

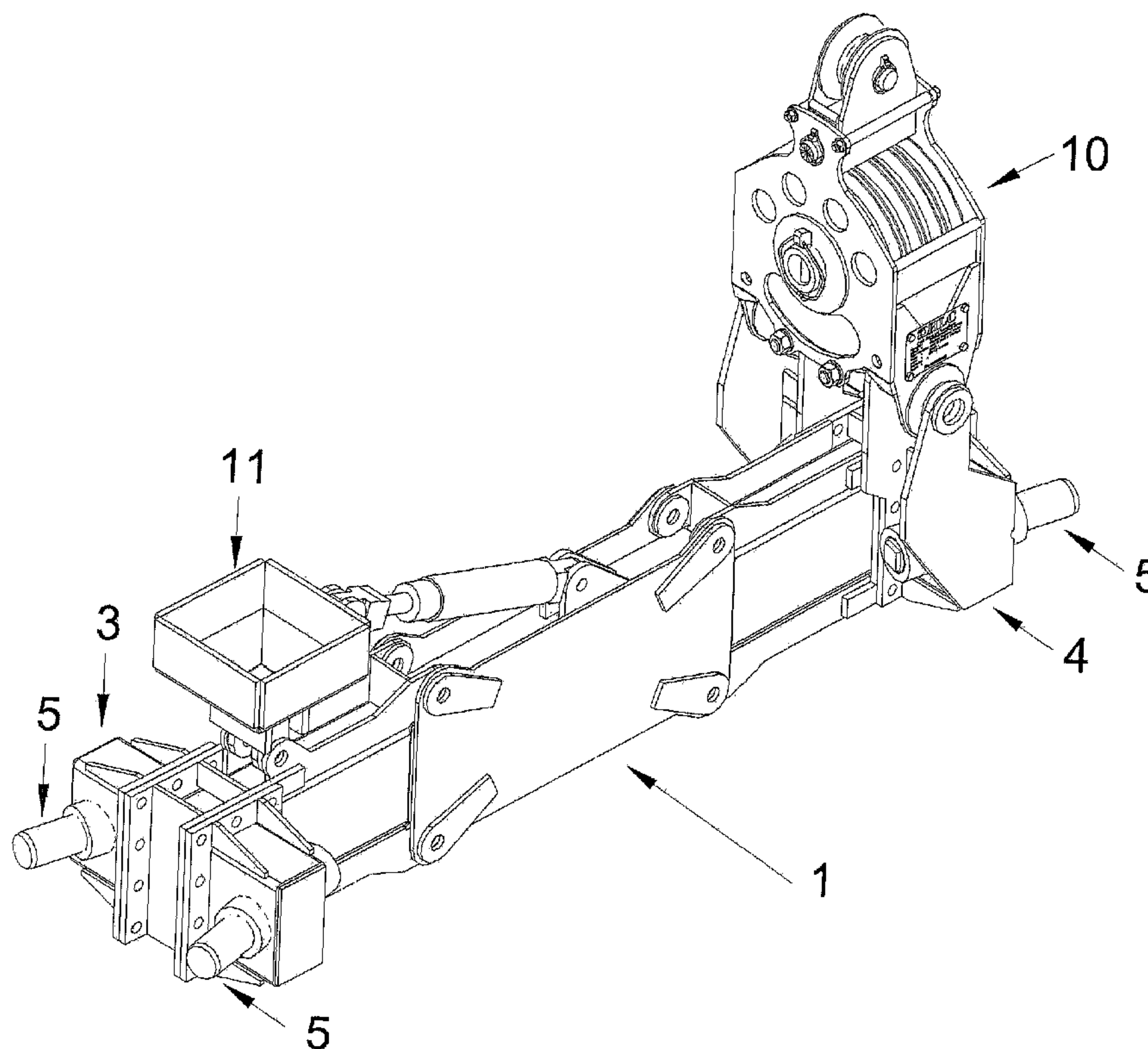


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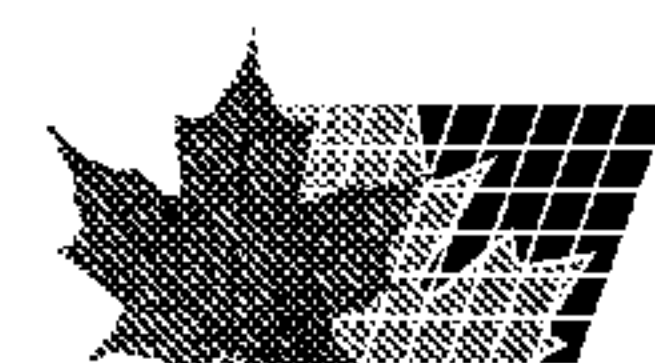
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(54) Title: METHOD AND LIFT CONSTRUCTION FOR LIFTING AND LOWERING A BLADE OF A WINDMILL



(57) Abrégé/Abstract:

The invention relates to a lift construction for lifting and lowering a blade of a windmill to and from its mounted position at a rotatable cone of the windmill, wherein it comprises: -a first yoke mountable at the inside of the blade -a second yoke mountable in the cone of the windmill, wherein the first yoke and the second yoke are arranged to cooperate.



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(54) Title: METHOD AND LIFT CONSTRUCTION FOR LIFTING AND LOWERING A BLADE OF A WINDMILL

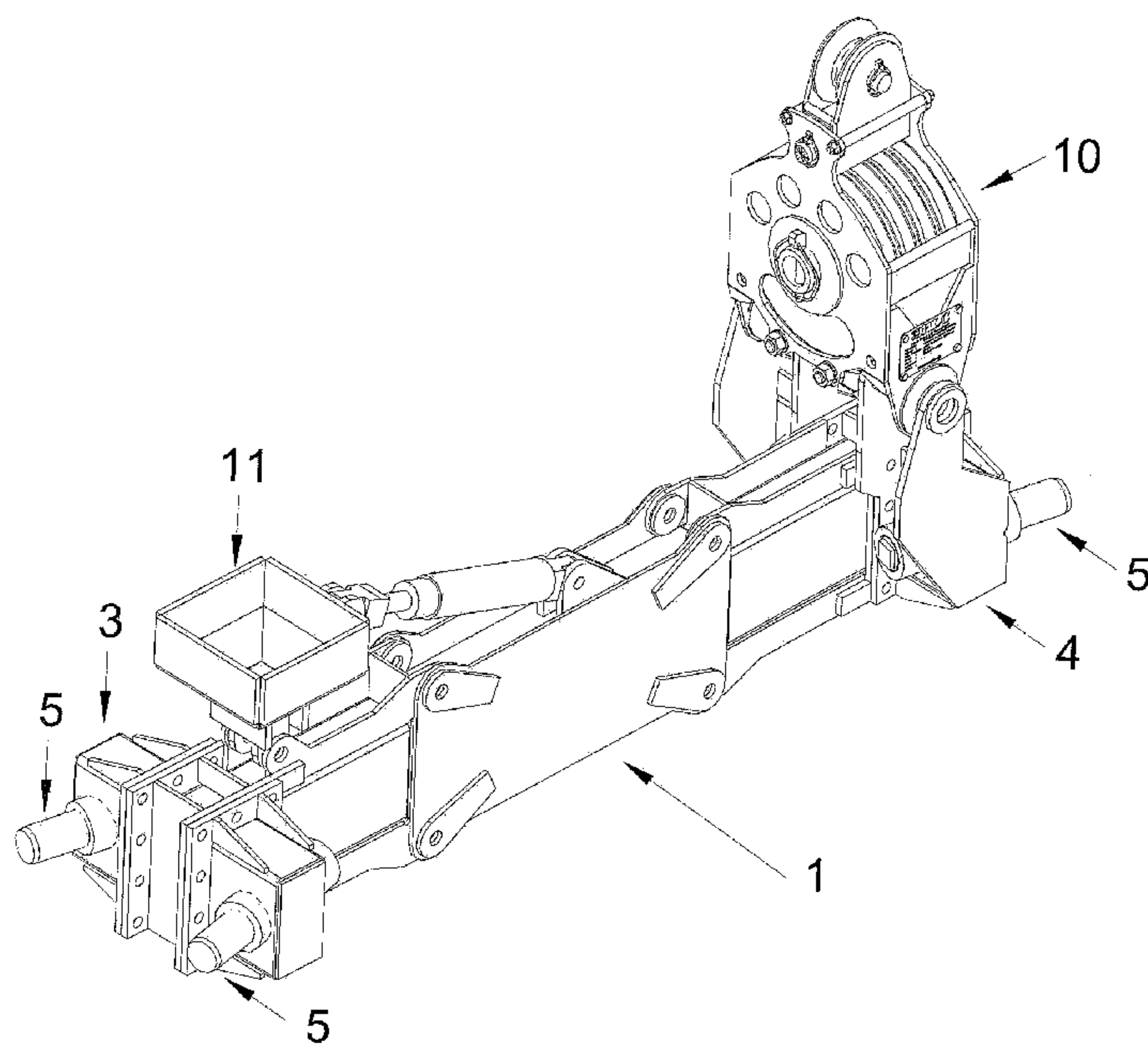


fig. 1

(57) Abstract: The invention relates to a lift construction for lifting and lowering a blade of a windmill to and from its mounted position at a rotatable cone of the windmill, wherein it comprises: -a first yoke mountable at the inside of the blade -a second yoke mountable in the cone of the windmill, wherein the first yoke and the second yoke are arranged to cooperate.

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Method and lift construction for lifting and lowering a blade of a windmill

The invention relates to a method and lift construction for lifting and lowering a blade of a windmill to and from its mounted position at a rotatable cone of the windmill, wherein a yoke is mountable in said cone.

5           Such a method and lift construction is known from JP 2006 152862 A, in which a wire is connected to a yoke in the cone of the windmill locked to the blade, which wire is subsequently used to suspend the blade there from and pull the blade up for eventually mounting the blade to the cone or  
10       lower the blade following in dismounting from the cone of the windmill.

          The blades of windmills are long and heavy. A typical windmill blade is approximately 43 metres long and weighs between 4000 kg and 50.000 kg. Due to its operation a  
15       windmill's blade suffers resonances due to the repeated compression of air near to the windmill's standard. Such repeating stresses may eventually result in fatigue-cracks, which are detrimental to the structural reliability of the windmill. As a consequence inspections are carried out so as  
20       to establish whether or not a windmill blade must be replaced or repaired.

          Any replacement of windmill blades is a costly affair, which is partly due to the heavy load of the windmill blades and the altitude at which the blades are mounted to the  
25       windmill's cone. Specifically the fact that windmill's are normally applied at places where no structural roads are available causes that specific measures are required, such as the application of temporarily road constructions, to make it possible that heavy duty cranes that may carry loads at high  
30       altitudes can be placed near to the windmill of which the blades have to be replaced.

          One aspect of the invention makes the replacement of windmill blades more easy without the necessity to employ heavy cranes, and reduces the costs that are associated with  
35       any such replacement or in general with the dismounting or the

mounting of the blades of a windmill.

In order to accomplish this, a method and lift construction for lifting and lowering a blade of a windmill is proposed as discussed herein.

5 In a first aspect of the invention a lift construction is proposed comprising two yokes:

- a first yoke mountable at the inside of the blade
- a second yoke of said two yokes mountable in the cone of the windmill,

10 wherein the first yoke and the second yoke are arranged to cooperate, wherein the first yoke and the second yoke have cooperating hoisting means that are provided at the ends of the yokes which - in use - are distant from the windmill's standard, and

15 in that first yoke and second yoke have cooperating positioning means near to the ends of the yokes which - in use - are closest to the windmill's standard for at least maintaining a predefined alignment and/or distance between said ends of the yokes.

20 With the lift construction of the invention it is possible that with

- a first yoke is mounted to the blade's inside, and
- a second yoke is mounted in the windmill's cone,

and

25 wherein the first yoke and the second yoke are provided with positioning means and hoisting means, that

- when the blade is near to the windmill's cone, the positioning means and hoisting means of the yokes carry out a concerted operation so as to move the windmill's blade

30 towards or away from the cone in a line that substantially coincides with the blade's orientation when in the mounted position, and that

- when the blade is beyond a predefined distance with respect to the windmill's cone, the blade is lifted or

35 lowered substantially vertically.

Accordingly, with the invention it is no longer required to employ heavy duty cranes which are capable to operate at high altitudes. Instead, the mounting or

dismounting of a windmill's blade can simply be carried out by employing said first yoke mounted at the inside of the windmill's blade and said second yoke mounted in the cone of the windmill.

5           As already indicated, for effectively carrying out the mounting or dismounting of a windmill's blade it is preferable that the first yoke and the second yoke having cooperating hoisting means that are provided at the ends of the yokes which - in use - are distant from the windmill's  
10       standard.

          Likewise, it is preferable that the first yoke and second yoke have cooperating positioning or pushing means near to the ends of the yokes which - in use - are closest to the windmill's standard for at least maintaining a predefined  
15       alignment and/or distance of the ends of the yokes.

          An effective way of carrying out the positioning means that are provided on the first yoke and the second yoke is that the first yoke has a receptacle and the second yoke has an actuator or vice versa, wherein the actuator has an end  
20       that fits in said receptacle, such that upon activation of the actuator a predefined pressure is applied to the receptacle so as to balance the blade of the windmill in a predefined alignment. Accordingly, it is possible that with said predefined alignment the blade of the windmill occupies a  
25       position with respect to the cone of the windmill that allows it to be mounted or dismounted from the cone.

          The ease of working with the lift construction according to the invention is promoted by arranging that the first yoke comprises at both its ends pins, which in use point  
30       at the blade's inside for mounting the first yoke to the blade. This is particularly true in case that the pins are placed at a position so as to be able to cooperate with pin-holes in the blade that are intended for connecting the blade to the windmill's cone.

35           Beneficially, the second yoke is provided with hoisting means that are connectable to the first yoke or a part thereof, in particular to a hoisting means or pad eye of the first yoke.

3a

The ease of operation of the lift construction in accordance with the invention is particularly supported by arranging that the hoisting means of the second yoke are (manually) adjustable.

5 In a certain embodiment it is beneficial that the lift construction of the invention comprises a guiding arm for a lifting cable, which arm is connectable to the second yoke. With this lifting cable it is possible to simply lower or lift the windmill's blade vertically, for which purpose it is  
10 desirable that the lifting cable is connectable to the first yoke or a part thereof, in particular to a hoisting means or pad eye provided on the first yoke.

In order to secure that the guiding arm operates securely and safely it is desirable that the guiding arm is  
15 supported, for instance by connecting chains that connect the arm to the windmill's cone or a part thereof.

The invention is further embodied in the separate yoke as described hereinbefore as part of the lift construction of the invention, which is used for mounting at  
20 the inside of the windmill's blade, and which has opposite ends that in use face the inside of the blade. Advantageously, these ends are movable to and from each other in order to easily accommodate to the diameter of the blade which is to be mounted or dismounted.

25 Such a yoke is preferably provided with at least first hoisting means near an end that in use faces an inside of a windmill's blade and furthermore it is preferred that at an end opposite to the end where the hoisting means are located, means are provided that are arranged to cooperate  
30 with further means of another yoke so as to press both yokes apart.

In another aspect of the invention, there is provided a yoke suitable for mounting at the inside of a windmill's blade, having opposite ends that in use face said inside of  
35 the blade, and which ends are movable to and from each other, **characterized** in that it has at least one hoisting means or pad eye near an end that in use faces an inside of a windmill's blade.

3b

In a further aspect of the invention, there is provided a method for mounting or dismounting a windmill's blade to a cone of a windmill, wherein a yoke is mounted in said cone, **characterized in that** two yokes are employed, 5 wherein: a first yoke is mounted to the blade's inside, and a second yoke is mounted in the windmill's cone, and wherein the first yoke and the second yoke are provided with positioning means and hoisting means, and the method is executed such that when the blade is near to the windmill's cone, the positioning 10 means and hoisting means of the yokes carry out a concerted operation so as to move the windmill's blade towards or away from the cone in a line that substantially coincides with the blade's orientation when in the mounted position, and that when the blade is beyond a predefined distance with respect to 15 the windmill's cone, the blade is lifted or lowered substantially vertically.

Advantageously the yoke of the invention is carried out such that it comprises at both its ends pins, which in use are for mounting to a blade of a windmill.

It is further preferable that the yoke is arranged such that the pins are placed at a position so as to be able to cooperation with pin-holes in the blade that are intended for connecting the blade to the windmill's cone.

The invention shall hereinafter be further elucidated with reference to an exemplary embodiment of the lift construction and method for lifting and lowering a windmill's blade in accordance with the invention and with reference to the drawing.

In the drawing:

- Fig. 1 shows a first yoke forming part of the lift construction of the invention;

- Fig. 2 shows a second yoke forming part of the lift construction in accordance with the invention;

- Fig. 3 shows a guiding arm forming part of the lift construction in one embodiment of the invention and;

- Figs. 4-9 shows an operational sequence carried out in a method for dismounting a windmill's blade from a windmill's cone employing the lift construction according to the embodiment of the invention employing the guiding arm shown in Fig. 3.

Wherever in the figures the same reference numerals are applied, these numerals refer to the same parts.

Making reference first to Fig. 1, a first yoke 1 is shown which is mountable on the inside of a windmill's blade 2 such as shown in Figs. 4-9.

As Fig. 1 clearly shows the first yoke 1 comprises at both its ends 3, 4 pins 5 that in use point at the inside of the blade 2 so as to be able to mount the first yoke 1 to the blade 2.

To this end the pins 5 are placed at a position so as to be able to cooperate with pinholes 6 (see Fig. 7) that are circumferentially provided at an end of the windmill's blade 2; see for instance Fig. 7 and Fig. 8 showing one such pinhole. These pinholes 6 are normally used for connecting the blade 2 to the windmill's cone 7.

Fig. 2 shows a second yoke 8 of the lift construction of the invention, which is mountable in the cone 7 of the windmill. This second yoke 8 is provided with hoisting means 9', 9'' that are connectable to the first yoke 1 shown in Fig. 1 or a

part thereof, in particular to a sheave block 10 or pad eye provided on the first yoke 1. The hoisting means 9', 9'' preferably include manually adjustable hoisting means 9'' as shown in Fig. 2.

5           The said sheave block 10 or pad eye of the first yoke 1 and the hoisting means in the form of winch 9'' of the second yoke 8 are provided as Fig. 1 and Fig. 2 respectively show, at the ends of the yokes 1, 8, which - as Figs. 4-9 clearly show - in use are distant from the windmills standard (not shown).

10           Fig. 1 and Fig. 2 respectively also show that the first yoke 1 and the second yoke 8 comprise positioning means 11, 12 that cooperate with each other and are placed near to the ends of the yokes 1, 8, which in use are closest to the windmill standard (not shown). That means that these positioning or pushing  
15 means 11, 12 are furthest away from the front end of the windmill's cone 7 as clearly shown in Figs. 4-9. By the operation of these positioning means 11, 12 of the first yoke 1 and the second yoke 8 it is possible to maintain a predefined alignment and distance between these ends of the yokes 1, 8 and consequently  
20 maintain the blade 2 in a predefined inclination with respect to the windmill's cone 7, also when the bolts are disconnected that are used to secure the blade 2 to the cone 7 of the windmill.

Fig. 1 clearly shows that the first yoke 1 may advantageously be provided with a receptacle 11 and Fig. 2 shows that  
25 the second yoke 8 may be provided with an actuator 12 - or vice versa - which actuator 12 has an end that accurately fits in the receptacle 11 of the yoke 1 such that upon activation of the actuator 12 a predefined pressure may be applied to the receptacle 11 so as to balance the blade 2 of the windmill in the desired  
30 predefined angle and position. In this predefined angle and position the blade 2 of the windmill occupies an alignment with respect to the cone 7 of the windmill that allows it to be easily mounted or dismounted therefrom.

In a certain embodiment the lift construction of the  
35 invention also preferably comprises a guiding arm 13 as shown in Fig. 3. With this guiding arm 13 a lifting cable 14 may be guided which is to be connected to the first yoke 1 or a part thereof, in particular to a sheave block 10 or pad eye provided on the first yoke 1. This is shown in Fig. 9.

40           It is preferable that the guiding arm 13 is supported, for instance by connecting chains 15 as is shown in Fig. 3 to

connect the arm 13 to the windmill cone 7.

The method and the lift construction of the invention for mounting or dismounting a windmill's blade 2 to a cone 7 of a windmill may now effectively be elucidated with reference to  
5 Figs. 4-9 wherein as an example the dismounting of the blade 7 from the cone 7 is shown schematically.

In Fig. 4 the first yoke 1 has been mounted to the inside of the blade 2. This can easily be done by taking the yoke 1 up by a service hoist of the nacelle or through the inside of  
10 the windmill through the (not shown) standard to the cone 7, which cone gives ample room for persons and the lift construction of the invention.

Likewise the second yoke 8 is mounted to the windmill's cone 7 and in accordance with the invention the first yoke 1 and  
15 the second yoke 8 are provided with positioning means 11, 12 and hoisting means 10, 9'.

Following the mounting of the first yoke 1 and second yoke 8 as shown in Fig. 4, then initially when the blade 2 is still near to the windmill's cone 7 - as shown in Fig. 5 - the  
20 positioning means 11, 12 and hoisting means 10, 9' of the yokes 1, 8 carryout a concerted operation so as to move the windmill's blade 2 away from the cone 7 in a line that substantially coincides with the blade's orientation when in the mounted position as shown in Fig. 4. This line of movement corresponds to the  
25 body axis indicated with centre-line 16.

When the blade 2 is beyond a predefined distance with respect to the windmill's cone 7 the concerted operation of the positioning means 11, 12 and hoisting means 10, 9' of the yokes 1, 8 may be interrupted and the hoisting means 10, 9' may then  
30 remain the only means of connection between the first yoke 1 connecting to the blade 2 and the second yoke 8 connecting to the cone 7 of the windmill. This is shown in Fig. 6.

In Fig. 7 it is shown that the distance between the blade 2 and the cone 7 of the windmill is further increased by  
35 substantially vertically lowering the blade 2 from the cone 7. This gives room for introducing a helpline 17 into the area of the cone 7 which serves to subsequently introduce a guiding arm 13 for a lifting cable 14 into the cone 7. Fig. 8 shows that this guiding arm 13 is connected to the second yoke 8 whereafter  
40 subsequently the lifting cable 14 is moved through and down to the hoisting means 10 or pad eye of the yoke 1 that connects to

the blade 2. At the stage when this is completed as shown in Fig. 9 it is clearly shown that indeed the lifting cable 14 connects to the hoisting means 10 of the first yoke 1. This allows that by simply operating from the ground the blade 2 may be further lowered so as to receive it eventually at the ground for further handling.

The method for raising a blade 2 and mounting it to the cone 7 of a windmill operates vice versa and requires no further elucidation.

10           The above given exemplary embodiment of the method and lifting construction of the invention is intended solely for illustrative purposes without necessarily restricting the scope of protection of the appended claims to the shown embodiment. The protective scope that merits the invention is entirely deter-  
15 mined by the appended claims whereby if necessary any ambiguity of these claims may be explained with reference to the above given elucidation with reference to the exemplary embodiment.

**CLAIMS**

1. Lift construction for lifting and lowering a blade (2) of a windmill to and from its mounted position at a rotatable cone (7) of the windmill, wherein a yoke is mountable in said cone, **characterized** in that it comprises two yokes:

- a first yoke (1) of said two yokes mountable at the inside of the blade (9), and

- a second yoke (8) of said two yokes mountable in the cone (7) of the windmill,

wherein the first yoke (1) and the second yoke (8) are arranged to cooperate, wherein

the first yoke (1) and the second yoke (8) have cooperating hoisting means (10, 9') that are provided at the ends of the yokes which - in use - are distant from the windmill's standard, and

in that the first yoke (1) and second yoke (8) have cooperating positioning means (11, 12) near to the ends of the yokes (1,8) which - in use - are closest to the windmill's standard for at least maintaining a predefined alignment and/or distance between said ends of the yokes (1,8).

2. Lift construction according to claim 1, **characterized** in that the first yoke (1) has a receptacle (11) and the second yoke (8) has an actuator (12) or vice versa, which actuator (12) has an end that fits in said receptacle (11), such that upon activation of the actuator (12) a predefined pressure is applied to the receptacle (11) so as to balance the blade (2) of the windmill at a predefined angle and/or position.

3. Lift construction according to claim 2, **characterized** in that in the predefined angle and/or position the blade (2) of the windmill occupies a position with respect to the cone (7) of the windmill that allows it to be mounted or dismounted from the cone (7).

4. Lift construction according to any one of claims 1-3, **characterized** in that the first yoke (1) comprises at both its ends (3, 4) pins (5), that in use point at the

blade's inside for mounting the first yoke (1) to the blade (2).

5. Lift construction according to claim 4, **characterized** in that the pins (5) are placed at a position so as to be able to cooperate with pin-holes (6) in the blade (2) that are intended for connecting the blade (2) to the windmill's cone (7).

6. Lift construction according to any one of claims 1-5, **characterized** in that the second yoke (8) is provided with hoisting means (9', 9'') that are connectable to the first yoke (1) or a part thereof, in particular to hoisting means (10) or a pad eye of the first yoke (1).

7. Lift construction according to claim 6, **characterized** in that the hoisting means (9'') of the second yoke (8) are adjustable.

8. Lift construction according to any one of claims 1-7, **characterized** in that it comprises:

- a guiding arm (13) for a lifting cable (14), which arm is connectable to the second yoke (8).

9. Lift construction according to claim 8, **characterized** in that the lifting cable (14) is connectable to the first yoke (1) or a part thereof, in particular to hoisting means (10) or a pad eye provided on the first yoke (1).

10. Lift construction according to claim 8 or 9, **characterized** in that the guiding arm (13) is supported, preferably by connecting chains (15) that connect the arm (13) to the windmill's cone (7) or a part thereof.

11. Yoke (1) suitable for mounting at the inside of a windmill's blade (2), having opposite ends (3,4) that in use face said inside of the blade (2), and which ends (3,4) are movable to and from each other, **characterized** in that it has at least one hoisting means (10) or pad eye near an end (4) that in use faces an inside of a windmill's blade (2).

12. Yoke (1) according to claim 11, **characterized** in that at an end (3) opposite to the end (4) where a hoisting means (10) or a pad eye is located, means (11) are provided that are arranged to cooperate with further means (12) of

another yoke (8) so as to press both yokes (1,8) apart.

13. Yoke (1) according to claims 11 or 12, **characterized** in that it comprises at both its ends (3,4) pins (5), that in use are for mounting to a blade (2) of a windmill.

14. Yoke (1) according to claim 13, **characterized in that** the pins (5) are placed at a position so as to be able to cooperate with pin-holes (6) in the blade (2) that are intended for connecting the blade (2) to the windmill's cone (7).

15. Method for mounting or dismounting a windmill's blade (2) to a cone (7) of a windmill, wherein a yoke is mounted in said cone (7), **characterized in that** two yokes (1, 8) are employed, wherein:

- a first yoke (1) is mounted to the blade's inside, and
- a second yoke (8) is mounted in the windmill's cone (7), and

wherein the first yoke (1) and the second yoke (8) are provided with positioning means (11, 12) and hoisting means (10, 9'), and the method is executed such that

- when the blade (2) is near to the windmill's cone (7), the positioning means (11, 12) and hoisting means (10, 9') of the yokes (1, 8) carry out a concerted operation so as to move the windmill's blade (2) towards or away from the cone (7) in a line that substantially coincides with the blade's orientation when in the mounted position, and that when the blade (2) is beyond a predefined distance with respect to the windmill's cone (7), the blade (2) is lifted or lowered substantially vertically.

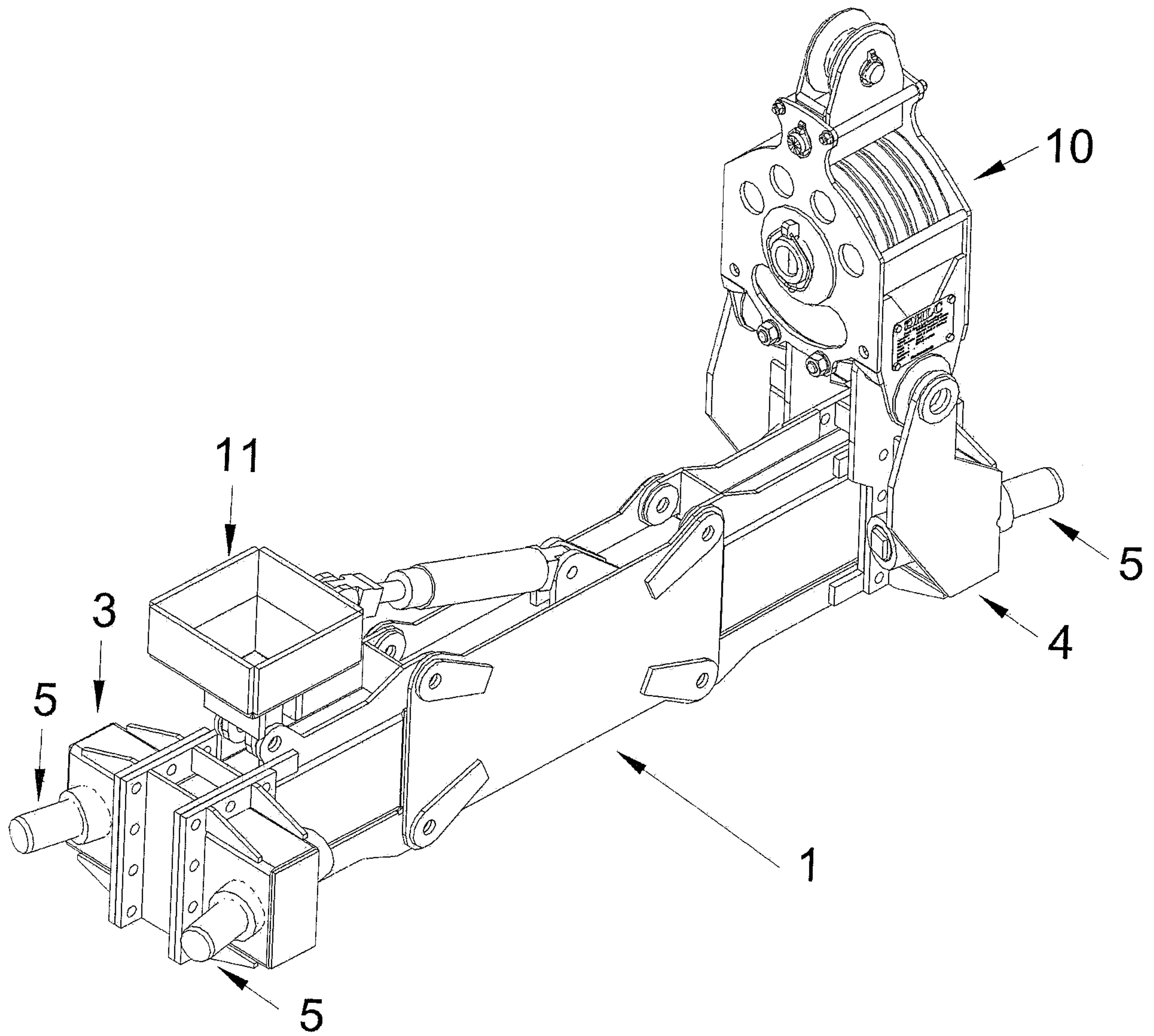


fig. 1

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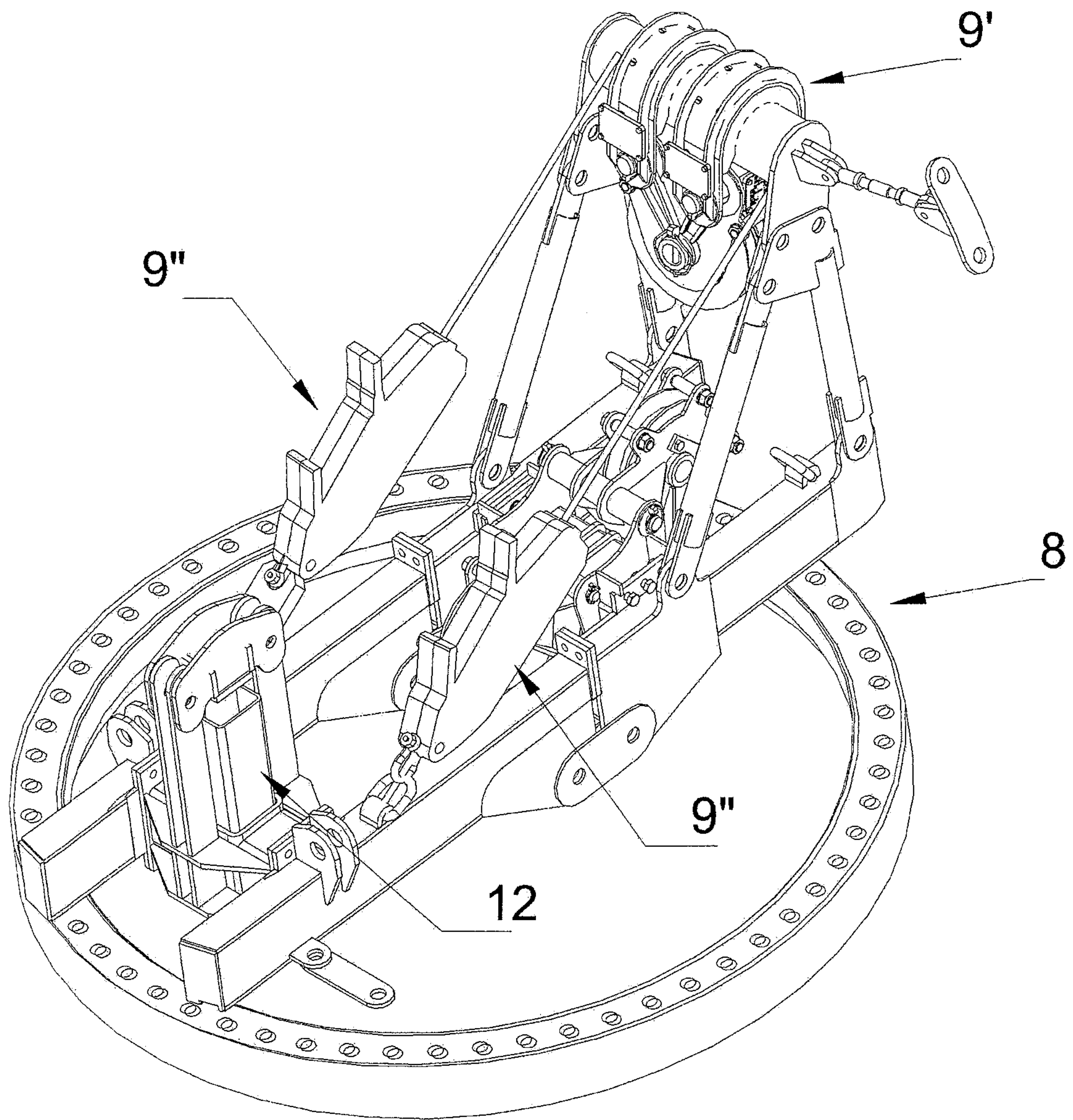


fig. 2

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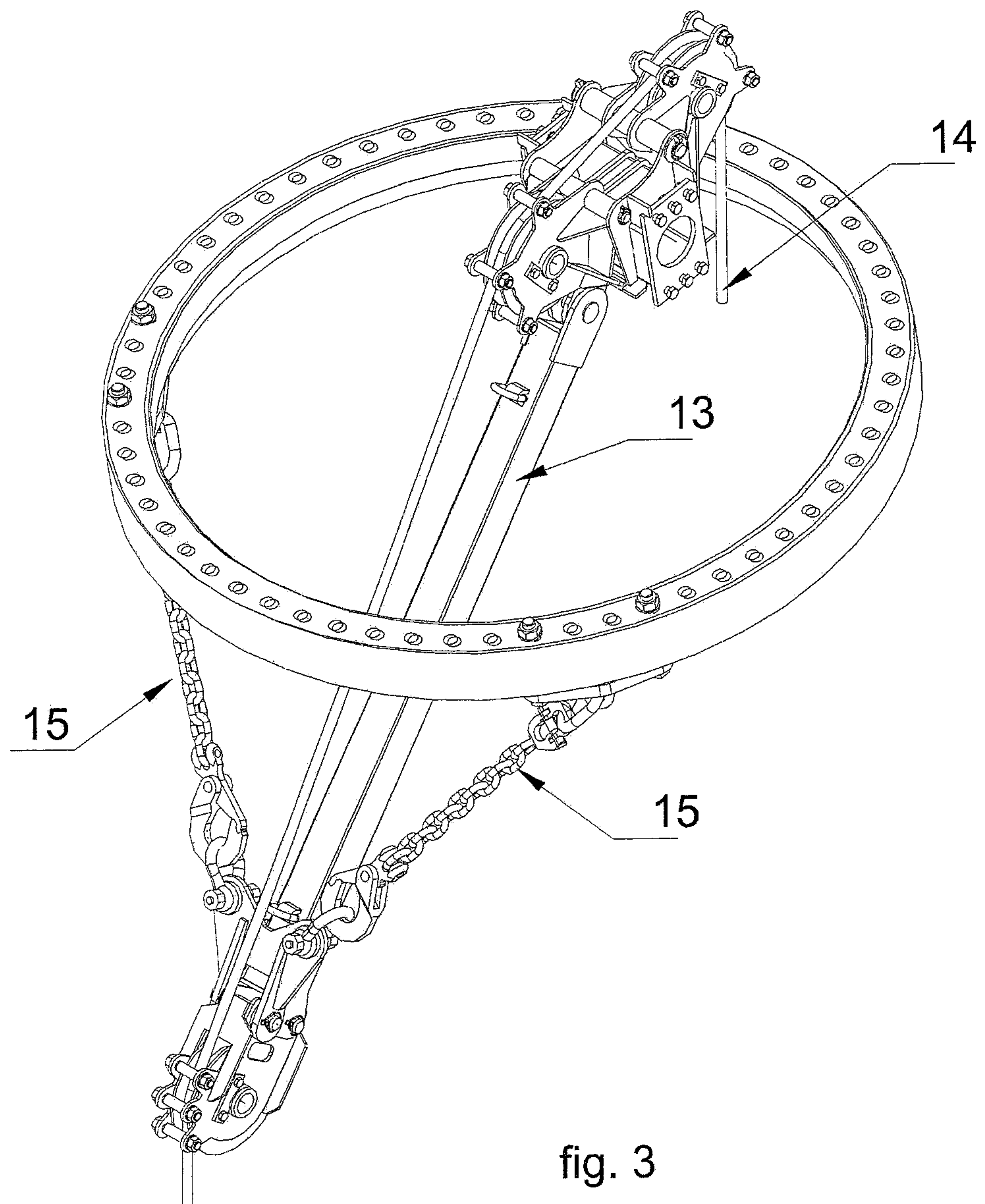
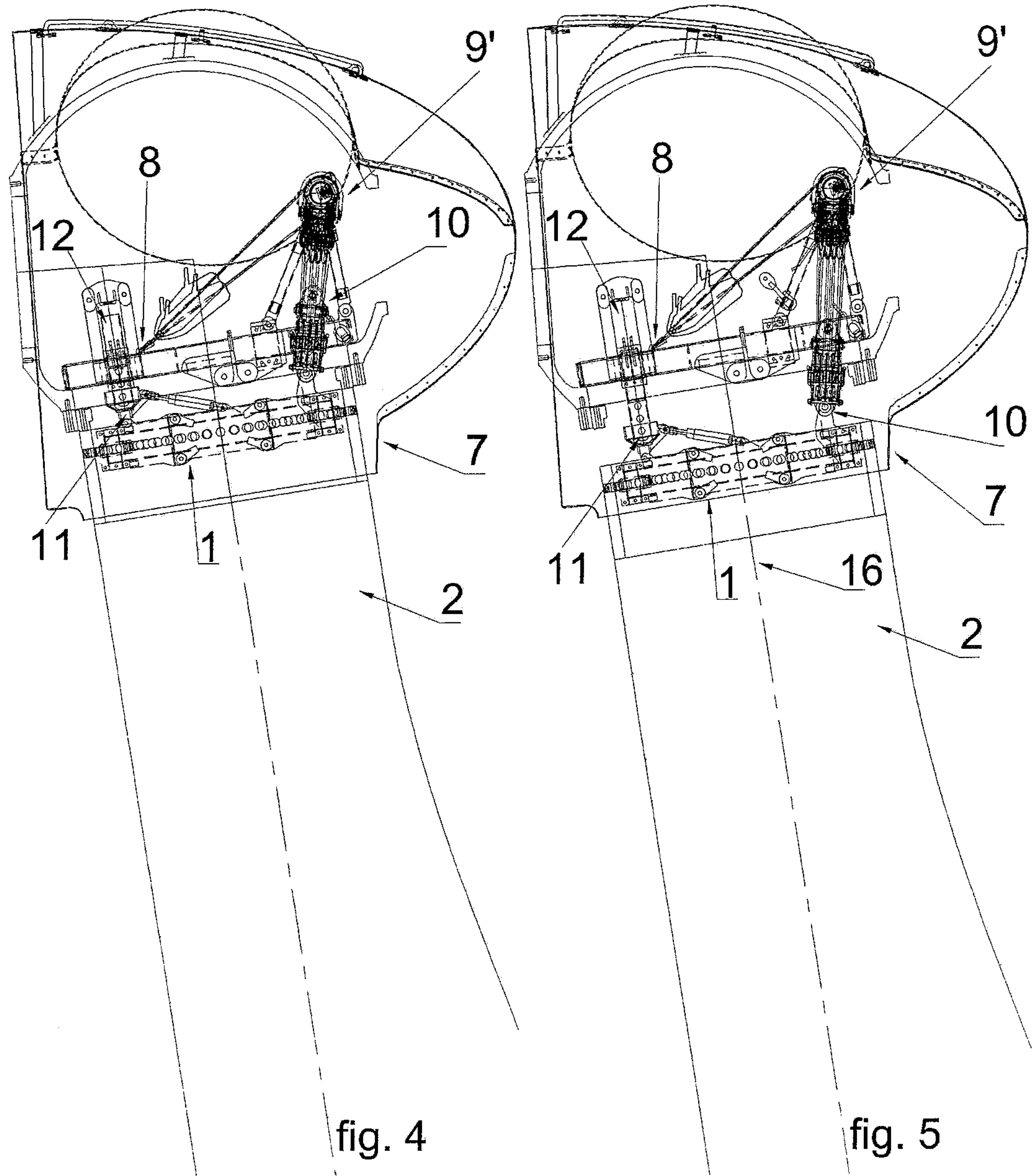
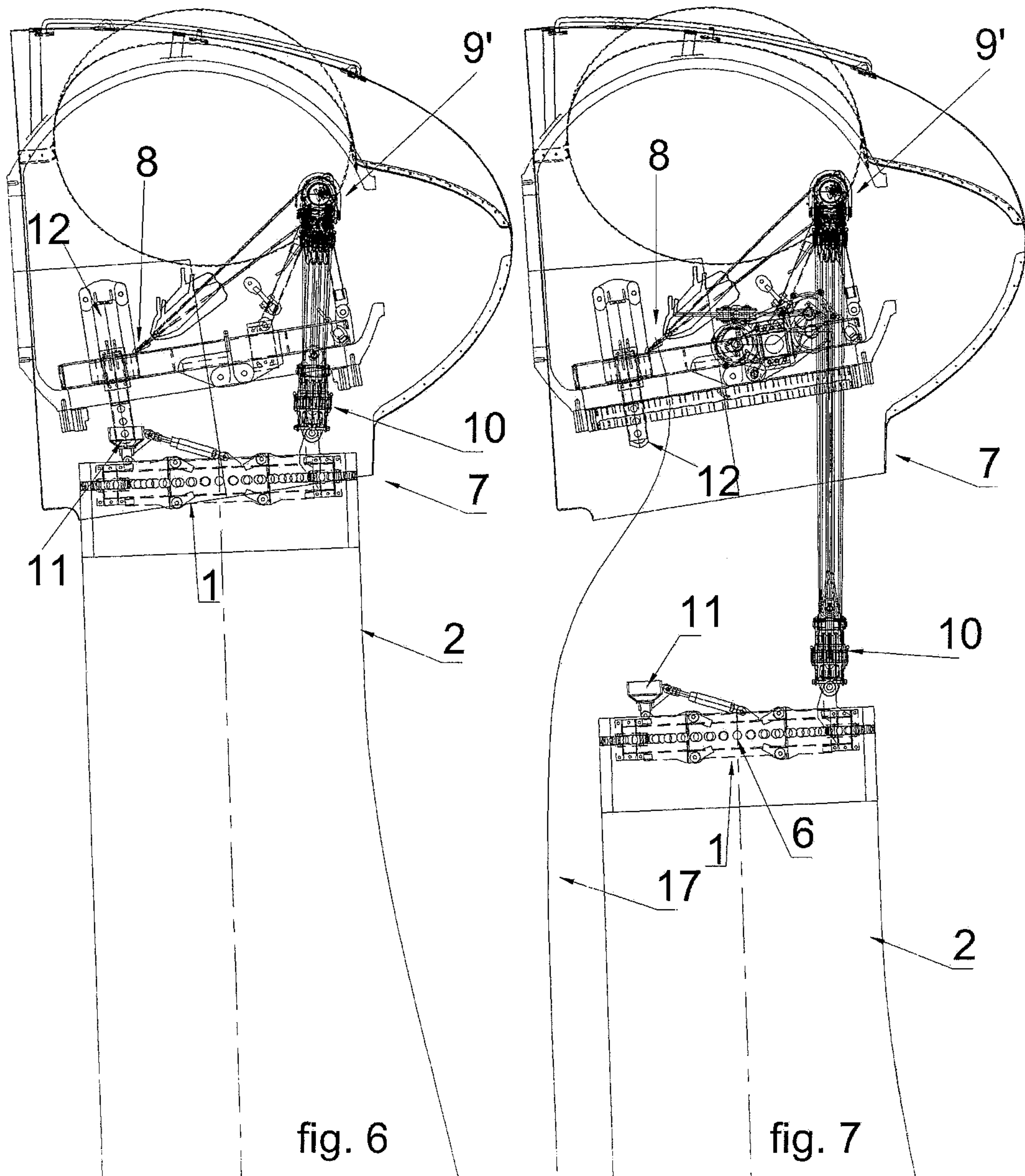


fig. 3





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