to claim 1, a control unit (10) according to claim 18, and one or more sensors
20 (11) for providing sensor data to the control unit (10).

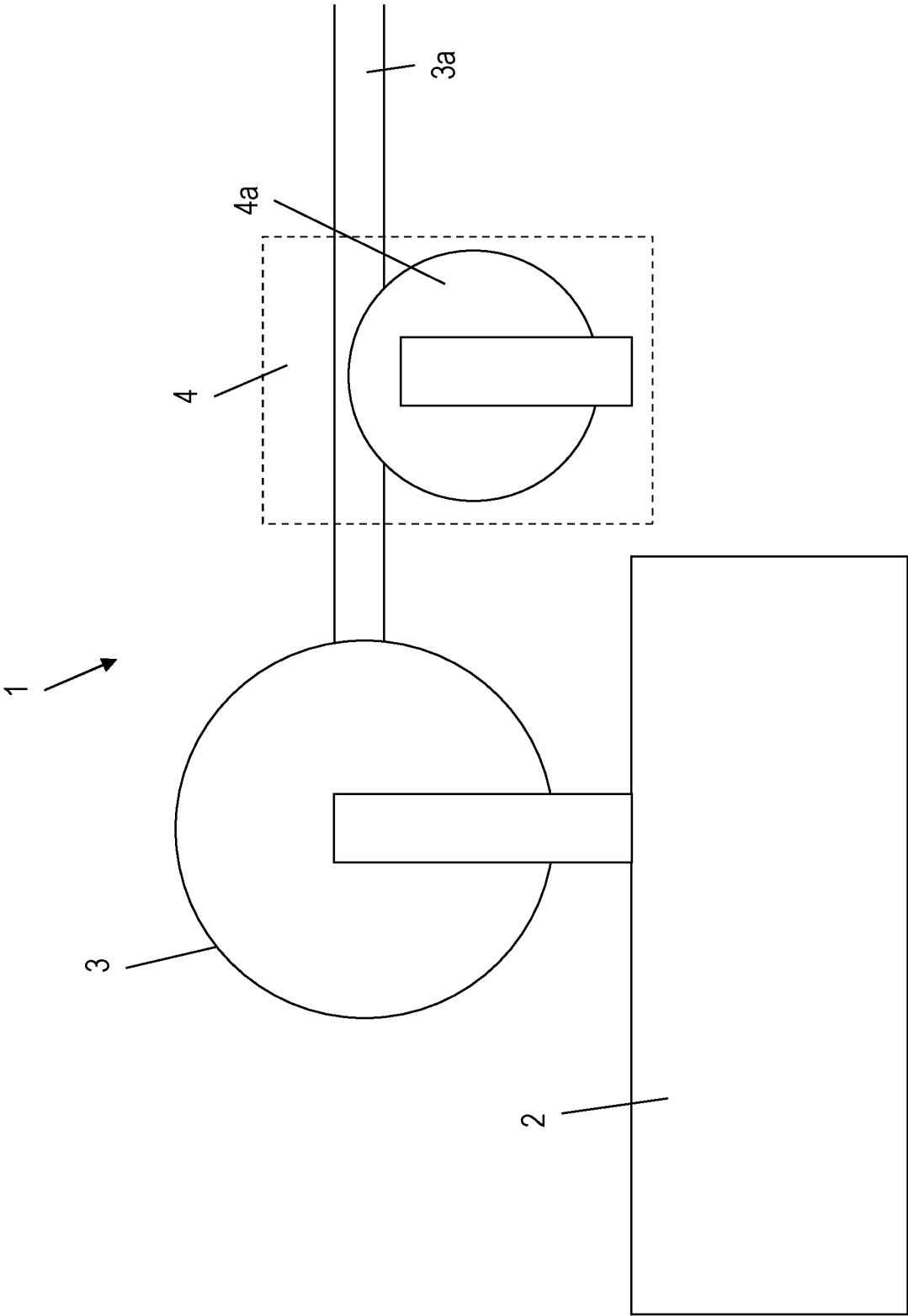


Fig. 1a

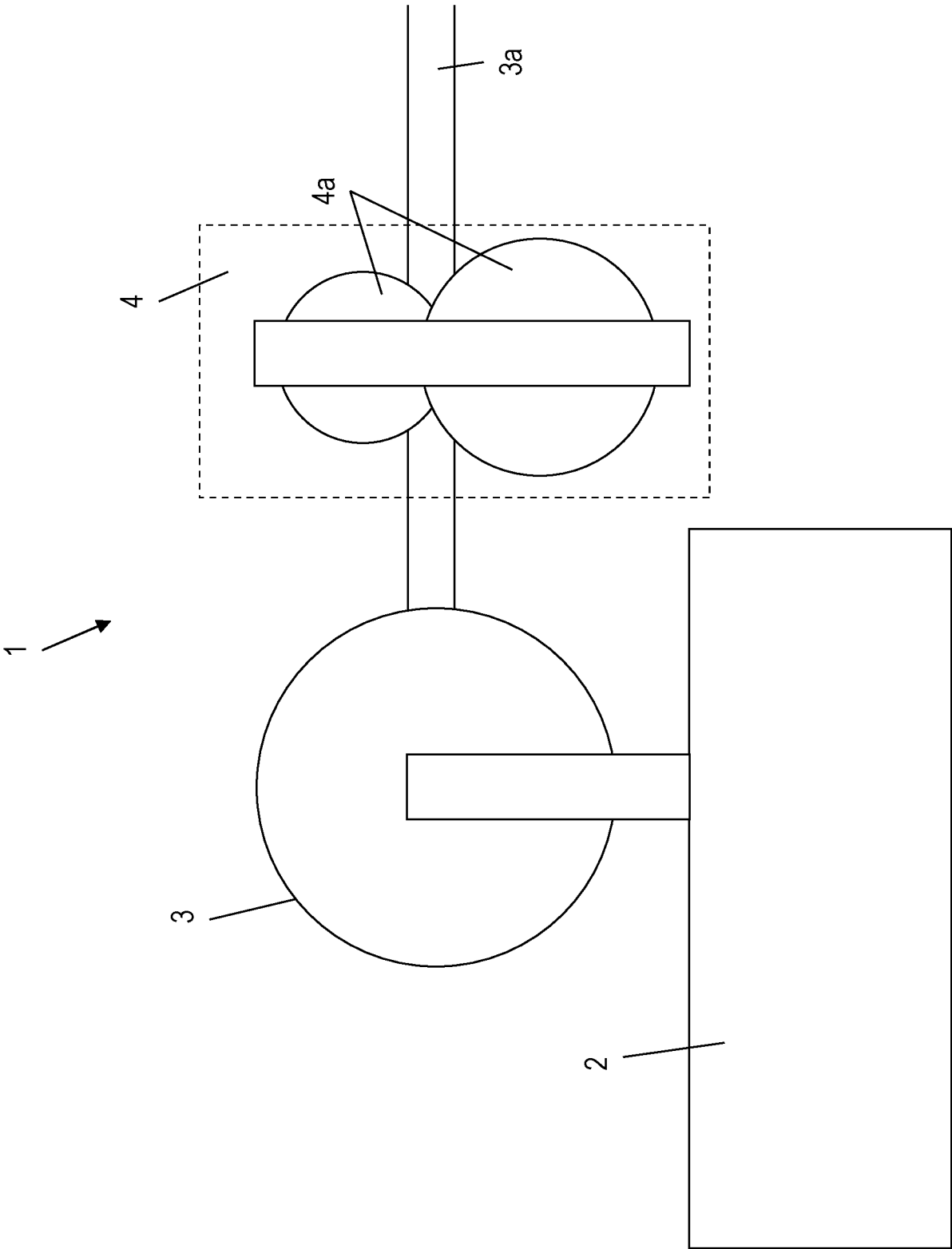


Fig. 1b

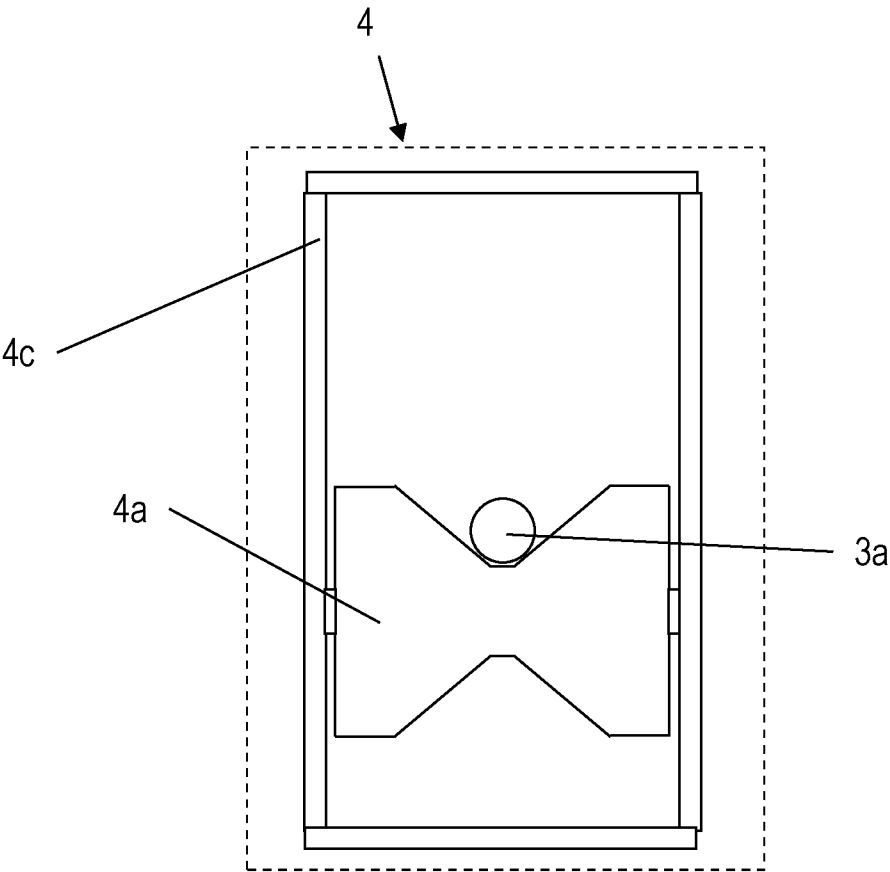


Fig. 2a

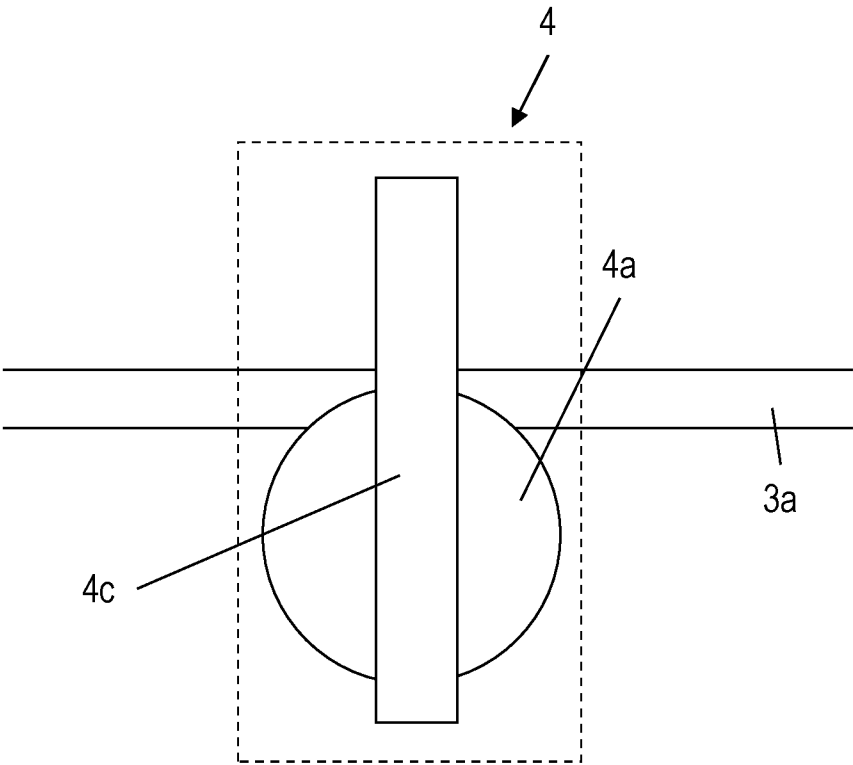


Fig. 2b

4/14

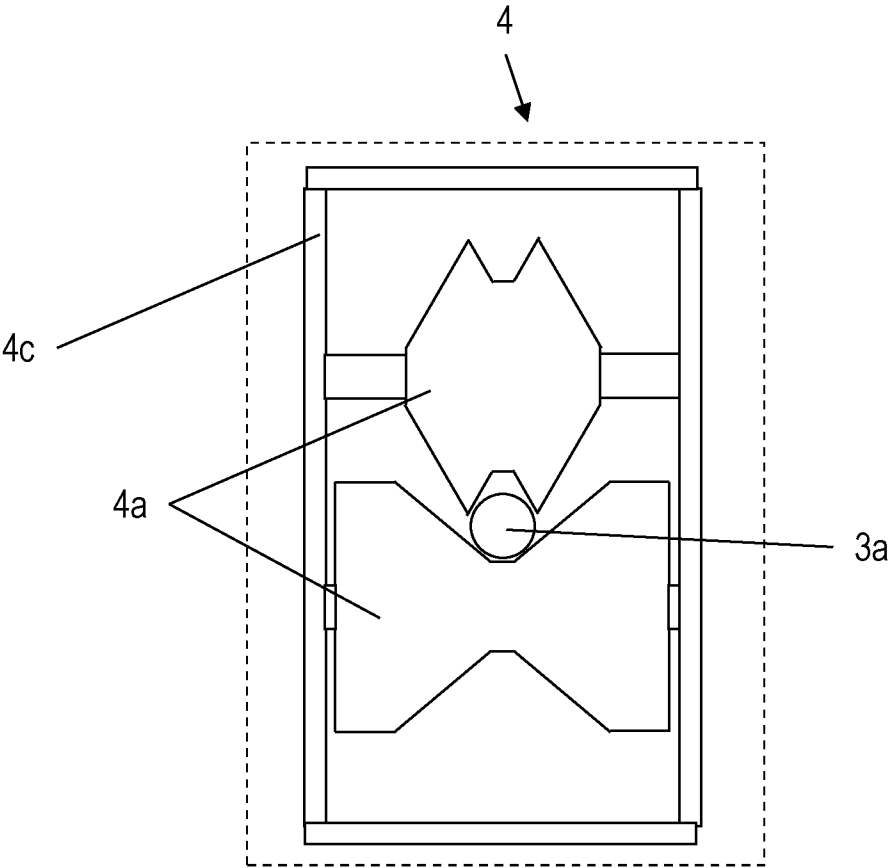


Fig. 2c

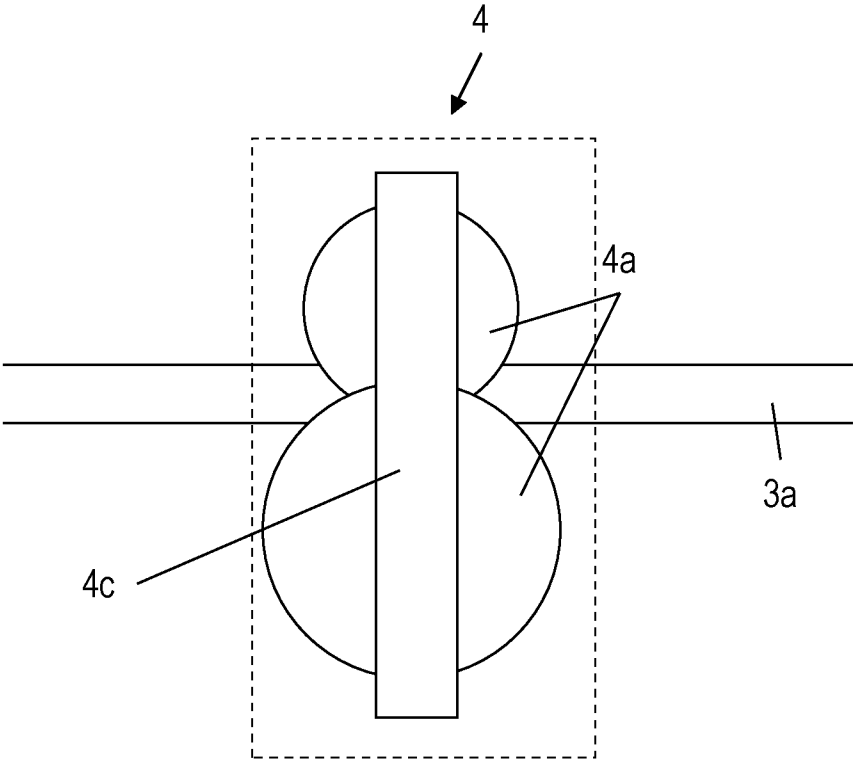


Fig. 2d

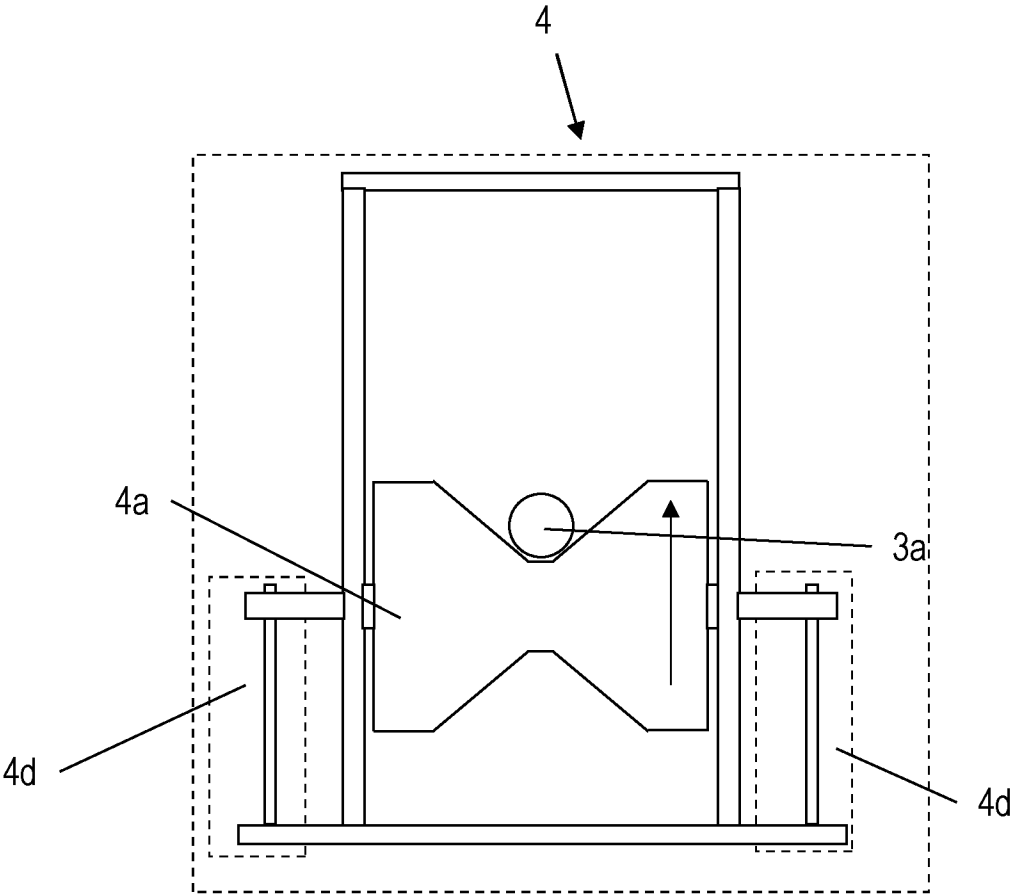


Fig. 3a

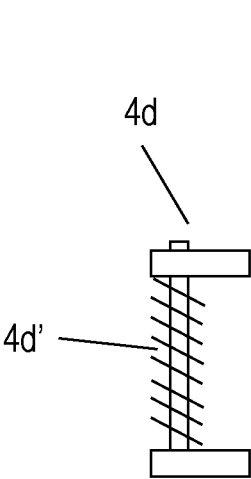


Fig. 3b

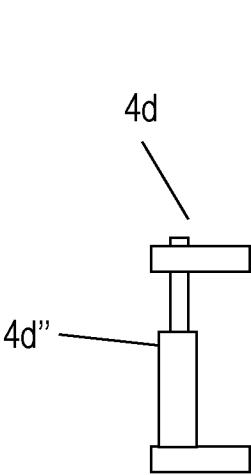


Fig. 3c

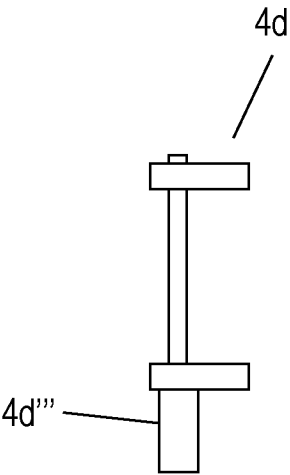


Fig. 3d

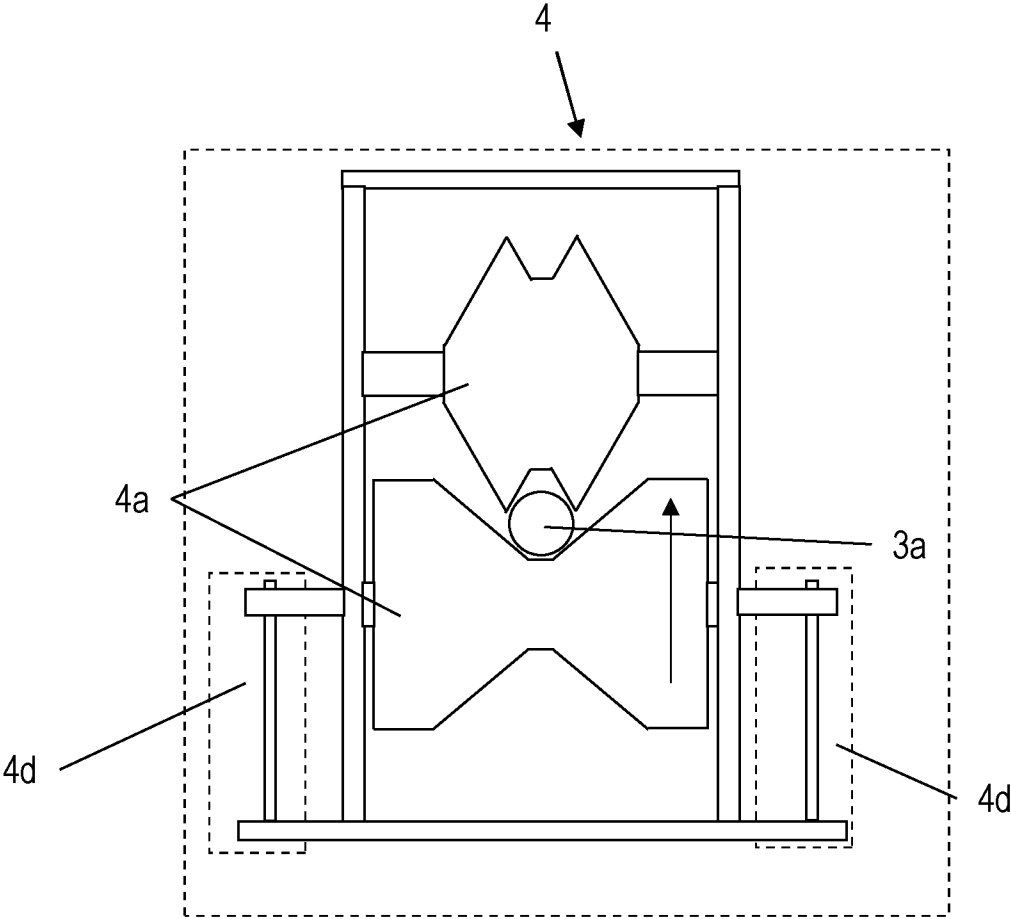


Fig. 3e

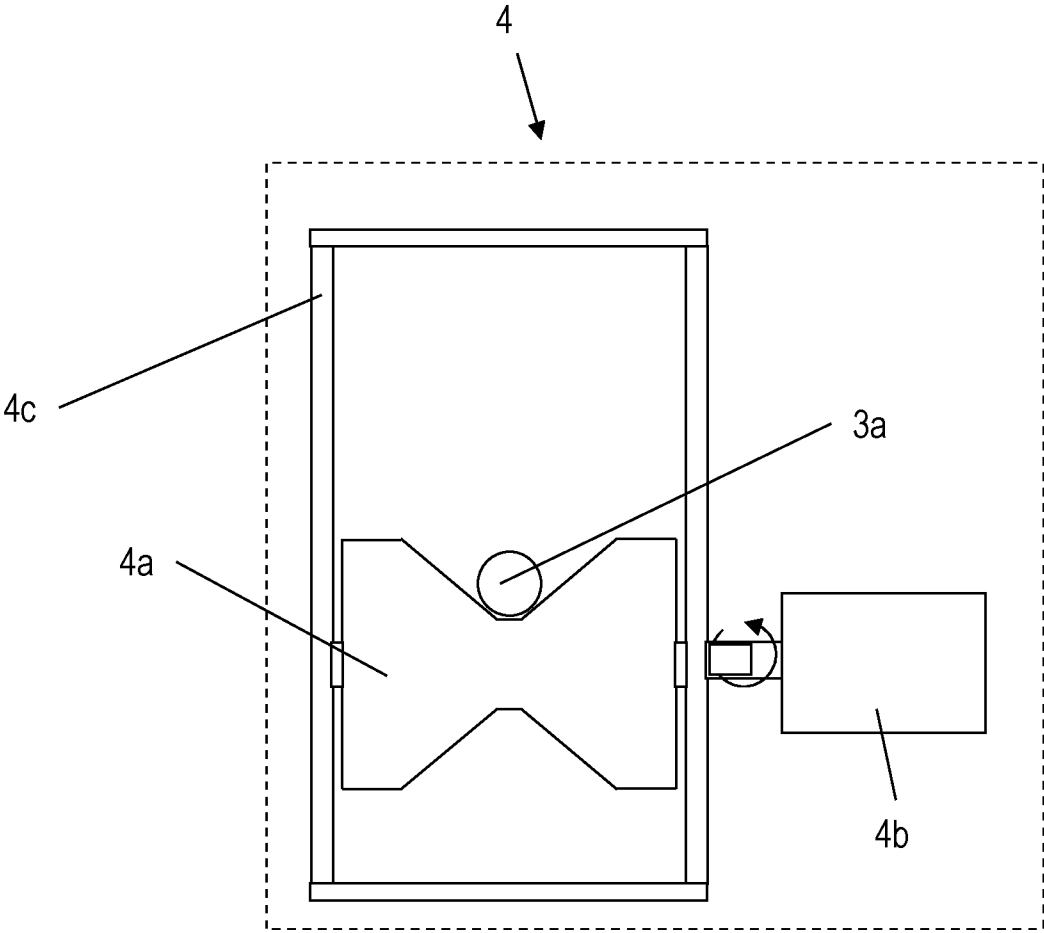


Fig. 4a

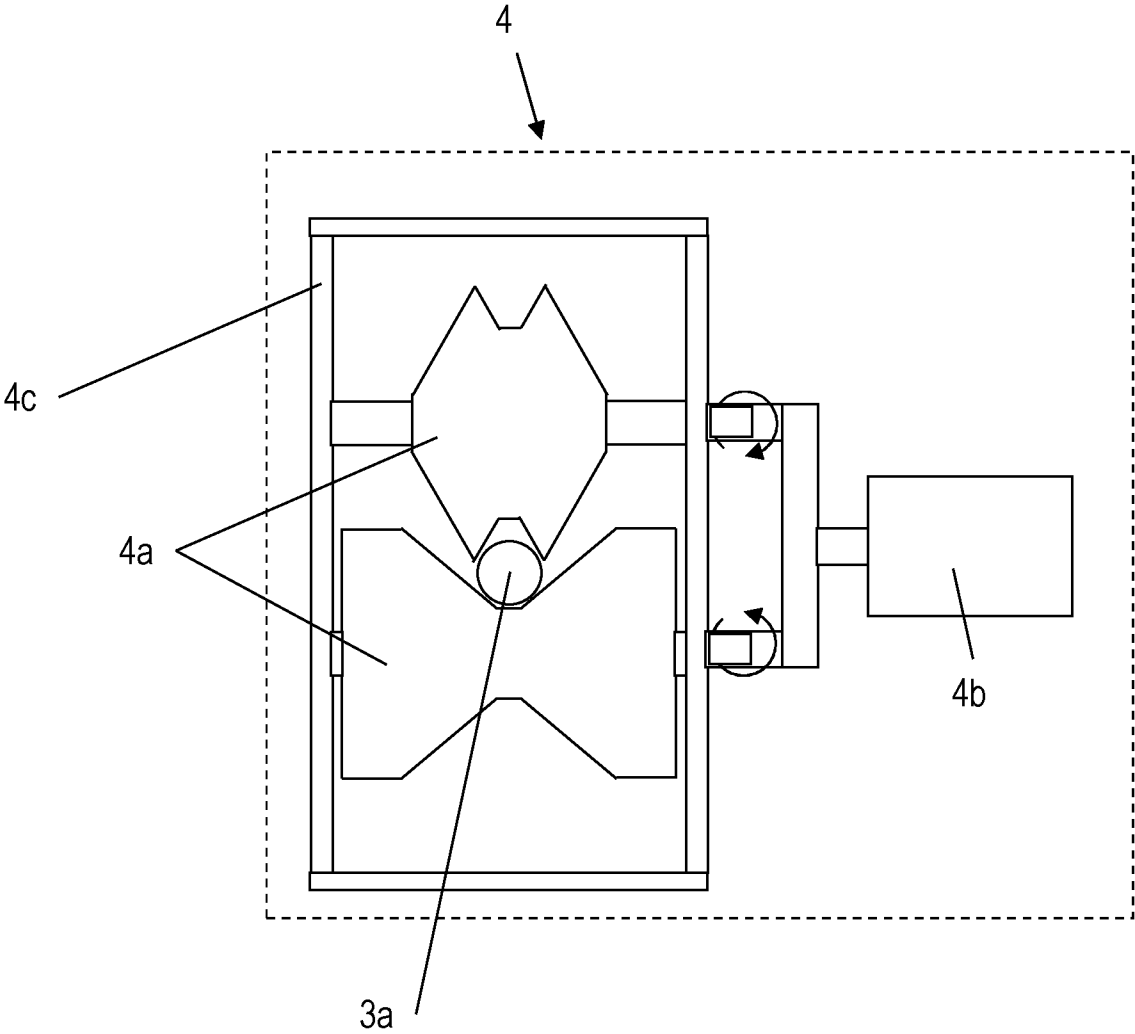


Fig. 4b

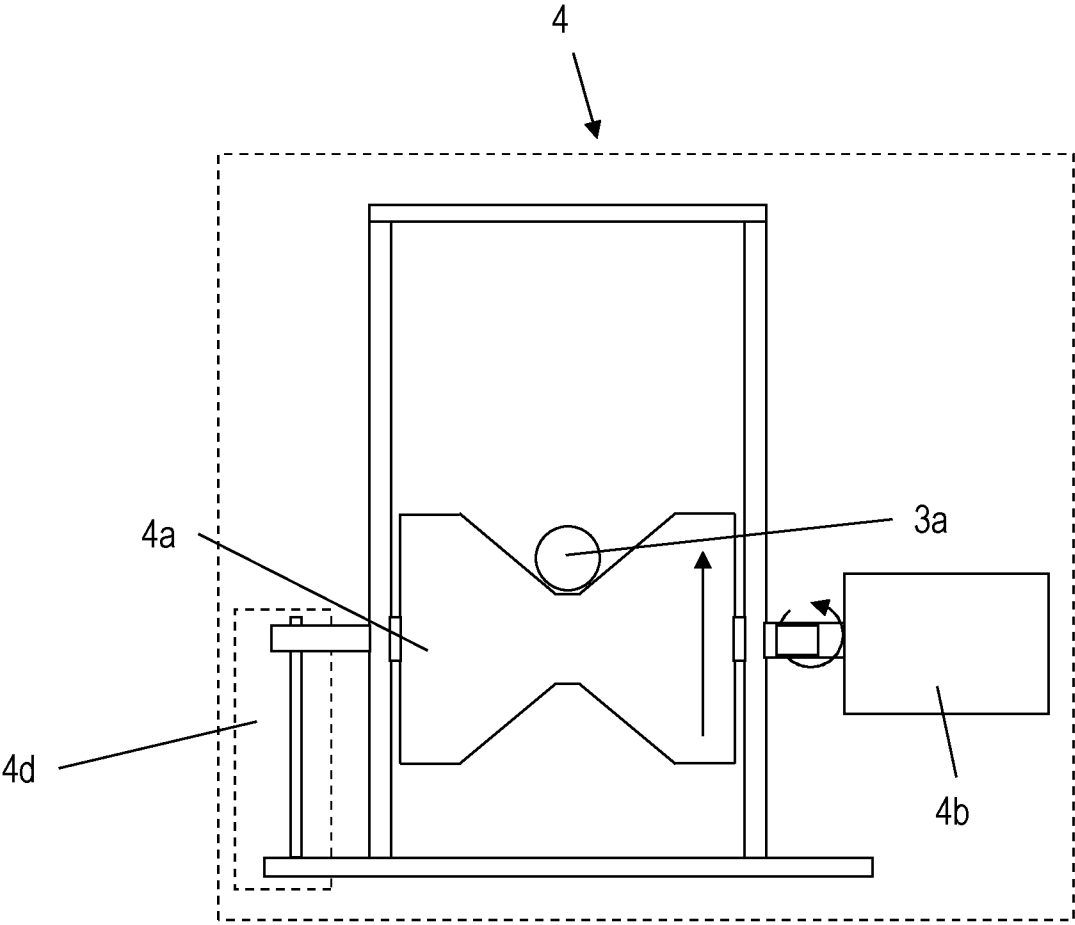


Fig. 5

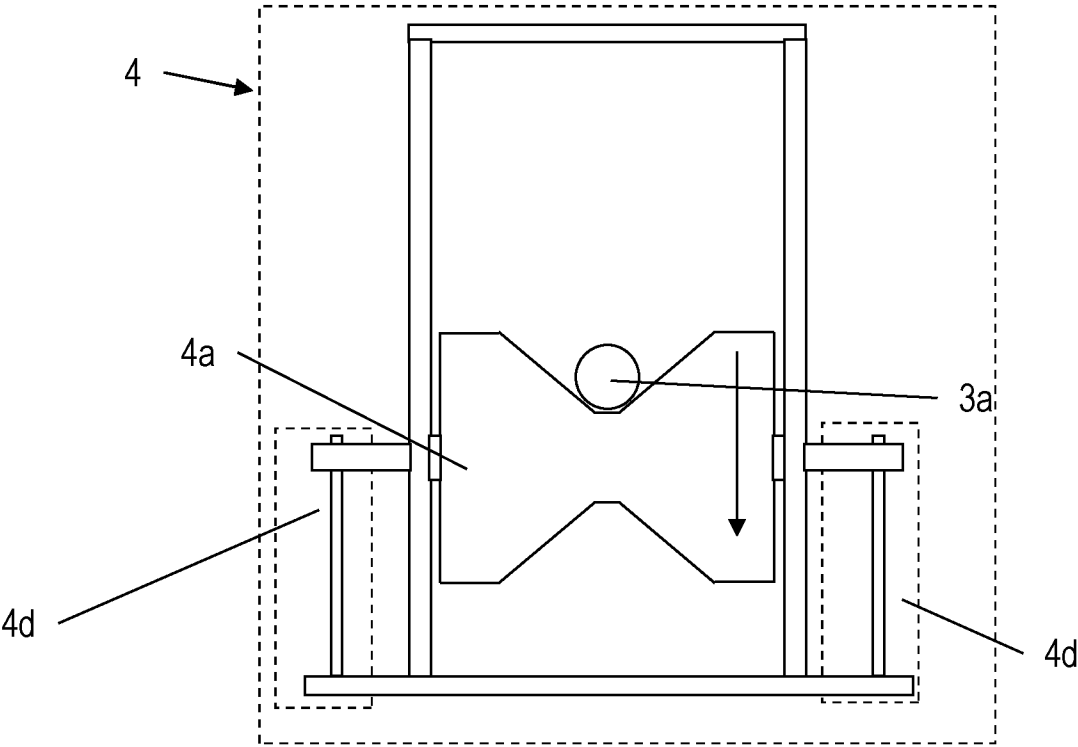


Fig. 6a

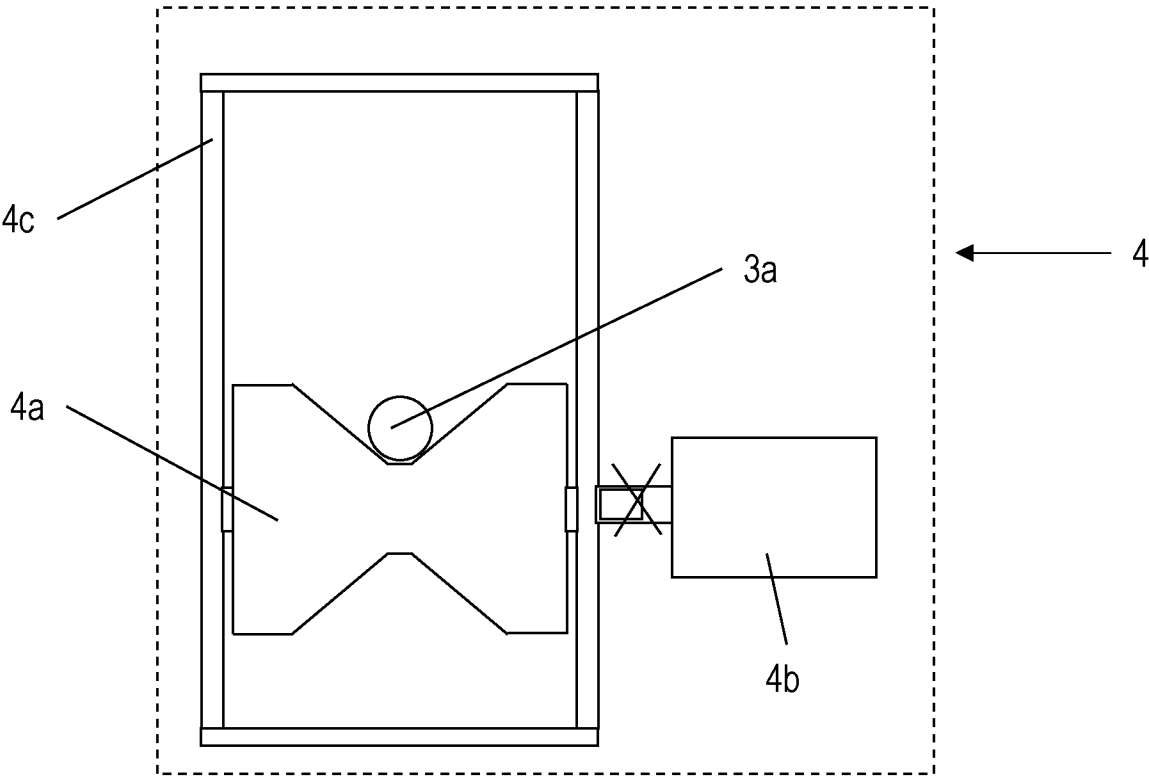


Fig. 6b

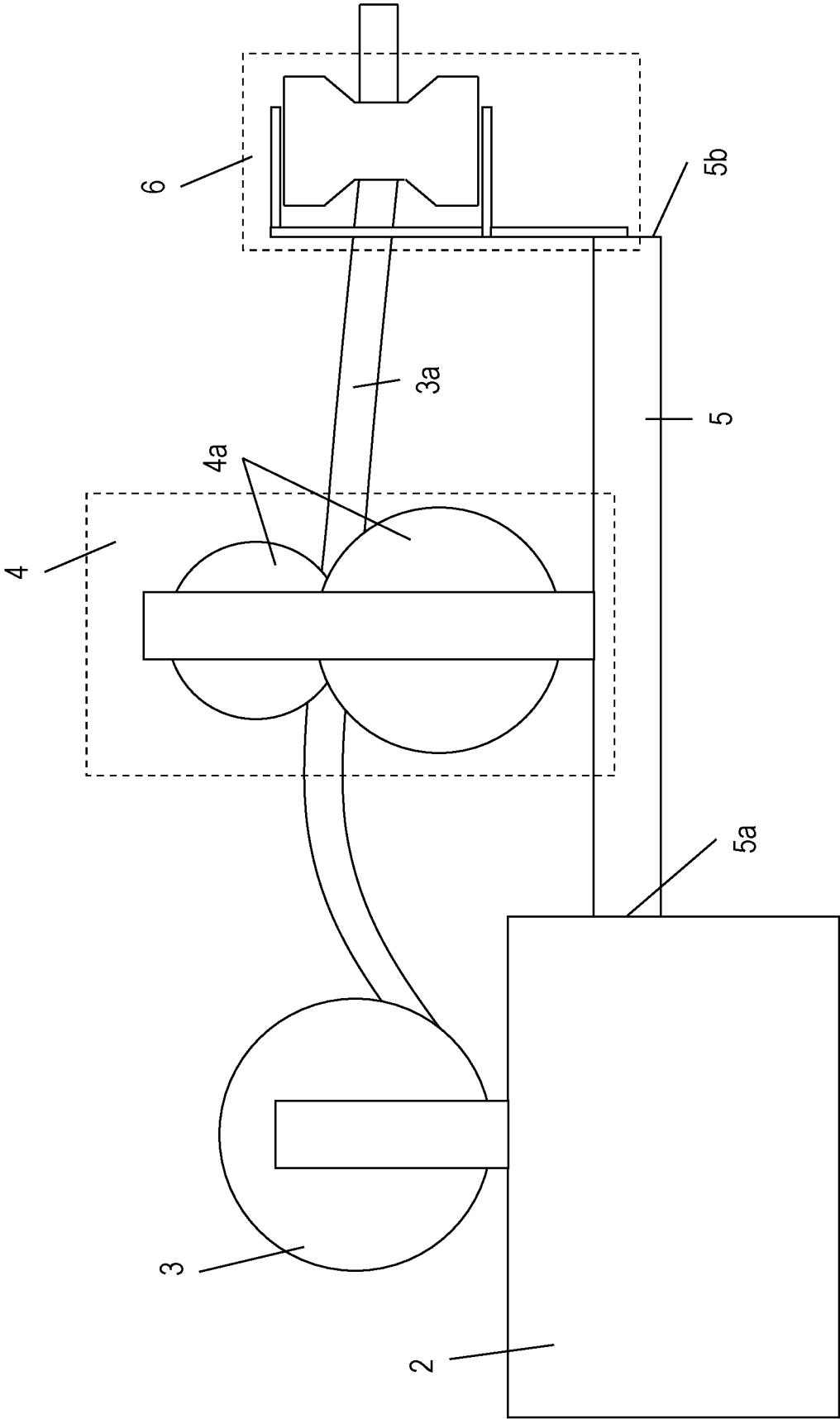


Fig. 7

12/14

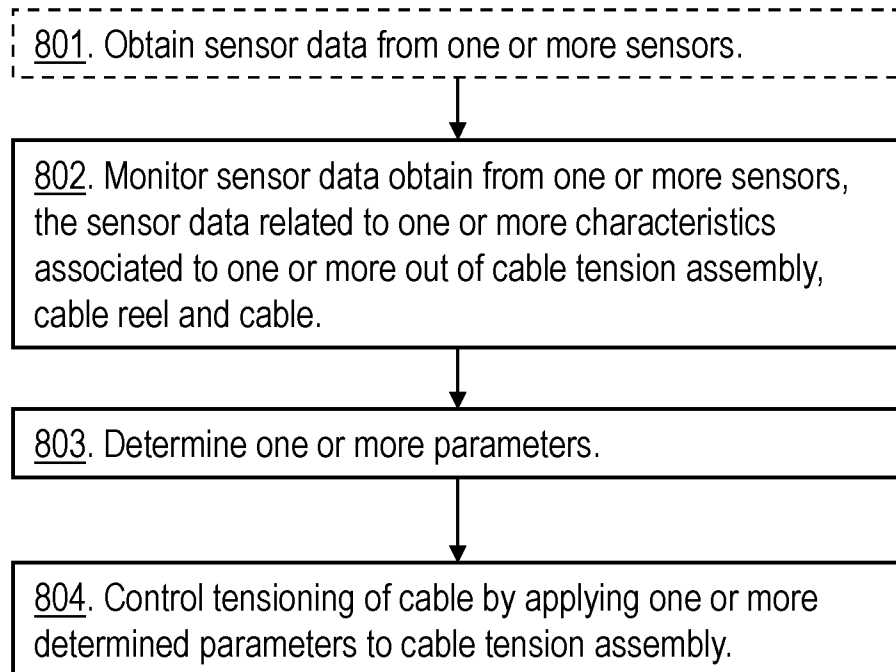


Fig. 8

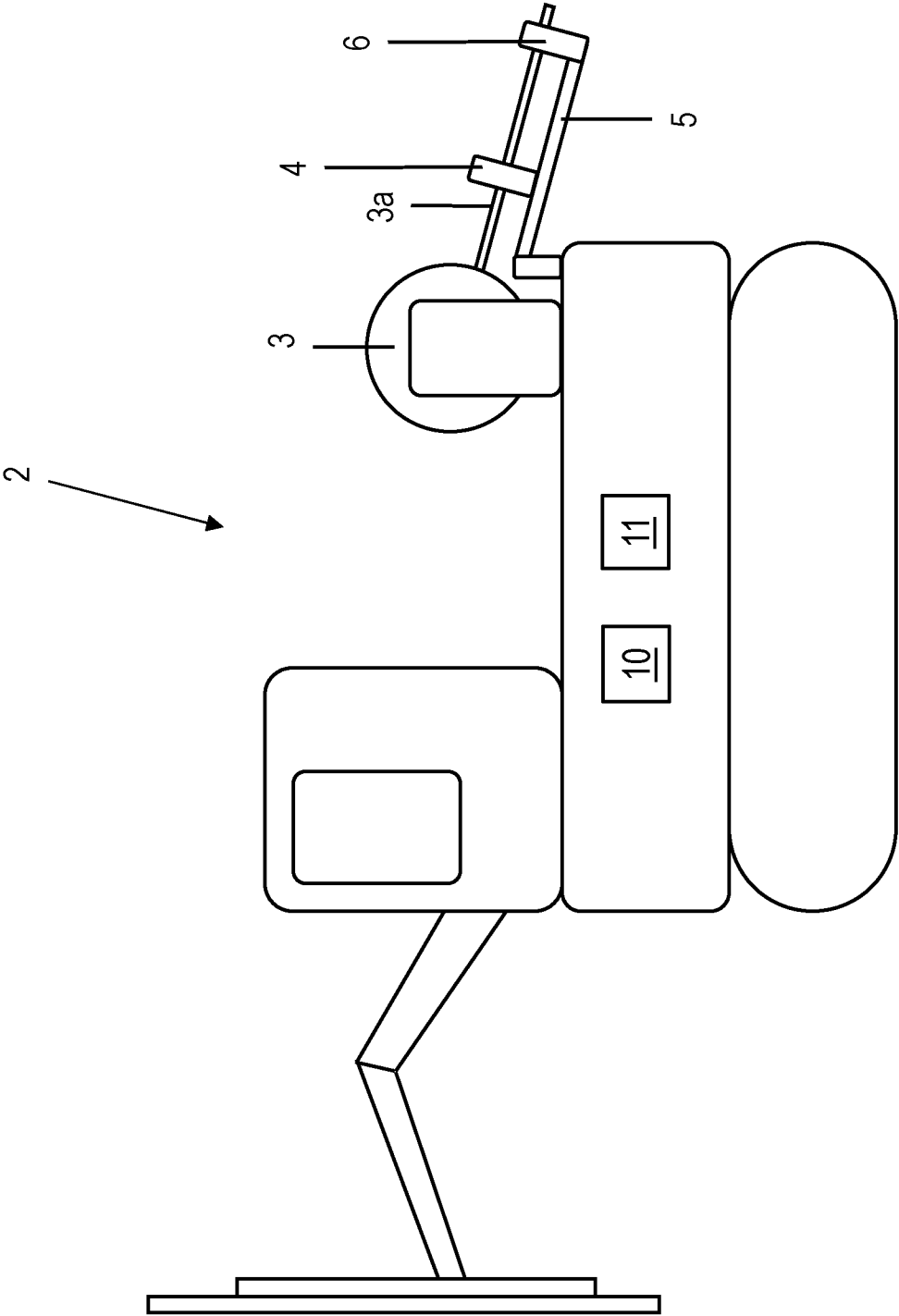


Fig. 9

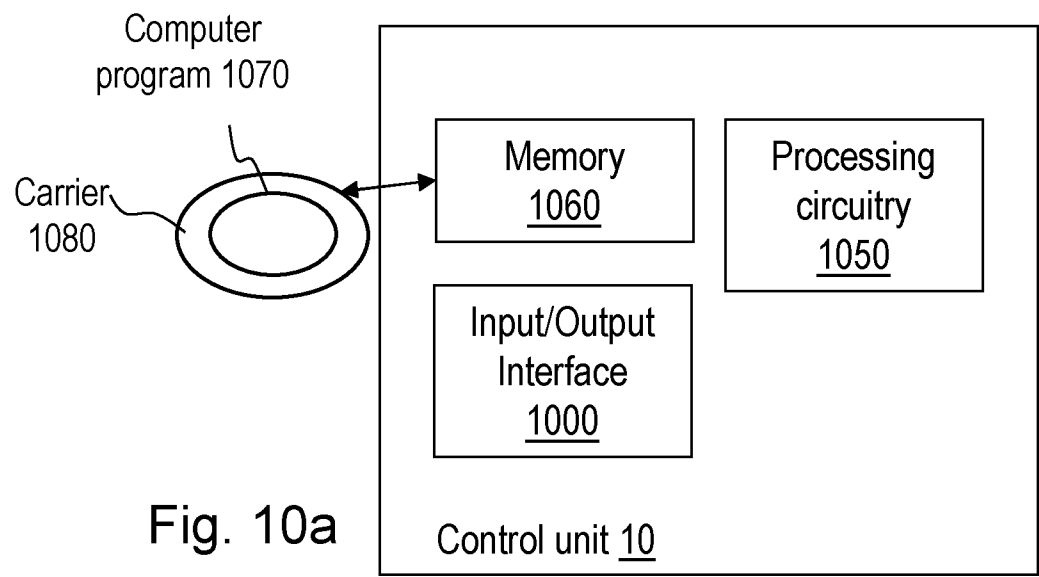


Fig. 10a

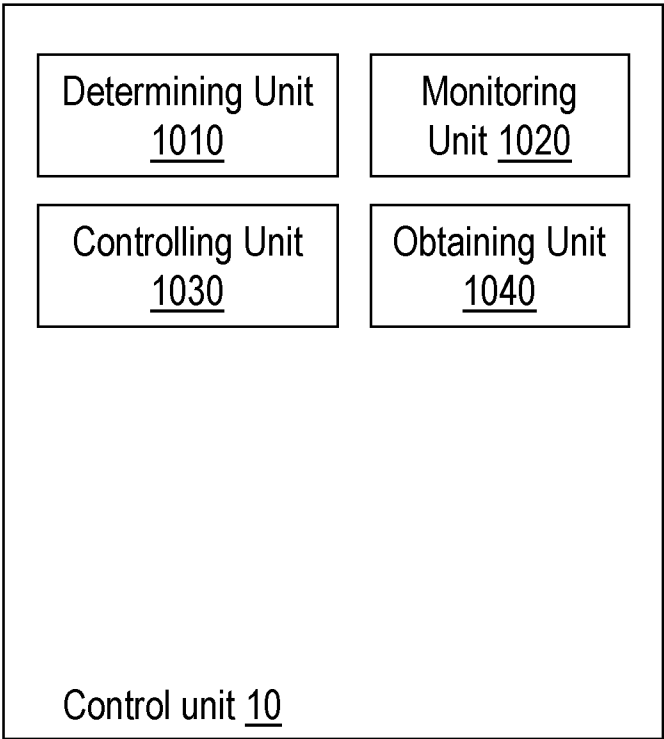


Fig. 10b

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2023/050593

A. CLASSIFICATION OF SUBJECT MATTER INV. B65H59/18 B65H59/20 B65H59/40 B65H75/42 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) B65H		
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		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2020/280181 A1 (TARASINSKI NICOLAI [DE] ET AL) 3 September 2020 (2020-09-03) paragraphs [0006], [0009], [0013] - [0018], [0028], [0033] - [0040]; figures 2-4 -----	1-4, 7-20
X	US 2013/146410 A1 (THOMAS TERRY M [US] ET AL) 13 June 2013 (2013-06-13) paragraphs [0004], [0012] - [0021]; figures 1-5 -----	1-4
X	US 2 947 494 A (EDWARD MERRITT HENRY) 2 August 1960 (1960-08-02) the whole document ----- -/--	1, 2, 5, 6
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 6 December 2023		Date of mailing of the international search report 20/12/2023
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Pussemier, Bart

INTERNATIONAL SEARCH REPORT

International application No

PCT/SE2023/050593

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/097783 A1 (PACK ROBERT TODD [US] ET AL) 26 April 2012 (2012-04-26) paragraphs [0001] - [0005], [0030], [0037] - [0040], [0056] - [0076]; figures 2-5, 12 -----	1-7, 9-20
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