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(54) **A MECHANIC-HYDRAULIC SYSTEM WITH A SAFETY DEVICE FOR SWITCHING OFF WINDING OF A CABLE ROPE OF A WINCH**

(57) A safety device for switching off winding of a cable rope of a winch at a constant or variable pulling force is disclosed wherein a mechanic-hydraulic system with a pressure regulator (21) is equipped with a rod (36) and an extension (37) with an adjustable length »i« for precise setting of the pulling force; that the extension (37) is located from a switch (38) at an adjustable distance »j«, the switch (38) being connected in parallel to the circuit of the winding function of the winch; that in the case a rope layer exceeds an outer radius »rz«, a cylinder (33) through forks (34) retracts for a pre-specified border value the extension (37) in regards to a drum (30), wherein the extension (37) activates the switch (38), which causes interruption of the electric and/or hydraulic circuit of active winding function. Switching off winding of the cable rope may also be executed with a mechanically controlled hydro-valve, which is connected into the primary hydraulic scheme of a winch and enables switching off the hydraulic circuit after reaching the border value of the radius »rz«.

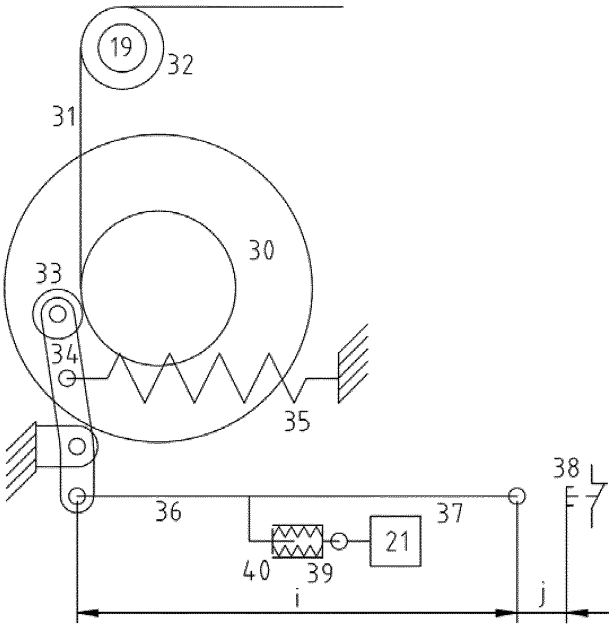

Fig. 4

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Description

Field of the invention

[0001] The present invention belongs to the field of mechanical engineering, more precisely to the field of hydraulic systems with hydraulic accumulators as additional sources of hydraulic pressure energy, in particularly suitable for devices with uneven consumption. At the same time the invention belongs to the field of safety devices in forestry winches.

The technical problem

[0002] The technical problem, which is solved by the present invention, is a constructional solution of a hydraulic system for controlling the winding drum of a winch, which will enable switching off winding of a cable rope of a winch. During use of a winch a situation can occur, in which the process of load pulling must be terminated safely and reliably. The aim is also a constructional execution of simple interruption of electric and/or hydraulic circuit in case the radius of the wound rope on the drum increases due to inaccurate winding of the rope onto the drum.

State of the art

[0003] So far known solutions of optimization of winch pulling force due to the effect of the number of pulling rope coils on the winch drum are EP2565144 »Winch« and S124108 »Forestry winch with controlled winding of traction rope and protection thereof overload«.

[0004] The winch, described in patent document EP2565144, includes a drive shaft, a rope drum provided for rolling a rope, a drum coupling for transmitting rotating movement of a drive shaft on the rope drum, a drum brake for breaking the rope drum and a rope ejector with at least one drivable pulley. The drivable pulley may be driven for unwinding of the rope and though transmission, which has a rope ejection coupling, wherein the pulley is connected with the drive shaft. The invention is characterized in that the rope ejection coupling is formed as a coupling, which is activated hydraulically. This solution differs from the present invention, because the hydraulically driven mechanism is provided for mechanical displacement of handles with the aim of maintaining almost constant pulling force of a winch.

[0005] According to Slovene patent no. 24108 a solution of a forestry winch is known, in which coiling of a towing cable is performed in a controlled manner, so that the cable windings on the surface of the winding drum are arranged side by side relatively to each other without any transpositioning or overlapping, and that each overloading of said towing cable and other components of a driving assembly due to towing of a too heavy load should be excluded. To this aim, the winch is furnished with a directing assembly, which is arranged between an upper pulley block and said winding drum and is freely rotatable or least pivotable at a certain angle around the vertical geometric axis, wherein said winch moreover includes a dynamometer suitable for measuring of tensioning force within said towing cable, so that also the winding drum can be controlled depending on each measured loading of the towing cable.

[0006] Known solutions from practice do not solve the technical problem in a way that is employed in the present invention, which enables mechanic activation of interruption of the electric and/or hydraulic circuit of the winch at a pre-defined border size of crosspiece of cable rope coils.

Description of the solution of the technical problem

[0007] The mechanic-hydraulic system with a safety device for switching off winding of a cable rope of a winch at a constant or variable pulling force is characterized in that the hydraulic system includes a check valve and a pressure regulator, which through a rod with an additional rod of variable length activates a switch for turning off electric circuit of active winding function at a pre-set limit outer radius of rope on the drum.

[0008] The mechanic-hydraulic system with a safety device for switching off winding of a cable rope of a winch at a constant or variable pulling force will be described in further detail based on figures, which show:

- Figure 1 a hydraulic scheme of the system with a pressure regulator,
- Figure 2 a schematic view of the system for controlling the constant or variable pulling force,
- Figure 3 a schematic view of radii of rope on the drum,
- Figure 4 a schematic view of the safety device for switching off winding at a constant or variable pulling force,
- Figure 5 a mechanic-hydraulic system without the safety device for switching off winding of a cable rope of a winch,
- Figure 6 the safety device for switching off winding of a cable rope of a winch.

[0009] A pump 3 fills a hydraulic accumulator 9 to a working pressure, which is set on a relief valve 5, through check valves 4 and 7. When oil in the hydraulic accumulator 9 reaches the set working pressure, the relief valve 5 opens and remains in this position until pressure in the hydraulic accumulator 9 drops for a specified value, which is approximately 10 to 15 bar. Oil freely runs to a flow regulator 16 and a control valve 6, when the valve 5 is open. The smaller resistance is on the side of the valve 6, therefore oil runs through it to an oil reservoir 1. Due to such design of the hydraulic equipment, the pump 3 mostly works at a lower pressure, namely up to 10 bar. If the user selects the rope unwinding function, the valve 6 (right) and a valve 11 (right) are simultaneously switched. Oil runs from the pump through the valve 6 to

a pressure regulator 16, a check valve 17 to a hydromotor 19, which drives the unwinding pulley, via which a rope 31 is led onto a drum 30 of the winch. Simultaneously oil from the hydraulic accumulator 9 through a throttle 8, the valve 11 and an adjustable throttle 13 activates a break cylinder 14, thereby releasing the break of the drum, so that the rope on the drum 30 starts to unwind due to the pulling force in the rope 31, caused by the hydromotor 19. The pressure in the inlet line to the hydromotor 19 rises up to 50 to 70 bar.

[0010] When a user switches on rope winding, the valve 11 (left) and a valve 20 (right) are switched and oil runs from the hydraulic accumulator 9 through the throttle 8, the valve 11 and a pressure regulator 21 and activates a cylinder 15 of the coupling.

[0011] In case the pressure in the hydraulic accumulator 9 drops to a specified value, the relief valve 5 closes and the pump fills the hydraulic accumulator 9 to the set working pressure.

[0012] When oil runs through the valve 5 to a common point with the valve 6 and the reservoir, the current also runs to a control valve 20, which is connected in parallel with the hydraulic cylinder 15 of the coupling. In case of winding it is necessary to simultaneously switch the valves 11 and 20, so that the hydraulic cylinder 15 of the coupling is turned on. When winding is turned on the left part of the valve 11 and the right part of the valve 20 are simultaneously switched. Oil runs from the accumulator towards the hydraulic cylinder 15 of the coupling, thereby activating it, while oil cannot run through the right part of the valve 20. After termination of winding, the valves 11 and 20 switch into their starting positions. If any of the valves is blocked, oil can always freely run into the reservoir through the valve 11 or through the valve 20. The hydraulic scheme comprises the pressure regulator 21 and the check valve 22, which is on one side connected with the node of the reservoir 1, the valve 6 and the valve 20, and on the other side connected with the pressure regulator 21.

[0013] Ordinary forestry winches have the largest pulling force F, when the drum 30 is empty or when there is only one layer of the rope 31 on the drum 30. Lamellae of the coupling are pressed with a constant force; therefore the torque M transferred from the drive shaft to the drum 30 of the winch is always constant. By winding of the rope 31 onto the drum 30 the radius »r« of the last layer of rope on the drum is increased, therefore the pulling force F decreases, since M = r x F applies.

[0014] As shown in figure 3, the first layer of rope on the drum has a radius »rn« and the last anticipated layer of rope on the drum has a radius »rz«. The working pressure is »po«. When the pushing cylinder is on the level of the first layer of the rope on the drum, the coupling receives a decreased working pressure, namely

$$pn = po \times rn/rz;$$

[0015] The result is that the working pressure »p« is lower at an empty drum. When the rope is entirely wound to the drum, the working pressure »p« is equal to the pressure »po«. When the rope is only partly wound and »r« is optional, the pressure can be calculated with the following equation:

$$p=po \times r/rz.$$

[0016] The pressure »p« in the pressure regulator 21 is adjusted by selecting the length of a rod 36, which defines the length of lever »e« and length »f«.

[0017] The mechanic-hydraulic system has a pushing cylinder 33 mounted on forks 34, which oscillate around a bottom axis 34a, to which on one side a spring 35 is fastened via an accessory 35a, while on the other side an attachment element 36a for the rod 36 is mounted. A distance »g« is between the centreline of the axis 34a, where the bottom part of the accessory 35a is mounted, and the centreline of the upper part of the accessory 35a, where the spring 35 is fastened. On the other side of the axis 34a an attachment element 36a with a groove 36a' is mounted. One part of the rod 36, which is preferably a threaded rod, is mounted in the groove 36a'. The other part of the rod 36 is rotatably mounted into a holder 36b, which with its part 36b' touches the piston of the regulation valve 21. A distance »e« is between the centreline of the axis 34a and the place in the groove 36a', where the first part of the rod 36 is mounted. The distance »f« is between the first part of the rod 36 and the centreline of the mounting of the other part of the rod 36 into the holder 36b. The pre-strained spring 35 pulls the forks 34 on the lever »g« and thereby pushes the pushing cylinder 33 to the drum 30 with the wound rope 31.

[0018] By winding the rope 31 onto the drum 30 the radius of the current layer of rope on the drum increases. The pushing cylinder 33, which is mounted on the forks 34, consequently moves farther from the axis of the drum 30, as the forks 34 spin around the axis 34a. Rotation of forks 34 causes a horizontal movement of the rod 36 along the groove 36a' of the attachment element 6a. Size of the horizontal movement of part 36b' of the accessory 36b is adjustable via distances »f« and »e«. The rod 36 via the part 36b' of the accessory 36b pushes the piston of the pressure regulator 21, which causes an increase in oil pressure. If the rod 36 is retracted, oil pressure decreases due to release of the piston of the pressure regulator 21 as a consequence of retraction of the part 36b'.

[0019] Depending on the execution of the pressure regulator 21, the piston of the check valve 22 may be pushed for a specified value with the rod 36. The length of the movement of part 36b' of an accessory 36b towards the control valve 21 is limited. The starting position of the part 36b' is that it is fully extended. In being so the pushing cylinder 33 on the drum 30 pushes onto the first layer of

rope. Oil pressure, which the pressure regulator 21 lets to the coupling cylinder, is »pn« and its lowest value is around 90 bar. The relationship between the retraction of the pushing cylinder 33 from the axis of the drum 30 and the movement of part 36b' of the accessory 36b towards the regulation valve 21 is approximately linear. Thus, by increasing layer radius on the drum 30 the oil pressure to the coupling 15 cylinder linearly increases. When layers of rope on the drum reach radius »rz« the piston of the pressure regulator 21 is maximally pushed with the rod 36 and the oil pressure to the coupling cylinder 15 is the highest.

[0020] As shown in figure 4, the mechanic-hydraulic system with the pressure regulator is equipped with a rod 36 and an extension 37 with an adjustable length »i« for precise setting of the pulling force. The extension 37 is located from a switch 38 at an adjustable distance »j«, the switch 38 being connected in parallel into the circuit of the winding function of the winch. If a rope layer exceeds the outer radius »rz«, the cylinder 33 through forks 34 retracts in regards to the drum for a pre-specified border value, wherein the extension 37 touches or activates the switch 38, which causes interruption of the electric circuit of active winding function. Additional protection of the pressure regulator 21 is executed with a pressure spring 40 and a switch 39. The safety device for switching off winding of the rope may also be executed with a mechanically controlled hydro-valve, which is connected into the primary hydraulic scheme of the winch and enables switching off the hydraulic circuit. In this solution, safe switching off of winch operation after reaching the border value of the radius »rz« is done with a hydro-valve instead of the electric switch 38.

[0021] The advantage of the present invention is that switching off winding of a winch rope is independently done through the regulator 21 and also through the switch 39.

Claims

1. A mechanic-hydraulic system with a safety device for switching off winding of a cable rope of a winch at a constant or variable pulling force, **characterized in that** the mechanic-hydraulic system with a pressure regulator is equipped with a rod (36) and an extension (37) with an adjustable length »i« for precise setting of the pulling force; that the extension (37) is located from a switch (38) at an adjustable distance »j«, the switch (38) being connected in parallel into the circuit of the winding function of the winch; that in the case a rope layer exceeds an outer radius »rz«, a cylinder (33) through forks (34) retracts the extension (37) for a pre-specified border value from a drum (30), wherein the extension (37) activates the switch (38), which causes interruption of the electric and/or hydraulic circuit of active winding function.

2. The mechanic-hydraulic system with a safety device for switching off winding of a cable rope of a winch at a constant or variable pulling force according to claim 1, **characterized in that** additional protection of the pressure regulator (21) is executed through a pressure spring (40) and a switch (39).

3. The mechanic-hydraulic system with a safety device for switching off winding of a cable rope of a winch at a constant or variable pulling force according to claim 1, **characterized in that** switching off winding of the cable rope is executed with a mechanically controlled hydro-valve, which is connected into the primary hydraulic scheme of a winch and enables switching off the hydraulic circuit after reaching the border value of the radius »rz«.

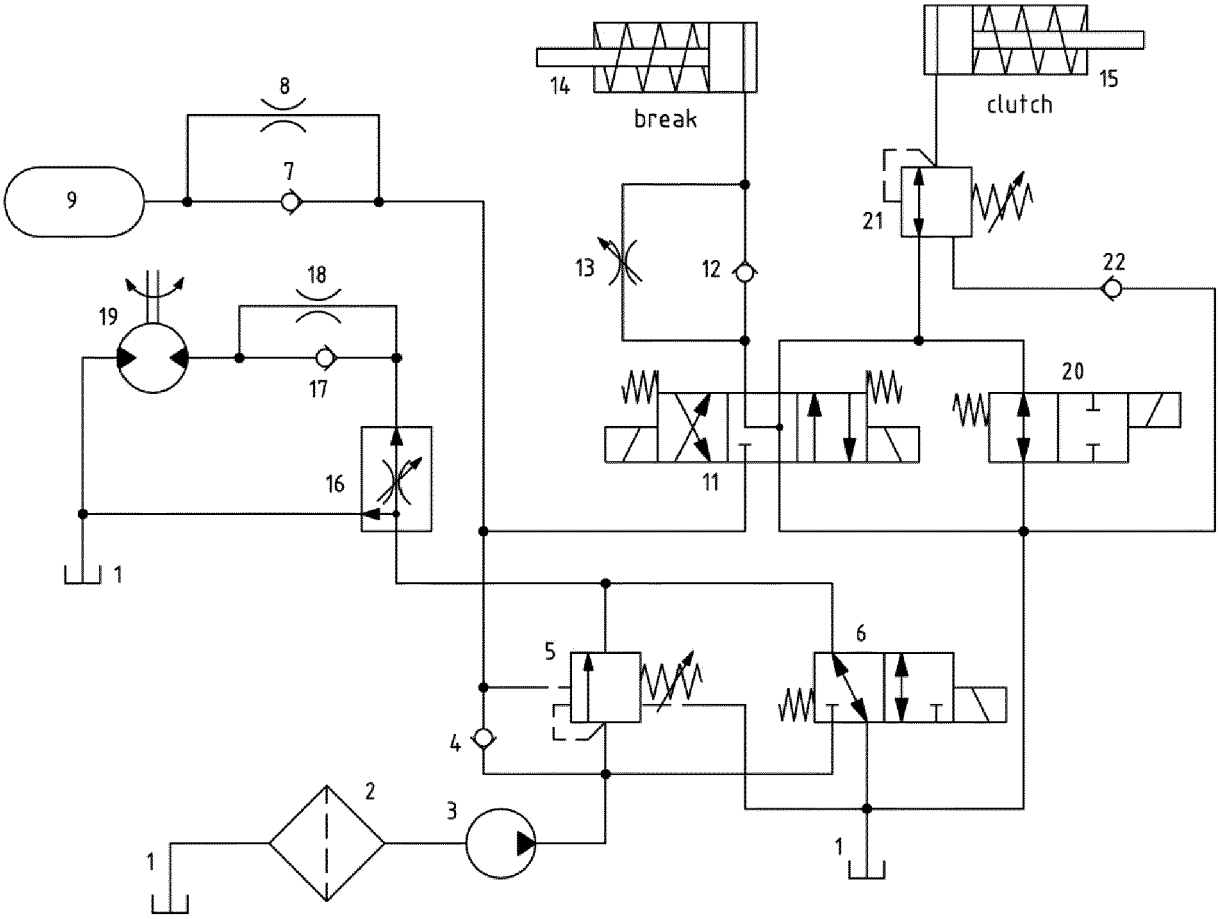
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Fig. 1

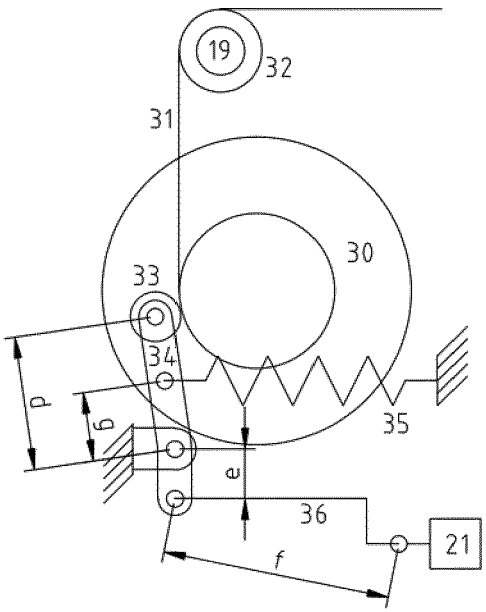
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Fig. 2

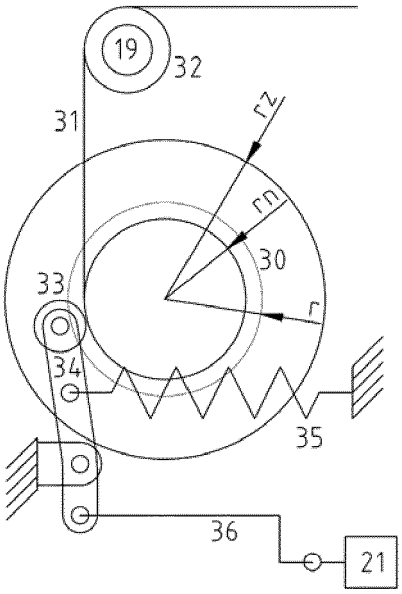
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Fig. 3

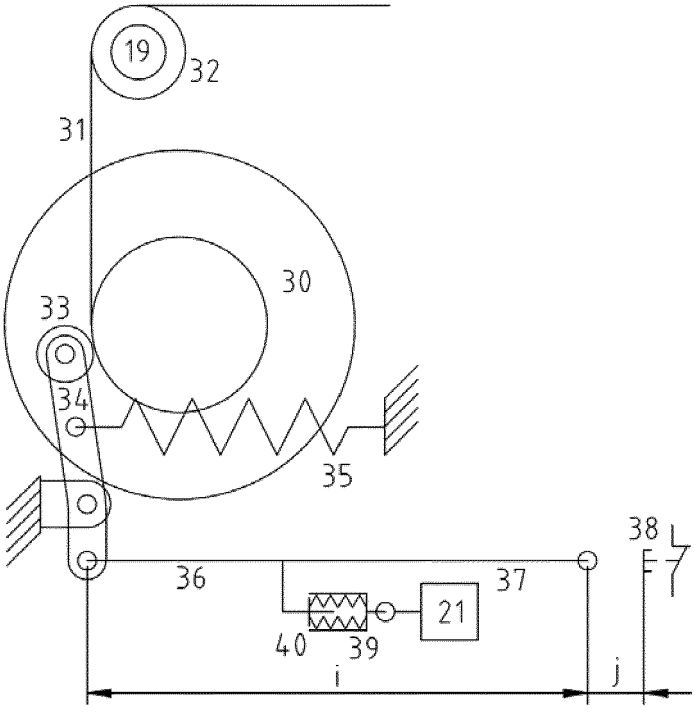
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Fig. 4

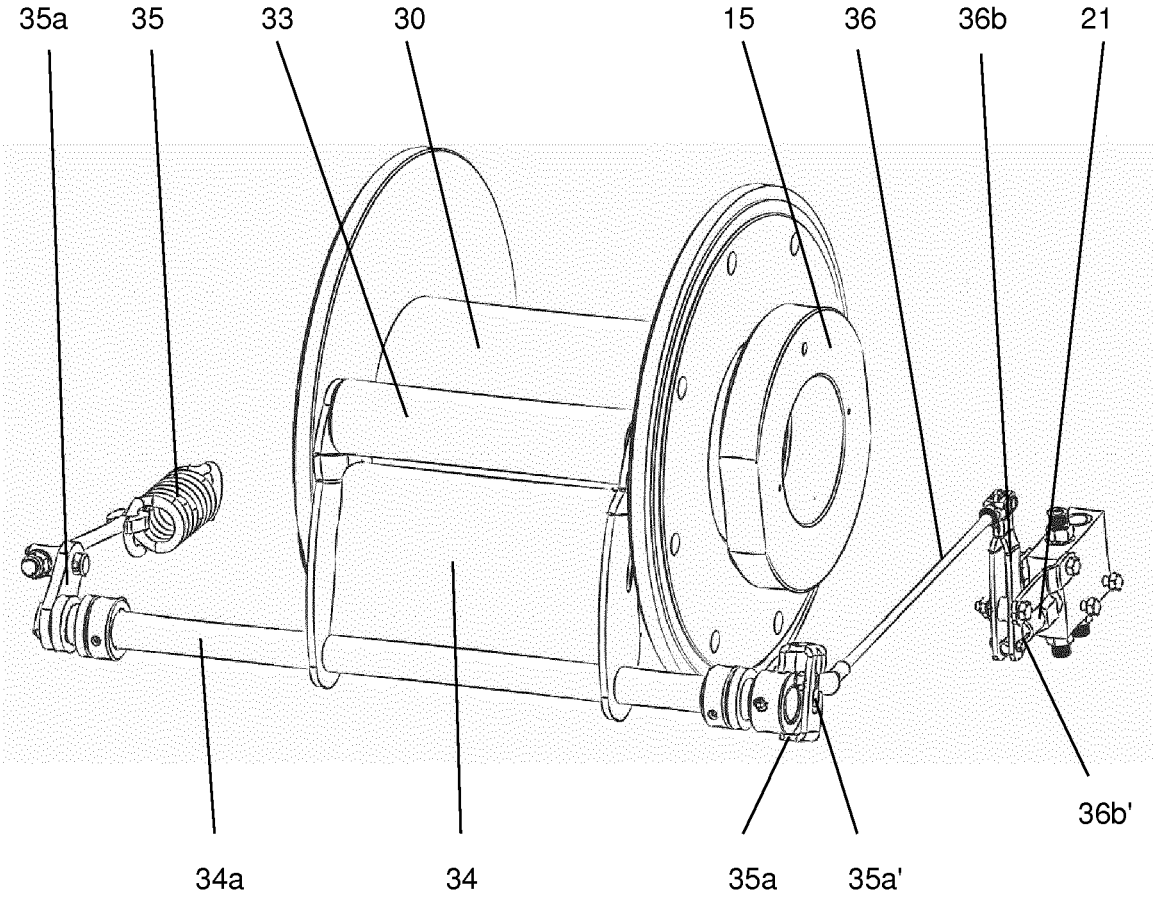

Fig. 5

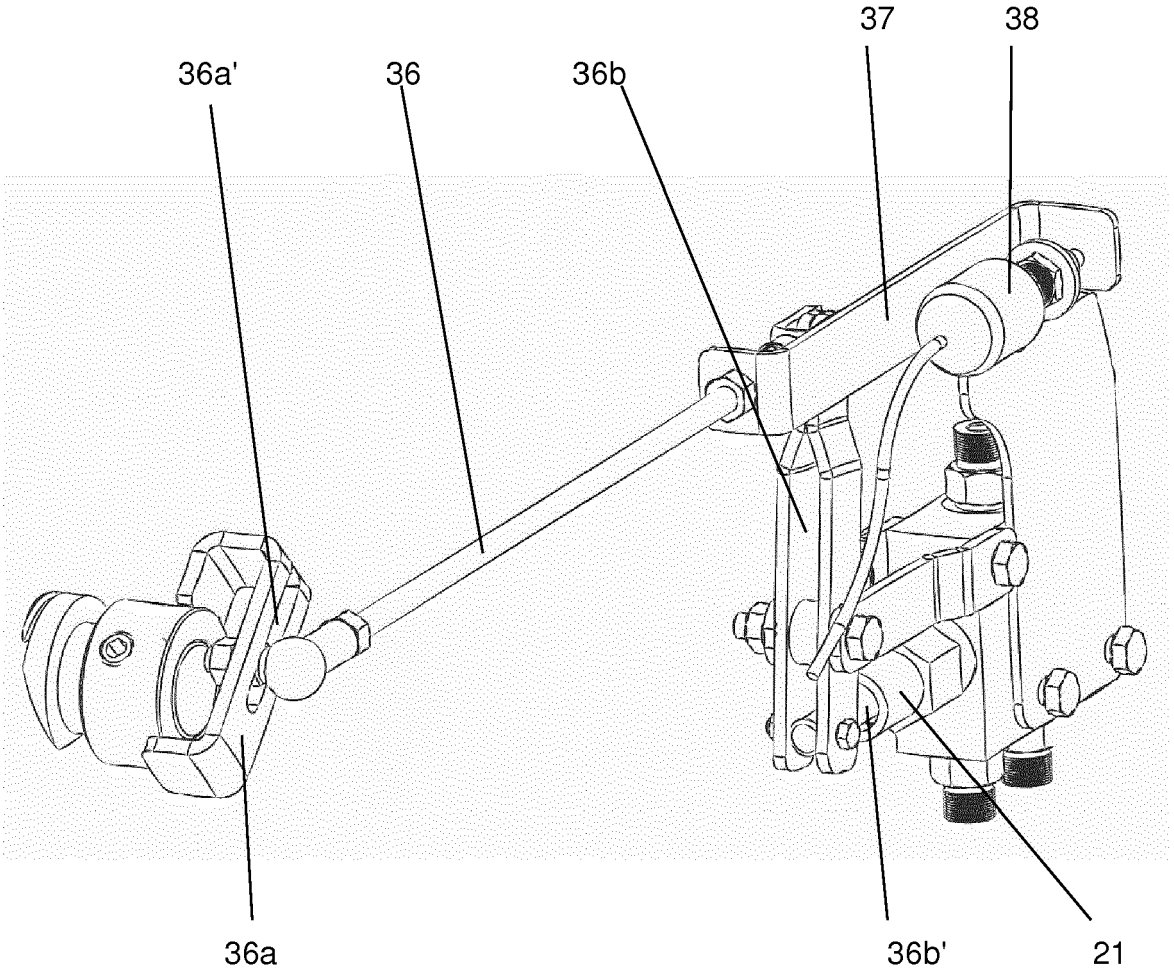

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 8083

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 29 22 421 A1 (BBC BROWN BOVERI & CIE) 11 December 1980 (1980-12-11) * page 9 - page 11 * * figures *	1	INV. B66D1/08 B66D1/50 B66D1/56
A	US 2014/091268 A1 (HERAVI OLIVER [US] ET AL) 3 April 2014 (2014-04-03) * abstract * * figures *	1	

TECHNICAL FIELDS SEARCHED (IPC)

B66D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 September 2016	Sheppard, Bruce

CATEGORY OF CITED DOCUMENTS

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16-09-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- SI 24108 **[0005]**