

Hoisting mechanism

The invention relates to a hoisting mechanism in accordance with
5 the preamble of claim 1.

A hoisting mechanism of this type is known and marketed by the Applicant. In the known hoisting mechanism, the displaceable hoisting-cable guide, by interacting with the hydraulic
10 components and the pressure source, causes shock loads on the hoisting cable, which act as shock loads on the hoisting mechanism, to be absorbed. In this context, the known pressure source is designed as a gas-filled reservoir, in which case the variation in the volume of the second chamber, which is filled
15 with hydraulic fluid, does not have any significant effect on the gas pressure.

The shock absorption does not provide any protection against unsafe situations such as those which can occur very suddenly in
20 practice. For example, in the case of hoisting mechanisms which are used at sea, for example on working ships or drilling installations, unsafe situations result from swell, sudden waves, movements of the ship and jamming of the hoisting hook or hoisting cable.

25 It is an object of the invention to provide a hoisting mechanism with an automatically operating, reliably functioning protection against overloading of the hoisting mechanism.

30 For this purpose the invention provides a hoisting mechanism in accordance with claim 1.

In this way, the hoisting mechanism is effectively provided with automatic protection against overloading, in particular against
35 loads which occur very suddenly.

In the case of the hoisting mechanism in accordance with claim 2, the topping-means loading sensor is connected to the pressure-limiting valve assembly via electronic means. In this

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case, it is preferable to provide a separate electrical voltage source for supplying power to these electronic means.

5 The hoisting mechanisms described in claims 3 and 4 do not use electronic means in the context of the overload protection described. This is because it has been found that in the case of vessels, such as in the case of offshore working ships, from time to time electrical faults occur, causing simultaneous failure of all electrical systems. The preferred embodiment of
10 claim 2, in which a separate voltage source is provided, already offers a solution to this, but the mechanical or hydraulic solution is even more robust.

Further advantageous embodiments of the hoisting mechanism
15 according to the invention are described in the subclaims and the following description based on the drawing.

The invention also relates to a vessel provided with a hoisting mechanism of this type.
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The hoisting mechanism according to the invention will be explained in more detail below on the basis of the drawing, in which:

25 Fig. 1 shows a highly diagrammatic illustration of a first exemplary embodiment of a hoisting mechanism according to the invention,

Fig. 2 diagrammatically depicts the relevant parts of the overload protection of the hoisting mechanism shown in Figure 1,

30 Fig. 3 shows a variant on the circuit diagram shown in Figure 2,

Fig. 4 shows a second exemplary embodiment of the hoisting mechanism according to the invention,

35 Fig. 5 diagrammatically depicts the relevant parts of the overload protection of the hoisting mechanism from Figure 4,

Fig. 6 shows a third exemplary embodiment of the hoisting mechanism according to the invention,

Fig. 7 diagrammatically depicts the relevant parts of the overload protection of the hoisting mechanism from Figure 6, and

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Fig. 8 diagrammatically depicts the relevant parts of a variant of the overload protection shown in Figure 2.

Figure 1 diagrammatically depicts a hoisting mechanism 1 with a
5 frame 2 and a jib 3, which is connected to the frame 2 about a substantially horizontal pivot shaft 4.

It will be clear that the hoisting mechanism may take all kinds of embodiments, for example, as a mast crane, which is positioned on
10 a base, for example on a vessel, a drilling platform or the like, optionally such that it can rotate about a vertical axis.

As has been mentioned, the hoisting mechanism according to the invention is advantageous in particular for applications at sea,
15 but the invention also offers the desired protection on land.

The hoisting mechanism 1 also comprises topping means for raising and lowering the jib 3. These topping means in this case comprise a topping cable 5, which engages on the jib 3 at a
20 distance from the pivot shaft 4 (at the location indicated by 6) preferably in the vicinity of the free end of the jib 3. The topping cable 5 runs over a cable pulley 7, for example at the top of the mast if a mast crane is under consideration, a cable pulley 8, and further cable pulley 9, to an associated topping-
25 cable drive 10, in this case in the form of an electrically or hydraulically driven drum winch.

The hoisting mechanism 1 also has a hoisting cable 11 and an associated hoisting-cable drive 12, in this case in the form of
30 an electrically or hydraulically driven drum winch. Hoisting-cable guide means define a path for the hoisting cable 11 between a hoisting-cable guide 13 which is arranged on the jib 3 and from which the hoisting cable 11 with hoisting hook 11a hangs downwards, and the hoisting-cable drive 12. In this
35 example, the cable pulleys 14, 15, 16, 17 define the path for the hoisting cable 11.

The cable pulley 17 is in this case designed to be displaceable with respect to the frame 2, in such a manner that displacement

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of the displaceable cable pulley 17 changes the length of the path for the hoisting cable 11.

It will be clear that the topping cable and/or hoisting cable
5 illustrated here as a single cable may also be designed with a plurality of cable parts which run over a plurality of cable pulleys, as is generally known in hoisting mechanisms.

A first hydraulic component 20, in this example a linear
10 hydraulic cylinder with housing 20a and piston rod 20b, having a first chamber 21 of variable volume, is arranged between the frame 2 on the one hand, and the displaceable cable pulley 17 on the other hand.

The hoisting mechanism 1 also comprises a hydraulic topping-
15 cable loading sensor 30 for detecting the loading on the topping cable 5. This topping-cable loading sensor 30 is in this case arranged between the frame 2 and the cable pulley 8. In the embodiment shown, the sensor 30 is a linear hydraulic cylinder
20 with a housing 30a, which is connected to the frame 2 and a piston rod 30b, which is connected to the topping-cable pulley 8. In the sensor 30 there is a chamber 31 of variable volume, in such a manner that the pressure of hydraulic fluid in the said chamber is representative of the loading on the topping cable 5.

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As can be seen from Figure 2, the hoisting mechanism 1 also has a second hydraulic component 40 with a second chamber 41 of variable volume. In this example, the component 40 is designed as a linear cylinder with a housing 40a and a piston 40b. The
30 piston 40b forms the separation between the chamber 41, which is filled with hydraulic fluid, and a chamber 43, which is filled with a pressurized gas. A component 40 of this type is also known as a medium separator.

35 The chamber 43 comprising pressurized gas is connected to a reservoir for pressurized gas, in this case formed by a number of interconnected gas cylinders 44.

These gas cylinders 44 and the chamber 43 together form a

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pressure source which maintains a substantially constant hydraulic pressure in the second chamber 41, irrespective of the volume of the chamber 41 (and therefore the position of the piston 40b).

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It is preferable for the effective pressure in the chamber 43 to be adjustable, for example by the operator of the hoisting mechanism. By way of example, this pressure is set to be lower if the load to be hoisted is further away from the frame of the
10 hoisting mechanism.

It can be seen from Figure 2 that a connecting line 50 is present between the first chamber 21 and the second chamber 41.

15 A pressure-limiting valve assembly 60 with associated hydraulic actuating means is incorporated in this line 50, as will be explained in more detail below.

In the embodiment of the assembly 60 shown, which is merely an
20 example, there are two pressure-limiting valves 61, 62, which are incorporated in parallel in the line 50.

The pressure-limiting valve 61 is actuated hydraulically on the basis of the hydraulic pressure in the first chamber 21. This
25 pressure is detected, as indicated by the diagrammatic control line 63. The pressure-limiting valve 61 is normally closed if the pressure detected in the first chamber 21 is below a predetermined hoisting-cable limit value which is representative of the permissible loading on the hoisting cable 11.

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The pressure-limiting valve 61 opens the connection between the first chamber 21 and the second chamber 41 if the pressure detected in chamber 21 is above the predetermined hoisting-cable limit value. The result of this is that the hoisting-cable
35 pulley 17 is supported by the gas pressure in chamber 43, which is substantially constant. The first hydraulic component 20 will then permit a displacement of the displaceable hoisting-cable pulley 17 under the influence of the hoisting-cable loading, so that the length of the path of the hoisting cable 11 is reduced.

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In the process, hydraulic fluid flows out of the first chamber 21 and into the second chamber 41 via line 50 at the pressure defined by the pressure source 44.

- 5 This paying out of the hoisting cable 11 automatically prevents overloading of the hoisting mechanism.

The position of the jib 3 is also of relevance in connection with preventing overloading of the hoisting mechanism 1.

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The invention provides for the chamber 31 of the topping-cable loading sensor 30 to be connected to the hydraulic actuating means of the pressure-limiting valve 62, in this case via hydraulic control line 65.

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This pressure-limiting valve 62 is designed in such a way that the connection between the first chamber 21 and the second chamber 41 is also opened if the pressure in the chamber 31 of the topping-cable loading sensor 30 is higher than a predetermined topping-cable limit value. If so, the first hydraulic component 20 permits a displacement of the displaceable hoisting-cable pulley 17, with hydraulic fluid flowing out of the first chamber 21 at the pressure defined by the pressure source 44. In this case, too, therefore, the hoisting cable can be paid out automatically.

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A return line 70 with nonreturn valve 71 which closes in the direction of the second component 40 is arranged in parallel with the pressure-limiting valve assembly 60. This allows hydraulic fluid to flow from the second chamber 41 to the first chamber 21 when the hoisting-cable loading decreases again.

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In one practical embodiment, the limit values for the two valves 61, 62 can be set to the same value, for example, in such a manner that the valves 61, 62 open at a pressure of 320 bar in the hydraulic actuating means associated with each valve 61, 62.

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As can be seen, the invention provides an automatically operating protection against overloading of the hoisting mechanism, even if this overloading occurs very suddenly. This

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protection acts mechanically/hydraulically and does not involve the use of any electronics. Even in the event of complete electricity failure, with the result that, for example, the electrically driven winches 10, 12 stop, the protection remains
5 present.

It will be clear that the limiting of the hoisting-cable loading can also be used for an optional second hoisting-cable system of the hoisting mechanism. Many hoisting mechanisms have a second
10 hoisting cable and associated second hoisting-cable drive. In this case, it is possible to provide an associated displaceable cable pulley and hydraulic component for this second hoisting cable. The chamber of the said hydraulic component can then be connected, together with the chamber of the hydraulic component
15 of the first hoisting cable to a valve, by means of which the operator of the hoisting mechanism can connect the hoisting-cable system which he has put in operation to the pressure-limiting valve assembly.

20 In a variant, there is a dedicated pressure-limiting valve assembly for each hoisting-cable system.

It will also be clear that the pressure-limiting valve assembly may be designed otherwise than as described here by way of
25 example. For example, there may be a single pressure-limiting valve which is actuated by the pressure in the chamber 21 and by the pressure in the chamber 31.

The gas cylinders 44 or other compressed-gas source could also
30 be replaced by a spring system or the like, so that it is possible to realize the substantially constant hydraulic pressure in chamber 41.

Figure 3 shows a variant on the circuit diagram shown in
35 Figure 2. The chamber 31 of the topping-cable loading sensor 30 is in this case connected via a line 76 with a (pressure-limiting) valve 75 therein to the other chamber 20c of the first hydraulic component 20. A pressure-limiting valve assembly 60 is incorporated in the line 50 between the first chamber 21 and the

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second chamber 41.

The valve 75 opens if the pressure in the chamber 31 exceeds a topping-cable limit value. In this example, this pressure then
5 acts on the piston rod side of the piston between the chamber 21 and the chamber 20c. In this way, some of the pressure in chamber 31 is transferred to the first chamber 21 and, via this, to the hydraulic actuation of valve assembly 60. This "adding"
10 of the pressure in chamber 31 to the pressure caused by the hoisting cable 11 in the chamber 21 therefore supplies the control pressure, as a result of which the valve assembly 60 does or does not open.

Figure 4 shows a hoisting mechanism in which parts corresponding
15 to the hoisting mechanism shown in Figure 1 are provided with identical reference numerals. The hoisting cable system is substantially unchanged. However, one or more hydraulic topping cylinders 30 are provided, in this example between the frame 2 and the jib 3, for the purpose of raising and lowering the jib 3.

20 Figure 5 shows the circuit diagram associated with the embodiment shown in Figure 4. It can be seen that the cylinder 30 used for topping of the jib 3 also serves as a topping-means loading sensor in the context of providing protection against
25 overloading of the hoisting mechanism. In this case, the chamber 31 of the topping cylinder 30, which leads to the jib being raised when hydraulic fluid is supplied to it, is connected via line 65 to the hydraulic actuating means of pressure-limiting valve 62.

30 Figure 6 shows a hoisting mechanism with a two-part jib, provided with jib part 3 and jib part 90. The jib part 90 is connected to jib part 3 about a horizontal pivot shaft 85. Associated topping means are provided for raising and lowering
35 the jib part 90. In this example, the said topping means comprise a hydraulic topping cylinder 80 between the jib parts 3 and 90, with a point of engagement 81 on jib part 90 and point of engagement 89 on jib part 3.

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Figure 7 shows a circuit diagram for a protection arrangement associated with the embodiment shown in Figure 7. It can be seen that for each topping cylinder 30, 80 the chamber 31, 86 which is responsible for raising the associated jib part is connected
5 to the hydraulic actuating means of a pressure-limiting valve 62, 68. Control lines 65, 66 are provided for this purpose.

The valves 62, 68 are in parallel with the valve 61 in the line 50, so that the connection between the chambers 21 and 41 is
10 also opened if the pressure in a topping cylinder 30, 80 rises above the associated limit value.

Figure 8 shows a variant of the protection arrangement illustrated in Figure 2. In this case, a throttle valve 67 is
15 provided in the line 50, in this example between the first chamber 21 and the pressure-limiting valve assembly 60. The throttle valve 67 is used to prevent rapid movements of the load hanging from the hoisting hook 11a if there is a major pressure difference between the first chamber 21 and the second chamber
20 41.

Figure 8 also shows a pump 69 which is arranged in parallel with the pressure-limiting valve assembly 60 and the throttle valve 67 and is connected on one side to the first chamber 21 and on
25 the other side to the chamber 41. This pump 69 can be used for the rapid supply of hydraulic fluid to the first chamber 21 if this is desired.

A further variant (not shown in the figures) includes signalling
30 means which - if the pressure-limiting valve assembly 60 opens the connection between the chambers 21 and 41 - activate the hoisting-cable drive 12, so that the hoisting cable 11 is paid out, for example at a maximum normal speed. This contributes to protecting the hoisting mechanism against overloading.

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CLAIMS

1. Hoisting mechanism, comprising:
- 5 - a frame (2),
- a jib (3), which is connected to the frame about a substantially horizontal pivot shaft (4),
- topping means (5, 10) for raising and lowering the jib,
- a hoisting cable (11) and an associated hoisting-cable
- 10 drive (12),
- hoisting-cable guide means (14, 15, 16, 17), which define a path for the hoisting cable (11) between a hoisting-cable guide (13) arranged on the jib, from which the hoisting cable hangs downwards, and the hoisting-cable drive (12),
- 15 - a device for limiting the loading on the hoisting mechanism, comprising:
- a hoisting-cable guide (17), which can be displaced with respect to the frame or the jib, for the hoisting cable (11), in such a manner that displacement of the
- 20 displaceable hoisting-cable guide (17) changes the length of the path,
- a first hydraulic component (20), which is arranged between the frame (2) or jib on the one hand, and the displaceable hoisting-cable guide (17) on the other
- 25 hand, and has a first chamber (21) of variable volume,
- a second hydraulic component (40) having a second chamber (41) with a variable volume,
- a pressure source (44) which is coupled to the second hydraulic component (40) in order to maintain a
- 30 substantially constant hydraulic pressure in the second chamber (41),
- with a connection (50) being present between the first chamber (21) and the second chamber (41),
- 35 characterized in that
- a pressure-limiting valve assembly (60) with associated actuating means (63, 65) is accommodated in the connection (50) between the first chamber (21) and the second chamber (41),

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the actuating means (63) detecting the pressure in the first chamber (21), and the pressure-limiting valve assembly (60) opening the connection (50) between the first and second chambers (21, 41) if the detected pressure in the first chamber (21) is above a predetermined hoisting-cable limit value which is representative of a permissible load on the hoisting device, so that the first hydraulic component (20) then allows a displacement of the displaceable hoisting-cable guide (17) which reduces the length of the path, with hydraulic fluid flowing out of the first chamber (21) at the pressure defined by the pressure source,

and in that the hoisting mechanism furthermore comprises a topping-means loading sensor (30) for detecting the load on the topping means (5), which topping-means loading sensor (30) is connected to the pressure-limiting valve assembly (60),

and in that the pressure-limiting valve assembly (60) is furthermore designed in such a manner that the connection (50) between the first and second chambers (21, 41) is also opened if the load detected by the topping-means loading sensor (30) is higher than a predetermined topping-means limit value, so that the first hydraulic component (20) then permits a displacement of the displaceable hoisting-cable guide (17), with hydraulic fluid flowing out of the first chamber (21) at the pressure defined by the pressure source.

2. Hoisting mechanism according to claim 1, in which the topping-means loading sensor is in communication, via electronic means, with the pressure-limiting valve assembly, a separate electrical voltage source preferably being provided for supplying power to the said electronic means.

3. Hoisting mechanism according to claim 1, in which the topping-means loading sensor (30) is mechanically connected to the pressure-limiting valve assembly (60).

4. Hoisting mechanism according to claim 1, which comprises a

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hydraulic topping-means loading sensor (30), which topping-means loading sensor (30) has a chamber (31) of variable volume, in such a manner that the pressure of hydraulic fluid in the said chamber (31) is representative of the loading on the topping
5 means,

and in which the chamber (31) of the topping-means loading sensor (30) is connected to the hydraulic actuating means (65) of the pressure-limiting valve assembly (60),
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and in which the pressure-limiting valve assembly (60) is furthermore designed in such a manner that the connection (50) between the first and second chambers (21, 41) is also opened if the pressure in the chamber (31) of the topping-means loading
15 sensor (30) is higher than a predetermined topping-means limit value, so that the first hydraulic component (20) then permits a displacement of the displaceable hoisting-cable guide (17), with hydraulic fluid flowing out of the first chamber (21) at the pressure defined by the pressure source.

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5. Hoisting mechanism according to one or more of claims 1 - 4, in which the topping means comprise a topping cable (5) and an associated topping-cable drive (10), and in which the topping-means loading sensor is a topping-cable loading sensor
25 (30) which detects the loading on the topping cable.

6. Hoisting mechanism according to claim 4, in which the topping means comprise a hydraulic topping cylinder (30, 80, Figures 5 and 7) for raising and lowering the jib, which topping
30 cylinder has a raising chamber (31, 86), so that when hydraulic fluid is supplied to it, the jib is raised and in which the topping-means loading sensor (30, 80) is formed by a topping cylinder, the raising chamber of which is connected to the pressure-limiting valve assembly (60).

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7. Hoisting mechanism according to one or more of the preceding claims, in which the jib comprises a plurality of jib parts (3, 90), adjacent jib parts being pivotable about a substantially horizontal pivot shaft (85) with respect to one

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another, and in which topping means (30, 80) belonging to each jib part are provided.

8. Hoisting mechanism according to claim 7, in which a
5 topping-means loading sensor is provided for each of the topping means (30, 80) associated with a jib part.

9. Hoisting mechanism according to one or more of the preceding claims, in which the pressure-limiting valve assembly
10 (60) comprises a first pressure-limiting valve (61) and, connected in parallel therewith, a second pressure-limiting valve (62), the hydraulic actuating means of the first pressure-limiting valve detecting the pressure in the first chamber (21) and the second pressure-limiting valve being coupled to the
15 topping-means loading sensor (30).

10. Hoisting mechanism according to one or more of the preceding claims, in which the topping-means loading sensor (30) is a hydraulic sensor, and the chamber (31) is connected to the
20 first hydraulic component (20), with a valve-positioned in between, in such a manner that the pressure in the first chamber (21) of the first hydraulic component (20) is boosted by at least part of the pressure in the chamber (31) of the topping-means loading sensor (30).

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11. Hoisting mechanism according to claim 8, in which the pressure-limiting valve assembly comprises a first pressure-limiting valve (61) and, in parallel therewith, a second and a third pressure-limiting valve (62, 63), the hydraulic actuating
30 means of the first pressure-limiting valve (61) detecting the pressure in the first chamber (21), and the second and third pressure-limiting valves (62, 63) each being connected to an associated topping-means loading sensor (30, 80).

35 12. Hoisting mechanism according to one or more of the preceding claims, which comprises a second hoisting cable and associated hoisting-cable drive, the second hoisting cable likewise having an associated displaceable cable guide and associated first hydraulic component, which is connected to a

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pressure source with a pressure-limiting valve assembly connected between them.

13. Hoisting mechanism according to claim 12, in which there is
5 a common pressure-limiting valve assembly and a control valve is positioned between the assembly and the two first hydraulic components.

14. Hoisting mechanism according to one or more of the
10 preceding claims, in which the pressure-limiting valve assembly (60) has associated signalling means, which - if the valve assembly (60) opens the connection between the first chamber (21) and the second chamber (41) - actuates the hoisting-cable drive (12) in such a manner that the hoisting cable (11) is paid out.

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15. Hoisting mechanism according to one or more of the preceding claims, in which a pump (69) is also provided, which pump is arranged in parallel with the pressure-limiting valve assembly (60) and is used to supply hydraulic fluid to the first
20 chamber (21).

16. Hoisting mechanism according to one or more of the preceding claims, in which a throttle valve (67) is incorporated in the connection between the first chamber (21) and the second
25 chamber (41).

17. Vessel provided with a hoisting mechanism according to one or more of the preceding claims.