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(54) **AN ELECTRO-HYDRAULIC WINDER OF A ROPE ONTO A DRUM OF A WINCH AND A WINCH WITH THE SAID WINDER**

(57) The present invention belongs to the field of forestry winches, more precisely to the field of constructional details in forestry winches, which are related to winding of the rope onto a drum of the winch. The invention relates to an electro-hydraulic winder of the wire rope onto the winch drum and the winch with the said winder.

The essence of the winder (1) for uniform winding of the wire rope onto the drum (4) of the winch is in that it comprises a mechanical assembly (2) of the winder and an electrohydraulic assembly (3) of the winder. The mechanical assembly is directly connected to the drum, onto which the wire is wound. It comprises a cross spindle (21) with a nut (22) and a transmission assembly, which transfers the rotation from the drum onto the spindle.

Movement of the nut left and right precisely mimics the path and the speed of movement of the wire rope during optimal winding. The nut is equipped with a rotational angle sensor (23) connected to the winch controller, said sensor measuring discrepancy of the path of the hydraulic assembly with regards to the nut. The controller of the winch based on measured discrepancy (angle) ensures correction of the path of the hydraulic assembly in order to coordinate the path of the nut and the holder with redirecting cylinders (32a) and consequently of the wire rope. The electrohydraulic assembly comprises a handle mechanism (33) with redirecting cylinders and a holder (32) of the winder, hydraulic cylinder (34) and a valve for controlling the hydraulic cylinder.

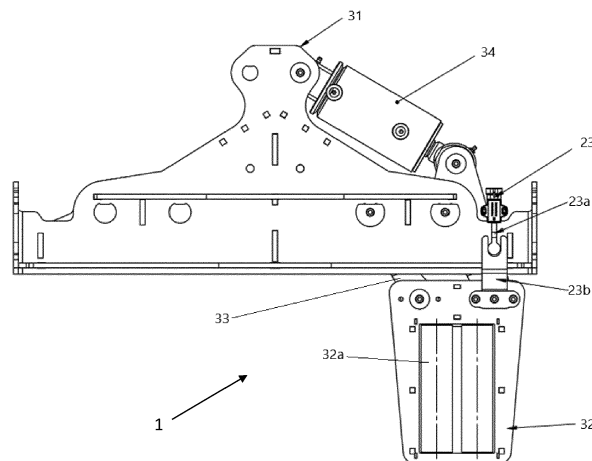


Figure 3

Description

Field of the invention

[0001] The present invention belongs to the field of forestry winches, more precisely to the field of constructional details in forestry winches, which are related to winding of the rope onto a drum of the winch. The invention relates to an electro-hydraulic winder for winding a wire rope onto a winch drum and the winch with the said winder.

Background of the invention and the technical problem

[0002] During operation of a winch the rope is guided and wound onto a drum uniformly and in layers. The construction of forestry winches is due to compact designs and short distances between the drum and the directing pulley problematic for winding, as the too large angle of the rope with regards to the drum disables reliable automatic winding of the wire rope onto the drum. By increasing the width of the drum with the aim of increasing the capacity of the winding rope on the drum, the quality of winding is furthermore decreased, resulting in a non-uniform wound rope.

[0003] The technical problem, which is solved by the present invention, is thus the construction of a system, which will enable uniform winding of the wire rope or the pulling rope onto the winch drum. Known mechanical assemblies follow winding of the rope onto the drum and ensure as uniform winding as possible; however, such winding with such assemblies is also prone to deviations, especially in case the winch is tilting and the weight of the winder affects the quality of winding. In addition, the disadvantage of mechanical winders is also large dimensions, hence such winders are problematic for installation and they are also hard to manufacture as a compact construction.

State of the art

[0004] Patent US2662703 describes an automatic mechanism for guiding the rope during winding, which is achieved with mechanical components and differs from the present invention in the construction. Patent US2424380 discloses a winch with a guide or a winder of a rope, wherein the guide is slidably mounted onto a driven shaft, so that during rotation of the drum during winding, the guide travels in both directions parallel to the drum, resulting in guiding of the rope that is being wound onto the drum. This means that the rope is not entangled and is not wound in bunches (more layers of the rope on one side of the drum and less layers or no layers on the other end of the drum). The solution according to this document comprises mechanical components, which differs from the present invention. Furthermore, a disadvantage of this solution is that it does not withstand lateral loads.

[0005] Document CN101700859 describes an auto-

matic winder of the rope, which comprises a steel wire rope pulley, a rope releaser sliding block and a winch roller which are sequentially connected by a steel wire rope. The multifunctional automatic rope winder has the steel wire rope pulley is placed on a disc rope releaser through a positioning shaft; the rope releaser sliding block is arranged on parallel slideways which are parallel vertically, and a rope release jack and a rope release positioning block are sequentially connected and arranged at one end of the rope releaser sliding block; the rope release jack is communicated with an electric hydraulic pump; and a rope tightening device is arranged in the rope releaser sliding block. Construction of this winder differs from the present invention.

Description of the solution of the technical problem

[0006] The technical problem is solved as defined in the independent patent claim, while the preferred embodiments are given in the dependent claims.

[0007] The essence of the winder for uniform winding of the wire rope onto the drum of the winch is in that it comprises a mechanical assembly of the winder and an electrohydraulic assembly of the winder, which together ensure uniform winding of the wire rope onto the drum, wherein the mechanical assembly senses movement of the wire rope and a tracking system senses coordination of the mechanical assembly and the electrohydraulic assembly, the latter comprising at least a holder with cylinders for guiding the wire rope and a hydraulic cylinder, which controls the said holder, wherein after detected discrepancy the tracking system corrects movement of the holder of the cylinders by controlling the hydraulic cylinder.

[0008] The mechanical assembly of the winder preferably comprises:

- a cross spindle connected with the drum onto which the rope is being wound, so that the cross spindle rotates in the same direction as the drum, and,
- a nut on the cross spindle, which is arranged to move left and right along the spindle depending on its rotation, wherein for example the nut in the most right position is re-directed into left direction until it reaches the most left position, and vice versa,

wherein the nut is equipped with the tracking system, preferably with an angle sensor with a detector, wherein the said sensor measures the angle between the nut on the cross spindle and forks of the detector, said forks being installed on the holder of the redirecting cylinders. The forks are installed on the holder of the cylinders, as this element guides the rope and its path as well as the speed of movement has to match the path and the speed of the nut.

The cross spindle is connected with the drum with a drive assembly, which ensures transfer of the rotation from the drum to the spindle, and preferably comprises:

- a chain, in
- two sprockets, wherein one is installed on one end of the cross spindle and the second is installed on the drum,

so that the speed of the nut travelling left and right matches the speed of movement of the wire rope in ideal winding of the rope onto the drum.

[0009] The chain drive may also comprise four sprockets and two chains. It is important the said transmission assembly between the drum and the cross spindle ensures suitable transmission ratio. Consequently, the connection between the cross spindle and the drum may be achieved in any suitable way, not only by using the chain drive. Equally, a belt transmission, a gear transmission or any other transmission can be used in order to transfer rotation movement from the drum onto the spindle.

[0010] The cross spindle is the preferred choice, as during rotation in one direction the nut on the spindle moves left and right, wherein the thread is complete and infinite. Instead of the cross spindle a thread could be used, but this solution should then also comprise an intermediate gear arranged to switch the rotation direction of the nut. A second possible solution is a transversely mounted chain gear with an angle drive from the drum and a hydraulic upgrade. It is also possible to use a linear measuring bar in combination with a sensor the number of drum rotations.

[0011] Movement of the nut left and right precisely mimics the path and the speed of the movement of the wire rope during winding onto the drum. In accordance the holder with redirecting cylinders is moved, the holder being moved when the drum rotates, so that the rope is being uniformly wound on the drum. This is achieved with the electrohydraulic assembly of the winder, said assembly comprising at least:

- housing of the winder,
- holder of redirecting cylinders, which guide the rope towards the drum, which is movably installed on the housing of the winder or is at least movably connected with the housing of the winder,
- preferably a handle parallelogram mechanism connected to the holder of redirecting cylinders, said handle mechanism being movably mounted onto the holder of the winder, wherein the handle mechanism is arranged to ensure parallel movement of the vertical cylinders with regards to the previous position when the holder with cylinders moves left or right, respectively;
- the hydraulic cylinder mounted on one side to the holder with redirecting cylinders or to the optional handle mechanism and on the other side to the holder of the winder, wherein the said cylinder causes movement of the holder with cylinders with its own movement;
- a suitable valve, preferably a three-way electrically controlled proportional valve for controlling the hy-

draulic cylinder, and

- preferably also a controller, most preferably controller of the winch, for adjusting speed and direction of movement of the hydraulic cylinder.

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[0012] A suitable valve may also be a mechanical three-way proportional valve installed on the nut of the cross spindle, wherein the controller is not needed.

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Instead of the handle parallelogram mechanism the invention could also comprise a steer cylinder without parallelogram mounting, but with the longitudinal guides, which ensure movement of the holder with cylinders.

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[0013] On the nut installed rotational angle sensor, which is connected to the controller of the winch, which measures discrepancy between the position of the nut of the cross spindle and the holder with cylinders (or the path of the hydraulic winder with regards to the path of the nut). The controller of the winch based on the measured angle discrepancy and ensures the correction of the

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path of the hydraulic part of the winder in order to achieve coordinated movement of the nut and the holder with redirecting cylinders and thus also the wire rope. The controller performs the correction of the position of the holder with cylinders so that the valve, preferably the three-way electrical proportional valve, is opened, which causes movement of the hydraulic cylinder and consequently the holder with cylinders in the correct direction.

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For operation of the winder it is key to detect the angle and to ensure response from the controller, as even during suitable operation of the winder discrepancies can occur, as the conditions during winding are constantly changing, for example speed of drum rotation due to changes in engine speed, kinematics of the handle mechanism (which does not always ensure uniform movement). In case the correction of the paths of the nut and the holder with cylinders does not occur, the rope is wound onto the drum in an uncontrolled manner, thus resulting in bunches, so that at full load the rope is damaged. The winder according to the invention allows setting a range of deviations by correcting the parameters, wherein the ideal angle is near 0°.

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[0014] The controller, preferably the controller of the winch, continuously tracks data from the sensor. When the controller senses a discrepancy between the nut of the cross spindle and the holder with cylinders or the handle mechanism, the controller opens the proportional three-way electrohydraulic valve and thus causes a change of the speed and direction of movement of the hydraulic cylinder. In case the holder with redirecting cylinders lags behind the nut, the speed of the holder has to increase, which is ensured by the valve which increases the speed of oil flow in the cylinder by opening. The parameters of discrepancy and opening of the valve can be changed on the controller, so that optimal operation of the system is achieved.

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[0015] The preferred embodiment of the winder is with the angle sensor and the forks on the holder with cylinders, but it could also be replaced with a linear measuring

bar or any other element, which can measure or determine the ratio between the nut and the holder with cylinders. The purpose of such measuring system in connection with the controller is thus reliable following of the nut of the cross spindle with the holder with cylinders.

[0016] The hydraulic cylinder is the preferred choice, as winches usually have a hydraulic system and because the forces for movement are high. It is also possible to ensure movement with a linear electromotor, but this solution can be too expensive and furthermore needs a source of energy, resulting in a need for additional optimization of the winder and winch construction.

[0017] A second possible embodiment of the winder for uniform winding of the wire rope onto the drum differs from the above-described embodiment only in that instead of controller and angle sensor a mechanical proportional valve is used, the said valve being installed on the nut of the winder, while the handle of the valve is connected to the forks of the holder with cylinders in the same way as in the embodiment described above.

[0018] The winch with the winder according to the invention may be any winch, having one or two drums, wherein the winder enables optimal winding of the rope in uniform layers, due to which the possibility of rope damage. The winder is mounted using known means onto the winch on the side, where the wire rope runs towards the drum.

[0019] The winder according to the invention will be described in more detail based on an exemplary embodiment and figures, which show:

- Figure 1 A drum with the cross spindle and a nut with an angle sensor
- Figure 2 Mechanism of the winder with a hydraulic cylinder and a holder with directing cylinders
- Figure 3 Front view of the winder with the holder of forks with sensor and position of the angle sensor and the detector

[0020] The winder 1 for uniform winding of the wire rope onto the drum according to a possible embodiment comprises a mechanical assembly 2 and an electrohydraulic assembly 3, which together ensure uniform winding of the rope on the drum 4. Figure 1 shows the mechanical assembly 2 of the winder 1 comprising at least:

- a cross spindle 21, connected with the drum 4, onto which the rope is wound, so that the cross spindle 21 rotates in the same direction as the drum 4; and
- nut 22 on the cross spindle 21, arranged to move left and right along the spindle 21 depending on its rotation, wherein the nut 22 for example after reaching the most right position redirects into left until it reaches the most left position and vice versa,
- an angle sensor 23 with a detector 23a installed on the nut 22, wherein the said sensor 23 measures the angle between the nut 22 on the spindle 21 and the forks 23b of the detector 23a of the sensor 23, which

are installed on the holder 32 of redirecting cylinders 32a as shown in figure 3.

The cross spindle 21 is with the drum 4 connected with a drive assembly 24, which ensures transmission of rotation from the drum 4 to the cross spindle 21 and suitable gear ratio with regards to the diameter of the wire rope, said assembly preferably comprising:

- a chain 24a, and
- two sprockets 24b, 24c, wherein the first is installed on one end of the cross spindle 21 and the second is installed on the drum 4,

so that the speed of the nut 22 left and right is equal to the speed of travelling of the wire rope at ideal winding of the rope on the drum 4. Consequently movement of the nut 22 left and right precisely mimics the path and the speed of the wire rope movement during winding on the drum 4.

[0021] Figures 2 and 3 show the preferred embodiment of the winder 1 mechanism with a hydraulic cylinder 34 and the holder 32 of cylinders 32a, which moves when the drum 4 rotates. This electrohydraulic assembly 3 of the winder 1 comprises at least:

- housing 31 of the winder,
- holder 32 of redirecting cylinders 32a, which guide the rope towards the drum 4, wherein the said holder 32 is movably connected to the housing of the winder 31,
- handle parallelogram mechanism 33 connected to the holder of redirecting cylinders in movable mountings 32b, said handle mechanism being movably mounted onto the holder of the winder in mountings 33a, wherein the handle mechanism 33 is arranged to ensure parallel movement of the vertical cylinders 32a with regards to the previous position when the holder 32 with cylinders moves left or right, respectively;
- a two-way hydraulic cylinder 34 on one side mounted onto the handle mechanism 33 and on the other side on the holder of the winder 31, wherein movement of the said cylinder 34 causes movement of the holder 32 with cylinders,
- a suitable valve (not shown in the figure), preferably a three-way electrically controlled proportional valve for controlling the hydraulic cylinder 34, and
- a controller (not shown in the figure), most preferably controller of the winch, for adjusting speed and direction of movement of the hydraulic cylinder 34.

Claims

1. An electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch, **characterized in that** the winder comprises a mechanical assembly

and an electrohydraulic assembly, which together ensure uniform winding of the wire rope onto the drum, so that the mechanical assembly senses movement of the wire rope and a tracking system senses coordination of the mechanical assembly and the electro-hydraulic assembly, the latter comprising at least a holder with cylinders for guiding the wire rope, and a hydraulic cylinder, which controls the said holder, wherein upon sensed discrepancy the tracking system corrects movement of the holder with cylinders by controlling the said hydraulic cylinder.

2. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to claim 1, **characterized in that**:

- the mechanical assembly comprising:

- a cross spindle, which is with a drive assembly connected with the drum onto which the rope is wound, so that the cross spindle rotates in the same direction as the drum, and,
- a nut on the cross spindle, which is arranged to move left and right along the spindle depending on its rotation, so that movement of the nut left and right precisely mimics the path and the speed of movement of the wire rope during winding onto the drum,
- a tracking system mounted on the nut for tracking the movement of the holder with redirecting cylinders and the nut, preferably with an angle sensor with a detector,

- the electrohydraulic assembly comprising:

- housing of the winder,
- the holder of redirecting cylinders for guiding the rope towards the drum, the holder being movably mounted on the housing of the winder or is with the latter at least movably connected,
- preferably a guide of the holder with redirecting cylinders, which is preferably shaped as a handle parallelogram mechanism connected to the holder with redirecting cylinders, wherein the handle parallelogram mechanism is movably mounted on the housing of the winder,
- the hydraulic cylinder, which is on one side mounted on the holder of redirecting cylinders or the optional guide, and on the other side to the holder of the winder, wherein movement of the said cylinder causes movement of the holder with redirecting cylinders,
- a suitable valve for controlling said hydraulic

lic cylinder, and

- optional controller, which is preferably controller of the winch for adjusting the speed and direction of movement of the hydraulic cylinder,

wherein the said tracking system, preferably sensor arranged to measure the angle between the nut on the cross spindle and a reference element, preferably forks of the detector of the sensor, which are installed on the holder with redirecting cylinders; and wherein based on measured discrepancies of the angle ensures correction of the hydraulic assembly by controlling the hydraulic cylinder in order to achieve uniform winding of the rope.

3. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to claim 2, **characterized in that** the drive assembly, which connects the cross spindle with the drum, is any suitable assembly, which ensures transfer of rotation from the drum onto the cross spindle, preferably the drive assembly is achieved with a chain transmission, gear transmission or a belt transmission.

4. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to claim 3, **characterized in that** the drive assembly is achieved with a chain transmission, wherein the said assembly preferably comprises:

- at least one chain, and
- at least two sprockets, wherein the first sprocket is installed on one end of the cross spindle and the second sprocket is installed on the drum,

so that the speed of the nut moving left and right matches the speed of the wire rope in ideal winding of the rope onto the drum.

5. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to any of the preceding claims, **characterized in that** instead of the cross spindle a thread with an intermediate gear for changing the direction of rotation of the nut is used, or a chain gear with a hydraulic upgrade or a measuring bar in combination with a sensor for sensing the number of drum rotations.

6. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to any of the preceding claims, **characterized in that** the suitable valve is any valve, preferably a three-way hydraulic valve or a mechanical proportional valve, wherein the latter does not require a controller.

7. The electro-hydraulic winder for winding a wire rope

onto a drum of a forestry winch according to any of the preceding claims, **characterized in that** the controller, preferably the controller of a winch, continuously tracks information from the sensor, and is upon detected discrepancy between the nut of the cross spindle and the holder with the cylinders arranged to open the valve and thereby cause a change in the speed and movement direction of the hydraulic cylinder and thus the holder with cylinders in a suitable direction.

8. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to any of the preceding claims, **characterized in that** the guide of the holder with redirecting cylinders is instead of the preferred parallelogram handle mechanism a steering cylinder is used together with longitudinal guides for moving the holder.
9. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to any of the preceding claims, **characterized in that** the tracking system is any suitable system, which can measure or determine the ratio between the nut and the holder with cylinders, preferably the tracking system is:
- an angle sensor and forks on the holder with cylinders, or
 - mechanical proportional valve installed on the nut of the winder, a handle of the valve being connected to the forks of the holder with cylinders,
 - a linear measuring bar.
10. The electro-hydraulic winder for winding a wire rope onto a drum of a forestry winch according to any of the preceding claims, **characterized in that** the discrepancy parameters and opening of the valve can be defined and changed on the controller, so that optimal winding of the rope is achieved.
11. A winch with the winder according to any of the preceding claims.
12. The winch according to the preceding claim, **characterized in that** it has one or two drums.

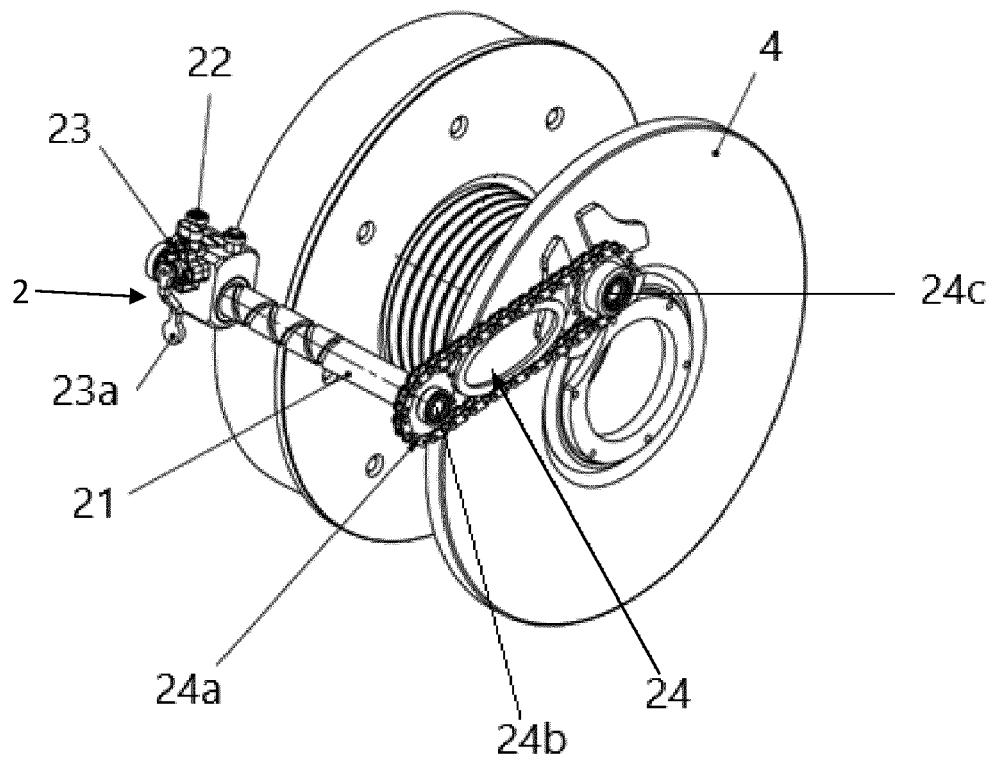


Figure 1

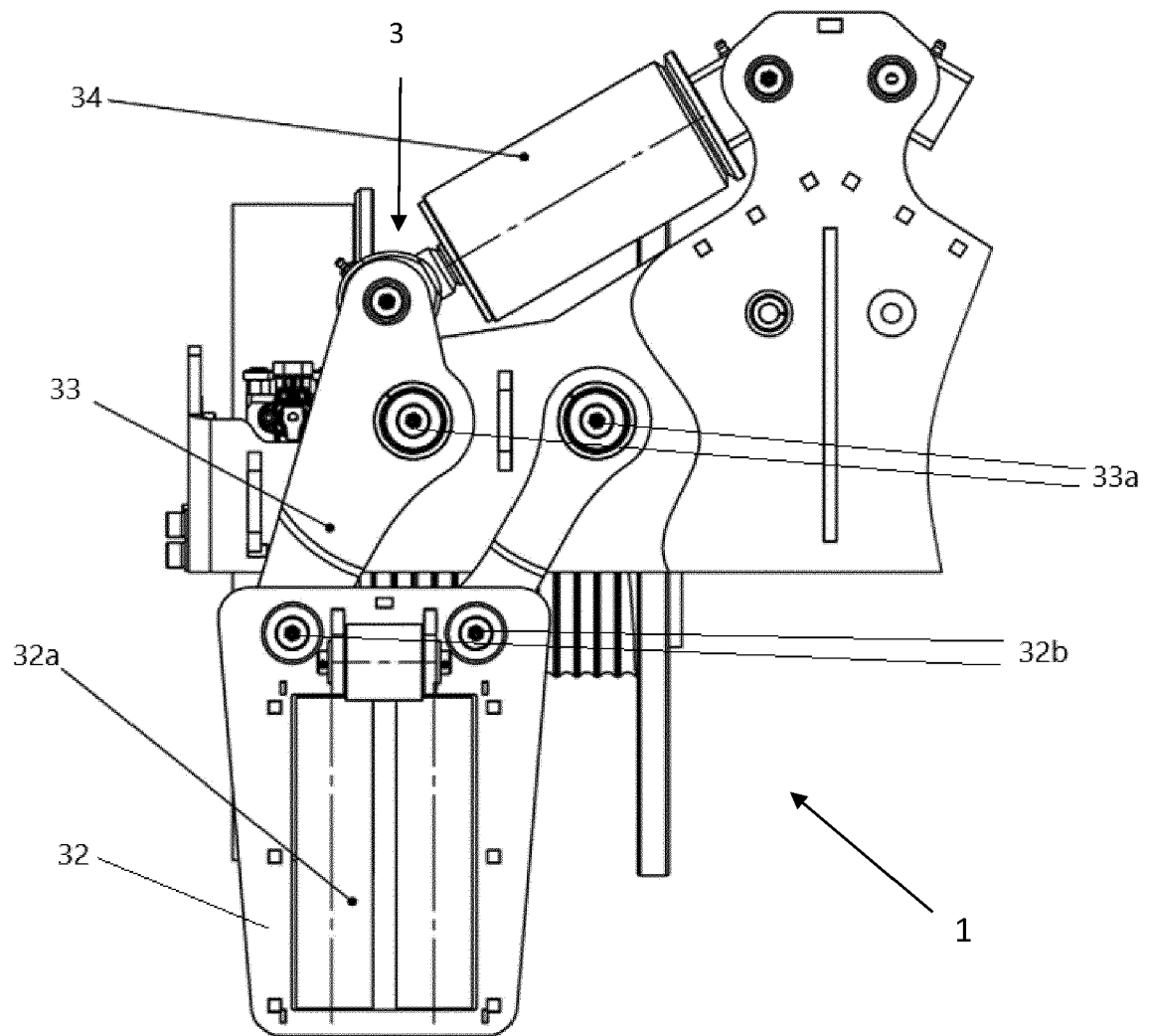


Figure 2

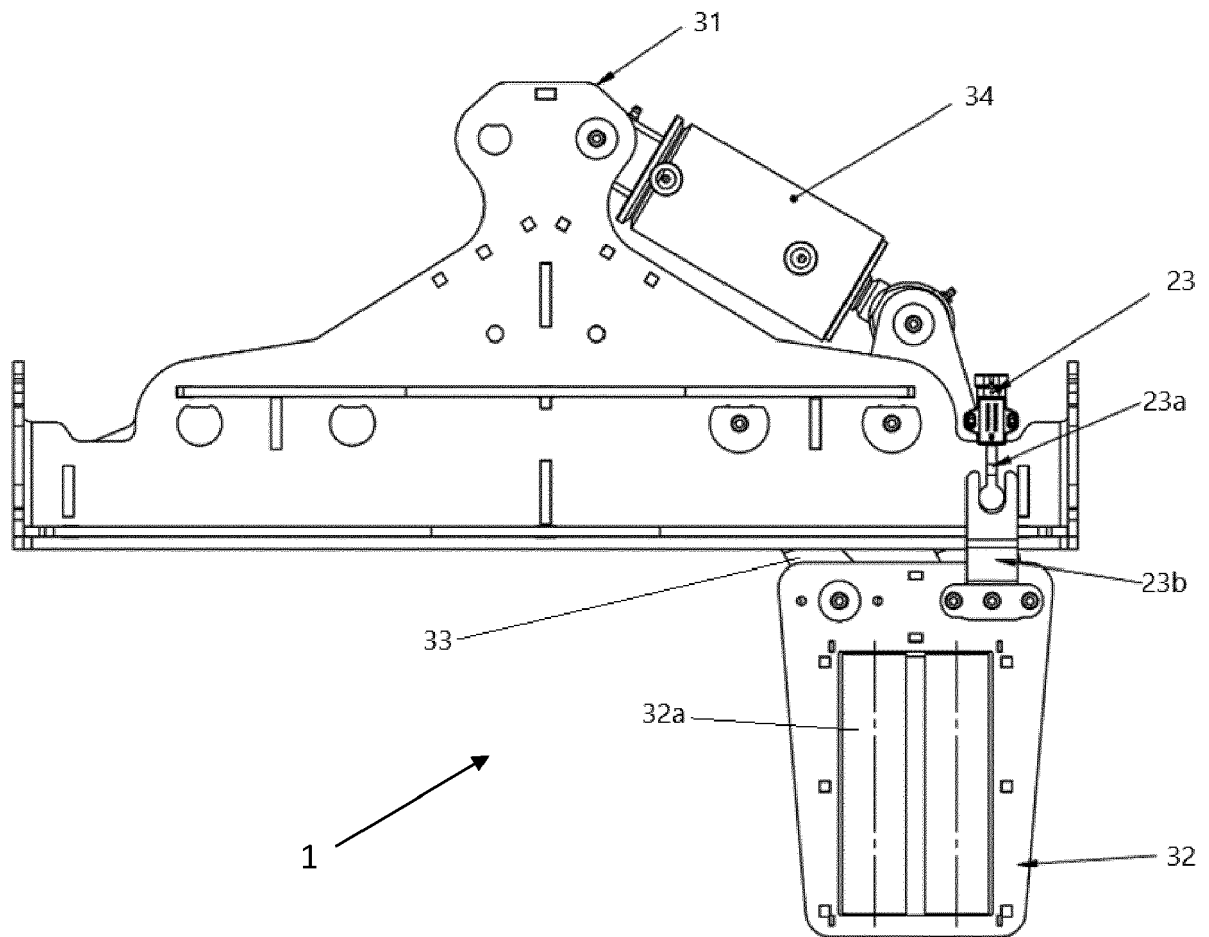


Figure 3



EUROPEAN SEARCH REPORT

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		24 March 2021	Rupcic, Zoran
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ON EUROPEAN PATENT APPLICATION NO.**

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