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(54) **SYMMETRICAL PULLEY WITH UNLIMITED ROTATION HAVING A MECHANISM FOR
TERMINATING WINDING OF A ROPE AND A WINCH COMPRISING THE SAID PULLEY**

(57) The present invention belongs to the field of forestry winches, more particularly to the field of constructional details in forestry winches, which are linked to pulling load by winding rope onto a drum via a pulley. The invention relates to a symmetrical pulley with unlimited rotation and having a mechanism for terminating winding of a rope as well as to a winch comprising the said pulley. Said pulley comprises:

- a fixed part with at least one sensor or switch for terminating winding of a rope onto a drum, and
- a rotatable part connected with the fixed part via a bearing, said rotatable part having:

- two equally sized sheaves inside a housing,
- two rollers installed above the said sheaves, and
- a two-part collision piece installed above both rollers, wherein each of the parts of the collision piece are movably mounted at the side of the housing, so that they cover the rollers and create an opening for a rope in the middle part, said opening being smaller than the end part of the rope,
- said collision part is via a lever connected with a ring that can activate the sensor or the switch in a way that terminates winding of the rope onto the drum.

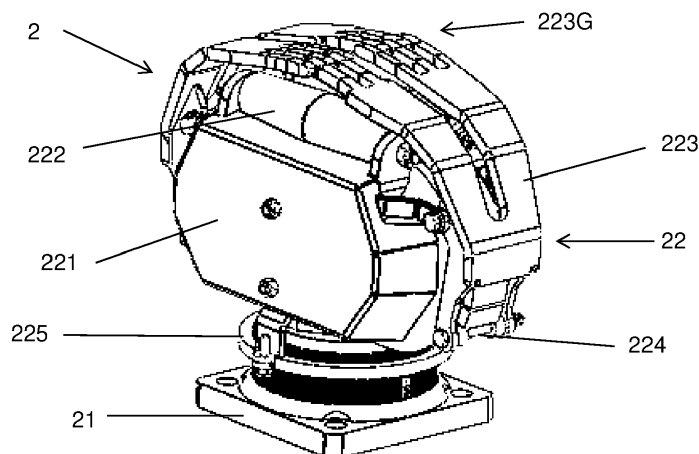


Figure 2

Description

Field of the invention

[0001] The present invention belongs to the field of forestry winches, more particularly to the field of constructional details in forestry winches, which are related to pulling a load by winding a rope onto a drum via a pulley. The invention relates to a symmetrical pulley with unlimited rotation and having a mechanism for terminating winding of a rope as well as to a winch comprising the said pulley.

Background of the invention and the technical problem

[0002] Termination or suspension of pulling of a load via winding of a pulling rope onto a drum is often required during use of a winch. It may occur that the user does not timely stop the winding, which leads to the rope being stuck in the already wound coils on the drum or the end of the rope gets torn off. At the same time other constructional elements, such as the guide of the pulling rope, may be damaged. Consequently, work has to be terminated and the damaged parts have to be repaired or exchanged if the deformation is permanent.

[0003] In order to prevent described damages caused by non-timely stoppage of winding several different systems for terminating winding of the pulling rope onto the drum have been developed, such as the ones described in patent EP 3095748, as well as documents SI 25045 and SI 25043. These solutions are adapted for upper pulleys of winches, which have limited rotation and thus different construction from the pulleys with unlimited rotation. The latter are of most importance for winches, as operation can be smoothly performed regardless of the terrain, as the pulleys with unlimited rotation can turn in any direction and thus enable winding of the rope onto the drum from all possible directions. Pulleys with unlimited rotation may be symmetrical or asymmetrical, wherein the difference with regards to the usual pulleys with limited movement is in that they can rotate for 360 degrees in any direction.

[0004] Symmetrical pulleys with unlimited rotation do not have mechanisms for automatic stopping, suspending or terminating winding of a pulling rope onto the drum of the winch, which would be triggered by closing of the end part of the rope to the pulley, while the known solutions for pulleys with limited movement due to different construction are not suitable for symmetrical pulleys with unlimited rotation. Therefore, the technical problem, which is solved by the present invention, is constructional design of a mechanism for terminating winding of the rope, which will be suitable for a symmetrical pulley with unlimited rotation.

State of art

[0005] Patent SI 24805 describes a pulley of a forestry

winch with a freely-rotatable housing around the symmetry axis in a fixed housing, having a sensor installed onto the fixed housing. Opposite the sensor the rotatable housing is provided with a ring that can be moved in the direction of the symmetry axis for activating the said sensor. The ring is connected with a ring guide, which is movable in the direction of the symmetry axis and in contact with a collision lever. A spring installed on the ring guide ensures a larger distance from the ring from the sensor. During winding of the rope onto the drum the plate attached to the rope hits the collision lever and moves it in the direction of pulling of the rope, which moves the ring guide and the ring towards the sensor. The ring activates the sensor, which via a control unit terminates pulling and winding of the rope onto the drum of the forestry winch.

[0006] The mentioned patent describes a non-symmetrical pulley (1), in which only one sheave (5) and pushing sheave (6) is used. The mass centre of the rotating part of the pulley is thus out of the axis of rotation. The rotating part of the housing has a tendency to rotate in such a way that the sheave (5) is under the axis. In case the pulley is turned only in one direction, termination of winding is not reliable. In case the rope is located inside the working area shown by the triangle in figure 1, rotation of the pulley is disabled, as the force in the rope has no lever force with regards to the axis of rotation, therefore the pulley does not rotate. Consequently, the rope is led via a pushing sheave (6), which is relatively small and the rope suffers from large bending stress, which leads to shorter life span of the rope. An even larger problem is pulling the rope from the transverse direction. In the upper part of the working area the force in the rope has no lever with regards to the rotation axis, the pulley does not rotate and the rope slides along the collision lever. The sum of forces onto the rope rotates the collision lever around its fulcrum, wherein unwanted termination of pulling may occur. In practice such situations may be dangerous, as for example in pulling a tree the latter may fall in an unwanted direction and cause damage or injuries.

Description of the solution of the technical problem

[0007] The present invention is based on a symmetrical pulley, which differs from the asymmetrical pulleys in its design, shape and operation. The technical problem is solved as defined in the independent claim, while the preferred embodiments of the invention are defined in the dependent claims.

[0008] The symmetrical pulley with unlimited rotation comprises a fixed part, which is attached, usually screwed, to the winch frame or a ramp board, and a rotatable part. The rotatable and the fixed part are connected with a bearing or a sliding bushing in the same way as is known in the field of freely rotatable pulleys. The essence of the symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope is in that the pulley is symmetrical with two equally sized

sheaves for leading the rope, wherein the sheaves are installed in a housing in the rotatable part, due to which the mass centre of the pulley is on the axis of rotation. In this way the pulley remains in the same position during operation, even if the force in the rope decreases. At the exit of the pulley, i.e. above the sheaves, preferably two rollers are provided, which serve to direct the rope and to position the rotatable part of the pulley. The rollers are preferably mounted onto the housing of the sheaves with holders using suitable screws. In case the rollers are present the wear of the rope is lower. If they are absent, the rope runs on the mechanical part of the pulley. Above both rollers and/or both sheaves the two-part collision piece is provided, having any suitable shape, wherein the collision piece is rotatably mounted at the sides of the pulley or the housing of the sheaves. Both parts of the collision part are shaped correspondingly to the shape of sheave housing and/or rollers, and they form a suitable opening for the rope in the middle. The opening may have any shape. Preferably, both parts of the collision piece are shaped as parts with a corresponding cut-out, for example as a comb. One of the possible embodiments of the collision parts is that they are shaped as a letter U, both legs of which are shaped as a comb, while a long opening is provided in-between, in which the rope may run towards the drum. The collision part after interaction with an end part of the rope moves the lever connected with the ring installed on the movable part so that it can embrace the fixed part of the pulley, wherein the ring is moved towards at least one sensor on the fixed part of the pulley. Consequently, the said ring terminates the signal of the sensor and thus causes a termination of the winding of the rope. The two-part collision part enables reliable termination of winding regardless of the pulley or the direction from which the rope is coming. The vertical rollers and the opening in the collision part enable that the rope turns the pulley in such a way, that the rope is lead via a sheave. Hence, the rope can never slide on the collision part, if the winch is pulling in the transverse direction (rotation of the pulley is directed by the rope weight). If the winch pulls in such a way that the rope is in the vertical plane, the upper sheave is active during pulling upwards, while the lower sheave is used during pulling downwards. In case the end part of the rope hits into the collision part, both parts are moved downwards, which causes a movement of the lever, which pushes the ring towards the sensor or the switch, thus terminating the winding of the rope.

[0009] When the rope is pulled out, the mechanism for terminating winding of the rope returns to its original state due to a spring, which is installed between both handles of the lever, so that they are moved apart and the ring is pulled above the sensors. The spring may be tension, compression, gas or any other spring that enables return of the mechanism into its original state. A hydraulic cylinder with a hydraulic accumulator could also be used, but such embodiments are more demanding and complicated.

[0010] The collision part may be designed in any suitable way so that its parts equally cover the sheaves or the rollers, if they are present, which enables a reliable termination of rope winding regardless of the position of the pulley and regardless of the direction from which the rope is coming. The lever connecting the collision part with the ring may be shaped in any suitable way, preferably it is designed as two handles, movably connected with each other, which are on one side mounted on the collision parts and on the other side to the ring, which can at least partially cover the sensor in the fixed part, in case the end part of the rope hits the collision part. The handles may be connected to the ring via a second intermediate part, which can move in the direction of the rope towards and away from the drum. The second intermediate part preferably comprises a middle part and two side parts, each of which is connected with its own handle of the lever. In the mechanism of the pulley according to the invention any type of sensor can be used, preferably inductive, magnetic, capacitive or optical. The sensor may also be replaced by switches or similar elements for terminating winding of the rope. At least one such element has to be present, preferably two, as this ensures more reliable operation in case of malfunction of one of them.

[0011] The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope can be installed in any winch or tractor, wherein the winch may have one or more drums. In case of two drum winches the pulleys are installed at a pre-defined distance, as is known in this technical field.

[0012] The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope will be described in further detail based on an embodiment and figures, which show:

- Figure 1 Asymmetrical pulley with unlimited rotation according to state of the art document SI 24805
- Figure 2 Elevation view of the symmetrical pulley with unlimited rotation according to a possible embodiment
- Figure 3 Side view of the symmetrical pulley with unlimited rotation according to a possible embodiment

[0013] Figure 1 shows a known solution of an asymmetrical pulley with unlimited rotation having the above-described disadvantages. The embodiment with one collision part or single part collision piece is not suitable for symmetrical pulleys, as due to the single mounting such collision piece cannot ensure a reliable termination or suspension of winding of the rope in any position of the pulley.

[0014] The preferred embodiment of the symmetrical pulley with unlimited rotation is shown in figure 2, wherein the pulley 2 comprises:

- a fixed part 21 for mounting onto a winch housing or a ramp board, said fixed part 21 having at least one sensor or switch 21a for terminating winding of a rope onto a drum, and
- a rotatable part 22 connected with the fixed part 21 via a bearing or a sliding bushing, said rotatable part 22 having:

- two equally sized sheaves 221a, 221b inside a housing,
- optionally two rollers 222 installed above the said sheaves 221a, 221b for directing the rope and positioning the rotatable part 22 of the pulley 2, and
- a two-part collision piece 223 installed above housings of said sheaves 221a, 221b and/or both optional rollers 222, wherein each of the parts of the collision piece 223 are movably mounted in a mounting 224 at the side of the housing, so that they cover the sheaves 221a, 221b and/or the rollers 222 and create an opening for a rope in the middle part, said opening being smaller than the end part of the rope,
- said collision part 223 is via a lever 226 connected with a ring 225 on the rotatable part 22 that can activate the sensor or the switch 21a in a way that terminates winding of the rope onto the drum.

[0015] The sheaves are installed inside their own housing 221a, 221b (behind their housing and not shown in the figure) and inside the protection of the lever 26 of the pulley 221, while rollers 222 are installed via holders with suitable screws onto the housing of the sheaves 221a, b. The collision part 223 comprises two equal parts, which have the shape of an approximate letter U, of which both legs are shaped as a comb 223G, while along the middle a long opening is provided, along which the rope can run towards the drum of the winch. Both parts in the shape of the letter U are curved, so that they correspond to the shape of the rollers 222 and sheave housing 221a,b, while the mounting 224 is carried out at the sides of the sheave housing 221a,b or the pulley protection 221 in any suitable way, which allows movement of both collision parts 223 upon interaction with the ending of the rope. The preferred embodiment is with an axis, mounted in the housing 221 of the pulley 2 and the collision part 223 and attached with screws or suitably long screw and a nut.

[0016] Figure 3 shows an elevation view of the pulley 2, wherein the lever 226 connecting both collision parts 223 with the ring 225 is visible, the ring 225 being able to activate at least one sensor 21a on the fixed part 21. The collision parts are wider in the side part of the pulley and in the mounting, wherein they are narrower in the part above the rollers. Onto the wider part of the collision parts 223 handles 2261a, 2261b are installed, which are on the other end connected to the middle part 2262a,

2262b with notches, which correspond to the notches in the intermediate part 2263, of which the second part is connected to the ring 225. On each side of the pulley 2 the lever is mounted, so that the pressure on the ring is symmetrical. Because the connections between parts of the lever are rotatable, movement of at least one of the collision parts move the handles and consequently the intermediate parts with notches. As the notches interact with the intermediate part 2263, the latter is moved downwards towards the fixed part 21 in order to discontinue the signal of sensors or in any other way activates the sensor or the switch 21a, which terminates winding of the rope onto the drum.

[0017] If the rope is pulled out, the pressure onto the parts of the collision pieces 223 is reduced, due to their movement all parts of the lever 226 are moved due to the spring, which connects both handles of the lever 2261a, 2261b. This lifts the ring 225 and the signal of the sensors 21a is re-established.

Claims

1. A symmetrical pulley with unlimited rotation having a mechanism for terminating winding of a rope onto a drum, wherein the said pulley comprises:

- a fixed part for mounting onto a winch housing or a ramp board, said fixed part having at least one sensor or switch for terminating winding of a rope onto a drum, and
- a rotatable part connected with the fixed part via a bearing or a sliding bushing, said rotatable part having:

- two equally sized sheaves, each inside a sheave housing,
- optionally two rollers installed above the said sheaves for directing the rope and positioning the rotatable part of the pulley, and
- a two-part collision piece installed above housings of said sheaves and/or both optional rollers, wherein each of the parts of the collision piece are movably mounted at the side of the housing, so that they cover the rollers and create an opening for a rope in the middle part, said opening being smaller than the end part of the rope, and
- said collision part is via a lever connected with a ring that can activate the sensor or the switch in a way that terminates winding of the rope onto the drum.

2. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to claim 1, **characterized in that** the both parts of the collision piece are designed as parts with corresponding cut-out, preferably in the

shape of a comb.

3. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to any of the preceding claims, **characterized in that** the collision part comprises two equally shaped parts, which have an approximate shape of letter U, both legs of which are correspondingly shaped, and wherein an opening for leading the rope is provided in-between; both parts shaped as the letter U are curved, so that they correspond to the shape of rollers and/or sheave housings. 5
4. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to any of the preceding claims, **characterized in that** the mounting of both parts of the collision piece is achieved with an axis installed in the housing of the pulley and into the collision part and attached with screws; or instead of the axis a screw with a nut is used. 10 15 20
5. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to any of the preceding claims, **characterized in that** the mechanism for terminating winding of the rope is arranged to return to its original state once the rope is pulled out, with a spring, which is installed between the handles of the lever, wherein the spring may be tension, compression, gas or any other spring that enables return of the mechanism into its original state; or instead of the spring a hydraulic cylinder with a hydraulic accumulator is used. 25 30
6. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to any of the preceding claims, **characterized in that** the lever is designed as two handles, movable connected one to the other, the said handles being mounted on one end to collision piece parts and to the ring on the other end, the ring being arranged to partially cover the sensor in the fixed part in case the end piece of the rope hits the collision piece. 35 40 45
7. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to the preceding claim, **characterized in that** the handles are connected with the ring via at least one second intermediate part, which can be moved in the direction of movement of the rope towards the drum and away from the drum, wherein the second intermediate part is preferably comprising a middle part and two side part, of which each is connected to one of the handles. 50 55
8. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to the preceding claim, **characterized in that** the handles are mounted onto a wider part of the collision parts and on the other end onto the side parts with notches that correspond to the notches on the middle part, of which a second part is connected with the ring; because the connections between parts of the lever are rotatable, movement of at least one of the collision parts moves the handles and consequently the intermediate parts with notches; as the notches interact with the intermediate part, the latter is moved downwards towards the fixed part and moves the ring as well; in case the ring is pushed far enough towards or along the fixed part, the signal of sensors is discontinued or the sensor or the switch are in any other way activated to allow termination of winding of the rope onto the drum.
9. The symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to any of the preceding claims, **characterized in that** the sensor may be any suitable, preferably an inductive, magnetic, capacitive or optical sensor, or any suitable switch, respectively.
10. A winch with the symmetrical pulley with unlimited rotation with the mechanism for terminating winding of a rope onto a drum according to any of the preceding claims.
11. The winch according to the preceding claim, **characterized in that** the winch has one drum or two drums.

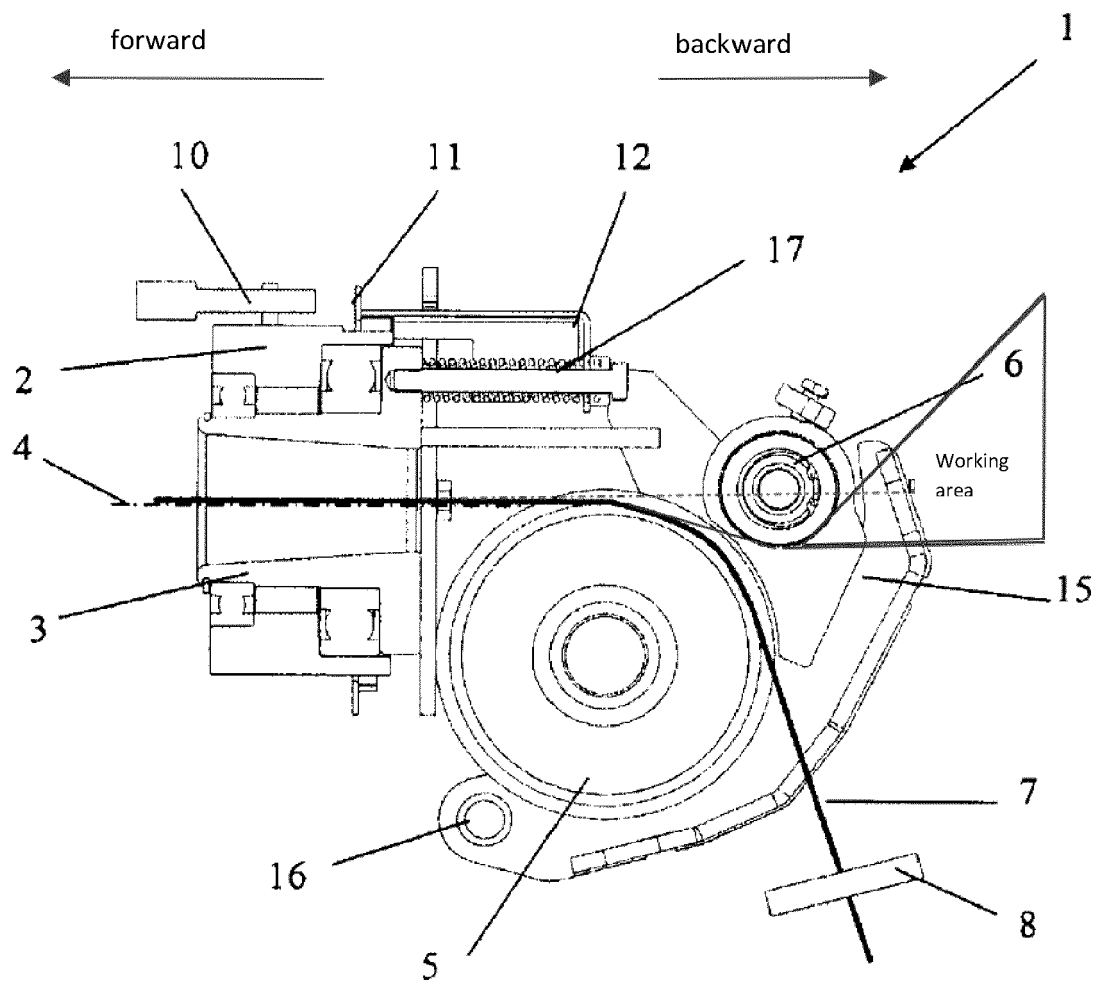


Figure 1 – state of the art

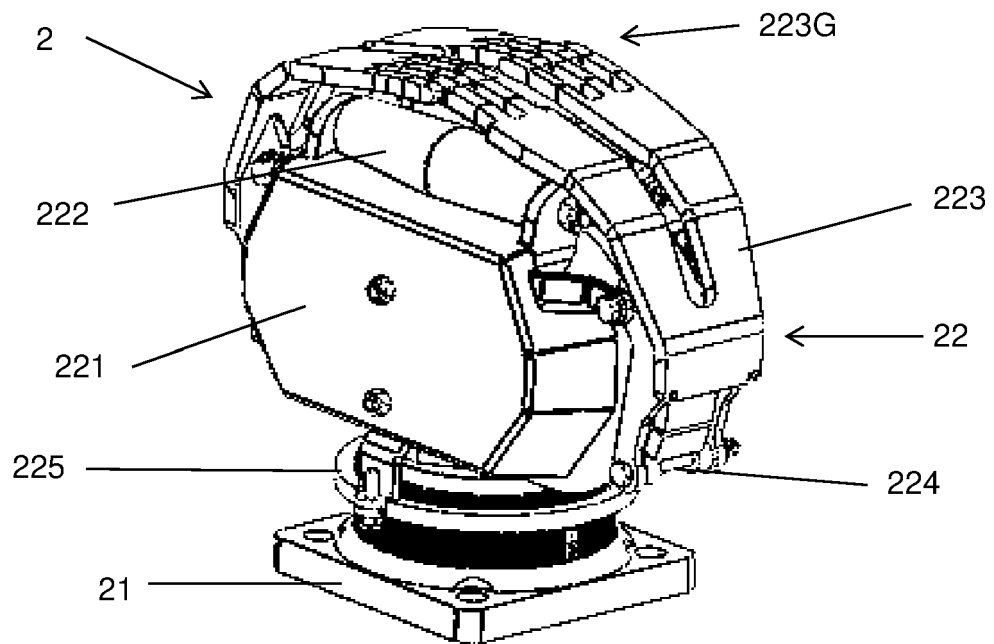


Figure 2

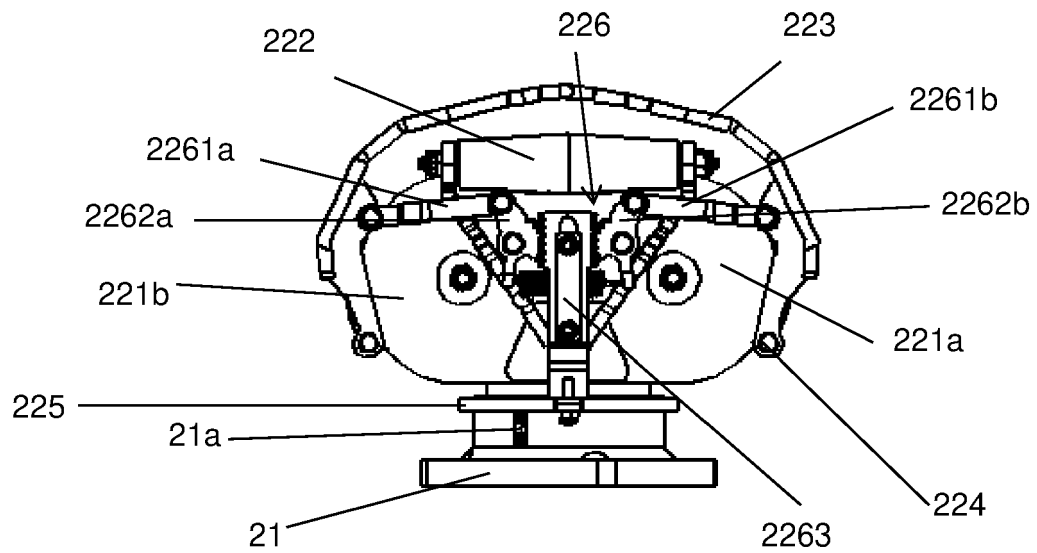


Figure 3

Application Number
EP 20 20 4196

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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	Verheul, Omiros	
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ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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24-03-2021

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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