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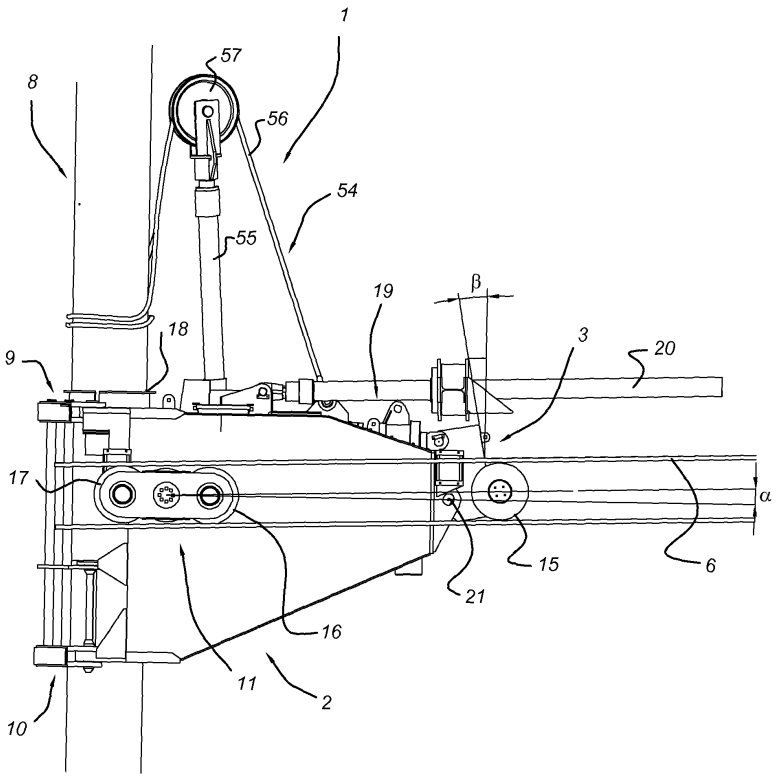
(54) **Articulated spud carriage.**

(57) The invention relates to a spud-pile carriage (1) for connecting a spud-pile (8) to a dredging vessel in a wheeled or sliding manner, in which the spud-pile carriage comprises a first (2) and second (3) carriage part, both of which are provided with wheels or sliders, characterized in that the first and second carriage parts are connected so as to be pivotable with respect to one another about a pivot pin.

Fig 3



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Description

Background of the invention

[0001] The invention relates to a spud-pile carriage.

[0002] The invention furthermore relates to a spud-pile device provided with a spud-pile carriage.

[0003] The invention furthermore relates to a dredging vessel provided with a spud-pile carriage.

[0004] In this context, a spud-pile is a pile which engages with the bottom in order to provide a fixed point for a dredging vessel during dredging. The spud, also referred to as spud-pile, is subjected to loads, in particular resulting from the dredging process and the movements of the vessel. In practice, a spud weighs between a few dozen tons and 200 tons.

[0005] NL1024018 discloses a device for resiliently supporting the spud-pile lifting part of a spud-pile carriage which can be driven on rails which are fitted on a dredging vessel. Said part is supported so as to be pivotable with respect to the spud-pile carriage and is connected to one end of an arm which extends substantially in the horizontal direction in the carriage and the other, free end of which is resiliently supported in the vertical direction. The support can be effected by the free end being accommodated between two blocks of rubber or a similar material which are supported by the spud-pile carriage. It is also possible for the free end of the arm to be supported by at least one hydraulic-pneumatic, double-acting pressure medium cylinder, which is connected on one side to a part of the spud-pile carriage and on the other side directly or indirectly to a part which is connected to the arm. Drawbacks of this known device are the complexity and dimensions, inter alia as a result of the use of the arm. The length of the carriage which the arm requires reduces the stroke of the carriage with respect to the dredging ship. This results in more frequent pile-repositioning of the dredging ship which in turn reduces the productivity of the dredging ship.

[0006] WO 2006/130934 A of Dredging International N. V. relates to an apparatus for accommodating a substantially vertical pole (also referred to as spud) of a dredging vessel, typically a cutter suction dredger, comprising a spud carriage which is mounted for limited rotation around a horizontal transverse axis. WO 2006/130934 A has for its object to propose an apparatus of the type as stated above which behaves as a spud carriage mounting in the pontoon with a variable rigidity (rigid in the case of small waves and more flexible at critical wave conditions) and in particular with a rigidity which decreases sharply at a determined maximum load of the spud plus spud carriage. WO 2006/130934 A discloses a first and a second spring means arranged under bias between vessel and spud in the longitudinal direction for the purpose of absorbing a moment on the spud carriage, which first and second spring means compensate each other in the non-loaded situation of the spud; and in that at least one spring means is provided with a spring force limiting means which hardly allows the spring force to increase further, from a determined maximum moment on the spud carriage. However the system of WO 2006/130934 A of steel wires and discs (see figures) is complicated itself and hard to integrate in a vessel. Moreover the use of wires does not provide a proper control of rigidity under all circumstances.

Summary of the invention

[0007] It is an object of the invention to provide an improved and/or an alternative spud-pile carriage.

[0008] It is a further object of the invention to control the load on a spud-pile during dredging.

[0009] It is a further object of the invention to improve the dredging process.

[0010] To this end, the invention provides a spud-pile carriage for connecting a spud-pile to a dredging vessel in a wheeled or sliding manner, in which the spud-pile carriage comprises a first and second carriage part, both of which are provided with wheels or sliders, in which the first and second carriage parts are connected so as to be pivotable with respect to one another about a pivot pin.

[0011] Rendering the first and second carriage parts pivotable, or bendable, with respect to one another makes it possible to attenuate loads on the spud, while the spud carriage can remain compact. This is advantageous in connection with the standardization of the spud-pile carriage and the use of construction material, in this case steel. In addition, the attenuation can be controlled more readily by the fact that it is possible to select the distance between the pivot pin and the spud without affecting the dimensions of the pile carriage. This length of the spud-pile carriage has to be as small as possible, so that the length of the stroke of the spud-pile carriage is as large as possible, which is advantageous for the production of the dredging vessel.

[0012] In one embodiment of the spud-pile carriage according to the invention, the pivot pin is at right angles to the spud-pile and the direction of travel of the spud-pile carriage. When the pivot pin is at right angles to the spud-pile and the direction of travel of the spud-pile carriage, the possibilities for attenuation are improved in terms of protecting the spud from loads in the length direction of the dredging vessel. The direction of travel of the spud-pile carriage with respect to a dredging vessel is in the length direction of the dredging vessel.

[0013] In one embodiment of the spud-pile carriage according to the invention, the first and second carriage parts are connected to one another by means of an actuator for transmitting a moment through the spud-pile carriage of the spud-pile to a rail system of a dredging vessel. By using an actuator, the loads on the spud can be attenuated in a more controlled manner. Attenuating the load on the spud is very important in practice, because the load on the spud-pile partly determines the operational reliability of a dredging vessel. The permissible load, or load-bearing capacity, of a spud-pile partly

determines up to which degree of rolling a dredging vessel can dredge. When the peak load on the spud is attenuated, this immediately has a positive effect on the operational reliability of a dredging vessel and, in addition, the spud is protected against fracturing.

[0014] In one embodiment of the spud-pile carriage according to the invention, the actuator forces the first and second carriage parts in the direction of a preferred position with respect to one another in order to keep the spud in a substantially vertical position. Due to the centring action of the actuator, the dredging vessel largely operates with the spud in the vertical position during normal operation, which is advantageous with regard to the accuracy of the dredging process. The accuracy of the dredging process is particularly important when dredging a profile.

[0015] In one embodiment of the spud-pile carriage according to the invention, the first and second carriage parts are connected to one another only by means of the pivot pin and the actuator for transmitting the entire moment of the spud-pile to a rail system of a dredging vessel. The actuator per se only transmits tensile or pressure forces. As a result of the coupling, the spud carriage as a whole transmits moments by means of the pivot pin and the actuator. As a result of the fact that the entire load on the spud is transmitted through the actuator, it is more readily possible to attenuate and measure this load.

[0016] In one embodiment of the spud-pile carriage according to the invention, retention means are provided for retaining the spud in order to transmit moments at right angles to the longitudinal axis of the spud, and the retention means being provided on the first carriage part. The retention means transmit moments in particular in the horizontal plane. By retaining the spud on one carriage part, forces resulting from a moment on the spud are transmitted through the actuator which further improves the possibility of attenuating and measuring the load on the spud.

[0017] In one embodiment of the spud-pile carriage according to the invention, the actuator comprises a centring cylinder for transmitting forces between the first and second carriage parts, with the centring cylinder comprising a first piston and a second piston, each having their respective first pressure chamber and second pressure chamber, a piston rod connected to one carriage part for acting on the first piston for transmitting pressure forces between the first and second carriage parts, and for acting on the second piston for transmitting tensile forces between the first and second carriage parts. By using the first and second piston, it becomes possible to prestress the piston rod, at least as regards the inward and outward movement of the piston rod, in the direction of the centre position of the actuator. When the piston rod is in the centre position, the first and second carriage parts are in their preferred position.

[0018] In one embodiment of the spud-pile carriage according to the invention, the second piston is slidably connected to the piston rod, in which case, in one embodiment, the piston rod extends through a central hole in the second piston in order to keep the second piston centrally slidable. By displaceably connecting the second piston to the piston rod, it is possible to determine the centre position of the actuator by means of a fixed stop on the housing of the centring cylinder, in which case the second piston acts on this stop.

[0019] In one embodiment of the spud-pile carriage according to the invention, the piston rod is fixedly connected to the first piston. This results in a simple construction which, moreover, makes it possible to adjust the centring cylinder while the latter absorbs tensile forces, that is to say that the tensile force at which the second piston moves out of the centre position can be adjusted using the first piston.

[0020] In one embodiment of the spud-pile carriage according to the invention, the first pressure chamber is connected by means of a fluid line to the second pressure chamber in order to connect the first and second pressure chambers to one accumulator. As a result of the fact that the first and second pressure chambers are connected, the same pressure prevails in both, which makes adjustment of the centring cylinder simpler. Connecting the first and second pressure chambers to one accumulator provides both pressure chambers with the same pressure-volume characteristic, making adjustment of the centring cylinder simpler. Incidentally, it is conceivable for the first and second pressure chambers to each be connected to a separate accumulator as a result of which the characteristic can be adjusted separately upon absorbing pressure and tensile forces, which may be advantageous for the dredging process in certain situations.

[0021] In one embodiment of the spud-pile carriage according to the invention, the piston surface of the second piston is twice as large as the piston surface of the first piston. As a result of this ratio of the piston surfaces, it is possible to balance the characteristic upon absorbing pressure and tensile force. Upon balancing the centring cylinder, the latter builds up a force of equal magnitude for the inward and outward movement of the piston rod and the retaining force with which the piston rod is held in the centre position is equal for the inward and outward movement.

[0022] In one embodiment of the spud-pile carriage according to the invention, a third pressure chamber is provided between the first piston and the second piston, which comprises a connection for the fluid connection of the third pressure chamber to a further accumulator. The third pressure chamber improves the possibilities of controlling the attenuation of the load on the spud and the adjustment of the retaining force.

[0023] In one embodiment of the spud-pile carriage according to the invention, the actuator comprises an accumulator in fluid connection with the first and second pressure chambers. Connecting the first and second pressure chamber to one accumulator provides both pressure chambers with the same pressure-volume characteristic, which renders adjustment of the centring

cylinder simpler, with the piston rod being forced in the direction of the centre position by means of the first piston and second piston, both of which are now under equal pressure. In the centre position, the sum of the volume of the first and second pressure chamber is at its maximum.

[0024] In one embodiment of the spud-pile carriage according to the invention, the actuator comprises a pressure sensor for measuring the pressure in a pressure chamber, specifically in one or more of the first, second and third pressure chambers, in order to measure the load on the spud. By measuring the pressure, the load on the spud can be more readily controlled.

[0025] To this end, the invention provides a spud-pile device for connecting a spud-pile to a dredging vessel in a wheeled manner, in which the spud-pile device comprises a rail system for connecting the spud-pile device to a dredging vessel, a spud-pile carriage according to the invention, situated on the rail system in a wheeled or sliding manner, in which the first and second carriage parts are pivotably connected to the rail system and are pivotable about a respective pivot pin.

[0026] In one spud-pile device according to the invention, the retention means are arranged on the first carriage part in such a way that the longitudinal axis of the spud and the pivot pin intersect. When the longitudinal axis of the spud and the pivot pin intersect, the load on the actuator due to the own weight of the spud is minimal.

[0027] To this end, the invention provides a dredging vessel provided with a spud carriage or spud-pile device according to the invention.

[0028] To this end, the invention provides a device provided with one or more characterizing features described in the attached description and/or illustrated in the attached drawings.

[0029] To this end, the invention provides a method comprising one or more of the characterizing steps described in the attached description and/or illustrated in the attached drawings.

[0030] It will be clear that the various aspects mentioned in the present patent application can be combined and may each be considered individually for a divisional patent application.

Brief description of the figures

[0031] The attached figures show various embodiments of a spud-pile device, or parts thereof, according to the invention, in which:

Fig. 1 shows a perspective view of a spud-pile device according to the invention;
Fig. 2 shows a view from the starboard side of the device from Fig. 1;
Fig. 3 shows the device from Fig. 2 with the carriage parts being tilted with respect to one another;
Fig. 4 shows the view from Fig. 3 with the carriage parts being tilted in the other direction;
Fig. 5 shows a centring cylinder in the centre position;
Fig. 6 shows the centring cylinder from Fig. 5 subjected to pressure load from the centre position;
Fig. 7 shows the centring cylinder subjected to tensile load from the centre position;
Fig. 8 shows a further embodiment of the centring cylinder;
Fig. 9 shows the centring cylinder from Fig. 8 subjected to pressure load from the centre position; and
Fig. 10 shows the centring cylinder from Fig. 8 subjected to tensile load from the centre position.

Description of embodiments

[0032] Fig. 1 shows a spud-pile carriage 1 in perspective. Here, the pile carriage can be driven over a rail system 5. Incidentally, the invention can also be applied to a pile carriage which can be moved over the rail system 5 by means of, for example, sliding blocks. The spud-pile carriage 1 can be driven so that the spud 8 can be displaced with respect to a dredging vessel. In this manner, the dredging vessel pushes itself away from the spud 8 in order to operate on the front side, for example dredge. Driving the pile carriage 1 and in particular the speed of the pile carriage 1 has a significant effect on the production of the dredging vessel. Here, the pile carriage 1 consists of two pile carriage parts 2, 3. The first pile carriage part 2 is provided with two holders 9, 10 for holding a spud-pile 8. It is also conceivable to use clamping systems for holding the spud 8. The holders 9 and 10 here connect the spud-pile 8 to the pile carriage part 2. To this end, the holders 9 and 10 engage with the wall of the spud 8. In this case, the holders 9 and 10 engage with the entire periphery 18 of the spud 8. Here, two holders 9, 10 are used in order to connect the spud-pile to the pile carriage part 2 at least as regards rotations in the horizontal plane. It is also conceivable to use a different number of holders 9, 10. Pile carriage part 2 is pivotable with respect to the rail system 5. In this case, the pile carriage part 2 is pivotable about axis 13. Here, this axis 13 is the central axis of a wheel set 11. The wheel set 11 in this case comprises two wheels 16 and 17 which can be driven over the rails 6 and 7 of the rail system 5. The second pile carriage part 3 is also pivotable with respect to the rail system 5. The second pile carriage part 3 is pivotable about an axis 12. Here, this axis 12 is the axis of a wheel 15 5 by means of which the pile carriage part 3 can be driven over the rail system 5. The two pile carriage parts 2 and 3 together form the pile carriage 1. The pile carriage parts 2 and 3 are hingedly, also pivotably, connected to one another. By hingedly connecting the two pile carriage parts 2 and 3, a flexible pile carriage is produced which can be deformed in its plane which makes it possible, for example, to apply attenuation and/or to control the stiffness in terms of the hinging of the pile carriage parts 2 and 3 with respect to one another independently of the stiffness of the pile carriage parts 2 and 3 themselves. In this way, the rotational stiffness of

the spud 8 with respect to the dredging vessel is controlled. The two pile carriage parts 2 and 3 are furthermore connected by means of an actuator 19. The actuator 19 keeps the two pile carriage parts 2 and 3 in their preferred position with respect to one another, specifically at their mutual angle. In this case, the actuator 8 centres the spud 8 in its vertical position. The actuator 19 minimizes the deviation from the vertical position of the spud 8. Here, the actuator 19 keeps the pile carriage parts 2 and 3 in their preferred position, in this case the position in which the two pile carriage parts 2 and 3 are situated in the plane of the rail system 5. When the first pile carriage part 2 and the second pile carriage part 3 are in their preferred position, the spud 8 assumes a vertical position. The actuator 19 transmits moments caused by the dredging process and the heaving of the dredging vessel in the direction of the rail system 5, that is to say in the direction of the dredging vessel. Here, the actuator 19 has a line of action substantially at right angles to the spud 8, which is advantageous in connection with the transmission of forces between the first and second pile carriage parts 2, 3, and moreover has a favourably small installation height. Depending on the installation options in the pile carriage, a different position of the actuator 19 with respect to the spud 8 is conceivable. The holders 9 and 10 here hold a spud 8 in such a manner that its central axis 59 intersects the axis 13 about which the pile carriage part 2 is pivotable with respect to the rail system 5. As a result thereof, the actuator 19 does not have to transmit any moment, due to the own weight of the spud 8. Here, the pile carriage parts 2 and 3 are furthermore pivotable with respect to one another about an axis of rotation 14 in order to compensate for imperfections in the rail system 5. In addition, this results in transverse forces on the spud 8 substantially being absorbed by wheel sets 11. Here, the pile carriage 1 can be driven with respect to the rail system 5 and is displaced by means of a hydraulic cylinder 20.

[0033] Fig. 2 shows a side view of the device from Fig. 1 from the starboard side. The pivot pin 21 about which the pile carriage parts 2 and 3 can be hinged with respect to one anther can clearly be seen. The actuator 19 keeps the pile carriage parts 2 and 3 in their preferred position with respect to one another.

[0034] Fig. 3 shows the device from Fig. 1 in side view. Here, the pile carriage parts 2 and 3 are rotated with respect to one another through an angle $\alpha+\beta$. Viewed from the starboard side, the pile carriage part 2 is rotated clockwise through an angle α together with the spud 8 as a result of a clockwise moment, viewed from the starboard side. In practice, the angle α is for example approximately 1.5°. This angle α is adjustable by selecting the position of the pivot pin 21 and this does not increase the length of the pile carriage 1. In this case, pile carriage part 3 is rotated anticlockwise through an angle β.

This situation may arise when the ship heaves upwards. As a result thereof, the actuator 19 is pushed in over a stroke. This stroke can be adjusted by selecting the distance between the actuator 19 and the pivot pin 21. The stroke of the actuator can be adjusted by selecting the mutual distance between the actuator 19 and the pivot pin 21, and the position of the pivot pin 21 itself, which determines the length of the two pile carriage parts 2 and 3. The actuator 19 is preferably only pushed in when a retaining force with which the pile carriage parts 2 and 3 are kept in the preferred position is exceeded. The actuator 19 exerts a pressure force on the pile carriage parts 2 and 3 so that these are forced back to the preferred position.

[0035] Fig. 4 is a view of the spud-pile device 1. Viewed from the starboard side, the first pile carriage part 2 is rotated anticlockwise through an angle α together with the spud 8.

Here, the second pile carriage part 3 is rotated clockwise through an angle β with respect to the rail system 5. This situation may arise when the dredging vessel heaves downwards. Here, the actuator 19 exerts a tensile force on the two pile carriage parts 2 and 3 in the direction of their preferred position with respect to one another.

[0036] Figs. 5-7 show a first embodiment of a centring cylinder 31 for use in an actuator 19 in a spud-pile device according to the invention. Fig. 5 shows the centring cylinder 31 with its piston rod 37 in the centre position, also referred to as the centre position of the centring cylinder 31. The centre position corresponds to the preferred position of the first and second pile carriage parts 2, 3 from Fig. 1. This centring cylinder 31 is attached to the pile carriage parts 2 and 3 by means of the piston rod 37 and the housing 50 for transmitting pressure or tensile forces. The fastening means are not shown in any more detail here in these figures. The load is transmitted through the centring cylinder 31. The load acts on the central piston rod 37 and the housing 50. In use, the centring cylinder 31 is subjected to both pressure and tensile loads. In this Fig. 5, the centring cylinder 31 is illustrated in the centre position. In this case, the central piston rod 37 is connected to a first piston 32 and a second piston 35. Pressure forces are transmitted through the centring cylinder 31 by means of the first piston 32. Tensile forces are transmitted through the centring cylinder 31 by means of the second piston 35. In this case, the first piston 32 is fixedly connected to the piston rod 37. Here, the second piston 36 is slidable over the piston rod 37. The centring cylinder 31 in this case comprises three pressure chambers 33, 38 and 39. The first pressure chamber 33 exerts pressure on the piston surface 34 of the first piston 32. The second pressure chamber 39 exerts pressure on the piston surface 36 of the second piston 35. In the centre position of the centring cylinder 31, the first piston 32 and the second piston 35 act on each other, in this case by means of a stop 52b of the first piston 32 and a stop 52a of the second piston 35. The pressure in the first pressure chamber 33 and the second pressure chamber 39 is equal. The piston surface 36 of the second piston 35 is larger than the piston surface 34 of the first piston 32. When no external load is exerted on the piston rod 37,

there is a stable balance. In this stable state, the second piston part 35 acts on the housing 50 of the centring cylinder 31. Here, the second piston 35 rests on the housing 50 by means of a stop 51b of the second piston 35 and a stop 51a of the housing 50. The centre position of the centring cylinder 31 is determined by the second piston part 35 acting on the housing 50 and the first and second pistons 32, 35 acting on each other. In the centre position, the piston surfaces 34 and 36 have a fixed distance relative to one another. The pressure in the third pressure chamber 38 is lower than the pressure in the pressure chambers 34 and 39. Partly as a result of the difference in pressure between the chambers 34 and 38, the first piston 32 with the piston rod 37 is forced in the direction of the centre position. Incidentally, it is conceivable that in the third pressure chamber 38 ambient pressure prevails, or that the third pressure chamber 38 is connected to a separate accumulator. As a result of the difference in pressure between pressure chambers 39 and 38, the second piston 35 is also forced to the centre position. In this centre position, the circumferential stop 51b of the second piston part 35 rests on the circumferential stop 51a of the housing 50. The stop faces 51a and 51b together determine the centre position of the centring cylinder 31. Therewith they cooperate with the stop faces 52a and 52b by means of which the first piston 32 acts on the second piston 35. The pressure chambers 33 and 39 are connected to a common supply line 42 as a result of which the pressure in these chambers is equal and the characteristic is also equal when the supply line is connected to an accumulator. This supply line 42 is connected to an accumulator in order to obtain a volume-pressure characteristic. This accumulator is not shown or described here in any more detail. It is conceivable for the pressure chambers 33 and 39 each to be connected to a separate accumulator. The pressures in the pressure chambers 33 and 39 are tuned to one another in such a manner that, without external load on the piston rod 37, the centring cylinder 31 assumes its centre position in which it is in stable balance. The first piston 32 is provided with a circumferential seal 47 which connects the periphery of the first piston 32 to the housing 50 in a sealing manner. On its outer periphery, the second piston 35 is provided with a seal 49 which connects the second piston 35 to the housing 50 in a sealing manner. On its inner periphery, the second piston 35 is provided with a seal 48 which sealingly connects the second piston 35 to the piston rod 37 and along which the second piston 35 is slidable. The seals 47, 48 and 49 are not described in any more detail here.

[0037] The centring cylinder 31 comprises, a central piston rod 37 for acting on a first piston 32 and a second piston 33, the first piston 32 and the second piston 35 being displaceable in opposite directions in a respective piston chamber 33, 39 between a centre position in which there is a stable balance and in which the pile carriage parts 2, 3 are in their preferred position with respect to one another, and an extended position for reducing the joint volume of the respective piston chambers 33, 39 in which the piston surface 36 of the second piston 35 is larger than the piston surface 34 of the first piston 35, an accumulator in fluid connection with the two piston chambers 33, 39 for determining a pressure in the piston chambers 33, 39 depending on the joint volume of the piston chambers 33, 39.

[0038] Fig. 6 shows the centring cylinder 31 from Fig. 5 when this is subjected to pressure loads from the centre position. When the force F exceeds a retaining force, the first piston 32 moves out of the centre position and thereby reduces the volume of the pressure chamber 33. The retaining force is determined by the pressure in the pressure chamber 33 and the piston surface 34 of the first piston 32. As the pressure chamber 33 is connected to the accumulator, the pressure in this pressure chamber 33 will therefore increase. As the pressure chamber 39 is connected to the same accumulator, the pressure will also increase in the pressure chamber 39. The increase in pressure in the pressure chamber 39 does not have any effect on the position of the second piston 35. In this case, the pressure in the third pressure chamber 38 is always lower than the pressure in the first and second pressure chambers 33, 39. If the pressure load F then ceases, the first piston 32 with the piston rod 37 will move in the direction of the centre position due to the difference in pressure between pressure chambers 33 and 38. In this centre position, the first piston 32 again rests on the second piston 35 in the manner described above and there regains its centre position.

[0039] Fig. 7 shows the centring cylinder 31 from Fig. 5 when the latter is subjected to tensile load from the centre position. When the force F exceeds a retaining force, the first piston 32 with the second piston 35 moves out of the centre position and thereby reduces the volume of the second pressure chamber 39. The first pressure chamber 33 increases, however the total volume of the first and second pressure chambers 33, 39 is reduced, as a result of which the pressure increases as a result of the accumulator (not shown) to which the first and second pressure chambers 33, 39 are connected by means of the conduit 42. Because the piston surface 36 of the second piston 35 is larger than the piston surface 36 of the first piston 32, the sum of the forces on the first piston 32 and the second piston 35, which act on one another, forces the latter to the centre position of the centring cylinder 31. When the piston surface 36 of the second piston 35 is twice as large as the piston surface 36 of the first piston 32, the retaining force for both the pressure force (Fig. 6) and the tensile force is equal, which is advantageous under certain dredging conditions. When the tensile load F then ceases, the first piston 32 with the second piston 35 and the piston rod 37 will move in the direction of the centre position due to the difference in piston surface 36 of the second piston 35 and the piston surface 34 of the first piston 32. In this centre position, the first piston 32 again rests on the second piston 35 in the known manner and there regains its centre position.

[0040] Figs. 8-10 show a further embodiment of the centring cylinder 31. Only the differences with regard to the embodiment from Figs. 5 to 7 will be explained. In the illustrated embodiment, the second piston 32 is slidable with respect to the housing 50 independently of the piston rod 37. In the centre position, the circumferential stop 58a of the first piston 32 rests on the circumferential stop 58b of the housing 50. The second piston 35 rests on the housing 50 in the same manner as described above. In this centre position, the piston rod 37 is enclosed between the first piston 32 and the second piston 35. An advantage of this construction is the fact that, partly by means of the pressure in the third pressure chamber 38, there is more freedom to adjust the retaining force for each type of load, that is to say pressure load or tensile load. In addition, when the first and second pressure chambers 33, 39 are each connected to a dedicated accumulator, the characteristic can also be adjusted for each type of load. The retaining force is the force which has to be exceeded in order for the centring cylinder 31 to move out of its centre position.

[0041] Fig. 9 shows the centring cylinder 31 from Fig. 8 while it is subjected to pressure load by force F from the centre position. The central piston rod 37, together with the first piston 32, moves out of the centre position. The pressure in the pressure chamber 33 increases again and therefore also the pressure in the pressure chamber 39, since both are connected to one accumulator in this case. If then the load F ceases again, the difference in pressure between the pressure chamber 33 and the pressure chamber 38 will force the first piston 32 together with the piston rod 37 back into the centre position again, in which case a balanced position is found again in the centre position of the centring cylinder 31 in a similar manner.

[0042] Fig. 10 shows the centring cylinder 31 from Fig. 8 while it is subjected to tensile load by force F from the centre position. In this case, the central piston rod 37 moves out of the centre position together with the second piston 35, with the pressure in the pressure chamber 39 and also the pressure in the pressure chamber 33 increasing again. In this case, the second piston 32 remains in engagement with the housing 50 by means of the stop faces 58a, 58b. The central piston rod 37 moves independently of the first piston 32. Due to the fact that the piston rod 37 together with the second piston 35 is moveable independently of the first piston 32, the pressure in pressure chamber 33 does not have any effect on the load on the piston rod 37. As a result thereof, this load can be adjusted by varying the pressure in the pressure chamber 38.

[0043] It will be clear that the above description has been given in order to illustrate the functioning of preferred embodiments of the invention, and not in order to limit the scope of the invention. On the basis of the above explanation, many variations which fall within the spirit and the scope of the present invention will be obvious to a person skilled in the art.

Claims

1. Spud-pile carriage (1) for connecting a spud-pile (8) to a dredging vessel in a wheeled or sliding manner, in which the spud-pile carriage (1) comprises a first and second carriage part (2, 3), both of which are provided with wheels (15, 16, 17) or sliders, in which the first and second carriage parts (2, 3) are connected so as to be pivotable with respect to one another about a pivot pin (21).

2. Spud-pile carriage according to Claim 1, in which the pivot pin (21) is at right angles to the spud-pile (8) and the direction of travel of the spud-pile carriage (1).

3. Spud-pile carriage according to one of the preceding claims, in which the first and second carriage parts (2, 3) are connected to one another by means of an actuator (19) for transmitting a moment through the spud-pile carriage (1) of the spud-pile (8) to a rail system (5) of a dredging vessel.

4. Spud-pile carriage according to Claim 3, in which the actuator (19) forces the first and second carriage parts (2, 3) in the direction of a preferred position with respect to one another in order to keep a spud (8) in a substantially vertical position.

5. Spud-pile carriage according to Claim 3 or 4, in which the first and second carriage parts (2, 3) are connected to one another only by means of the pivot pin (21) and the actuator (19) for transmitting the entire moment of the spud-pile (8) to a rail system (5) of a dredging vessel.

6. Spud-pile carriage according to one of the preceding claims, in which retention means (9, 10) are provided for retaining the spud (8) in order to transmit moments at right angles to the longitudinal axis (59) of the spud (8), and the retention means (9, 10) being provided on the first carriage part (2).

7. Spud-pile carriage according to one of the preceding claims 3-6, in which the actuator (19) comprises a centring cylinder (31) for transmitting forces between the first (2) and second (3) carriage parts, with the centring cylinder (31) comprising a first piston (32) and a second piston (35), each having their respective first pressure chamber (33) and second pressure chamber (39), a piston rod (37) connected to one carriage part (2, 3) for acting on the first piston (32) for transmitting pressure forces between the first (2) and second (3) carriage parts, and for acting on the second piston (35) for transmitting tensile forces between the first (2) and second (3) carriage parts.

8. Spud-pile carriage according to Claim 7, in which the

second piston (35) is slidably connected to the piston rod (37), in which case, in one embodiment, the piston rod (37) extends through a central hole in the second piston (35) in order to keep the second piston (35) centrally slidable.

9. Spud-pile carriage according to one of Claims 7 - 8, in which the piston rod (37) is fixedly connected to the first piston (32).

10. Spud-pile carriage according to one of Claims 7 - 9, in which the first pressure chamber (33) is connected by means of a fluid line (42) to the second pressure chamber (39) in order to connect the first and second pressure chambers (33, 39) to one accumulator.

11. Spud-pile carriage according to one of the preceding Claims 7 - 10, in which the piston surface (36) of the second piston (35) is twice as large as the piston surface (34) of the first piston (32).

12. Spud-pile carriage according to one of the preceding Claims 7-11, in which a third pressure chamber (38) is provided between the first piston (32) and the second piston (35), which comprises a connection (43) for the fluid connection of the third pressure chamber (38) to a further accumulator.

13. Spud-pile carriage according to one of the preceding Claims 7 - 12, in which the actuator (19) comprises an accumulator in fluid connection with the first and second pressure chambers (33, 39).

14. Spud-pile carriage according to one of the preceding Claims 7 - 13, in which the actuator (19) comprises a pressure sensor for measuring the pressure in a pressure chamber (33, 39, 38) in order to measure the load on the spud (8).

15. Spud-pile device for connecting a spud-pile (8) to a dredging vessel in a wheeled manner, in which the spud-pile device comprises a rail system (5) for connecting the spud-pile device to a dredging vessel, a spud-pile carriage (1) according to one of the preceding claims, situated on the rail system (5) in a wheeled or sliding manner, in which the first and second carriage parts (2, 3) are pivotably connected to the rail system (5) and are pivotable about a respective pivot pin (13, 12), and in which the retention means (9, 10) are arranged on the first carriage part (2) in such a way that the longitudinal axis (59) of the spud (8) and the pivot pin (13) intersect

Fig 1

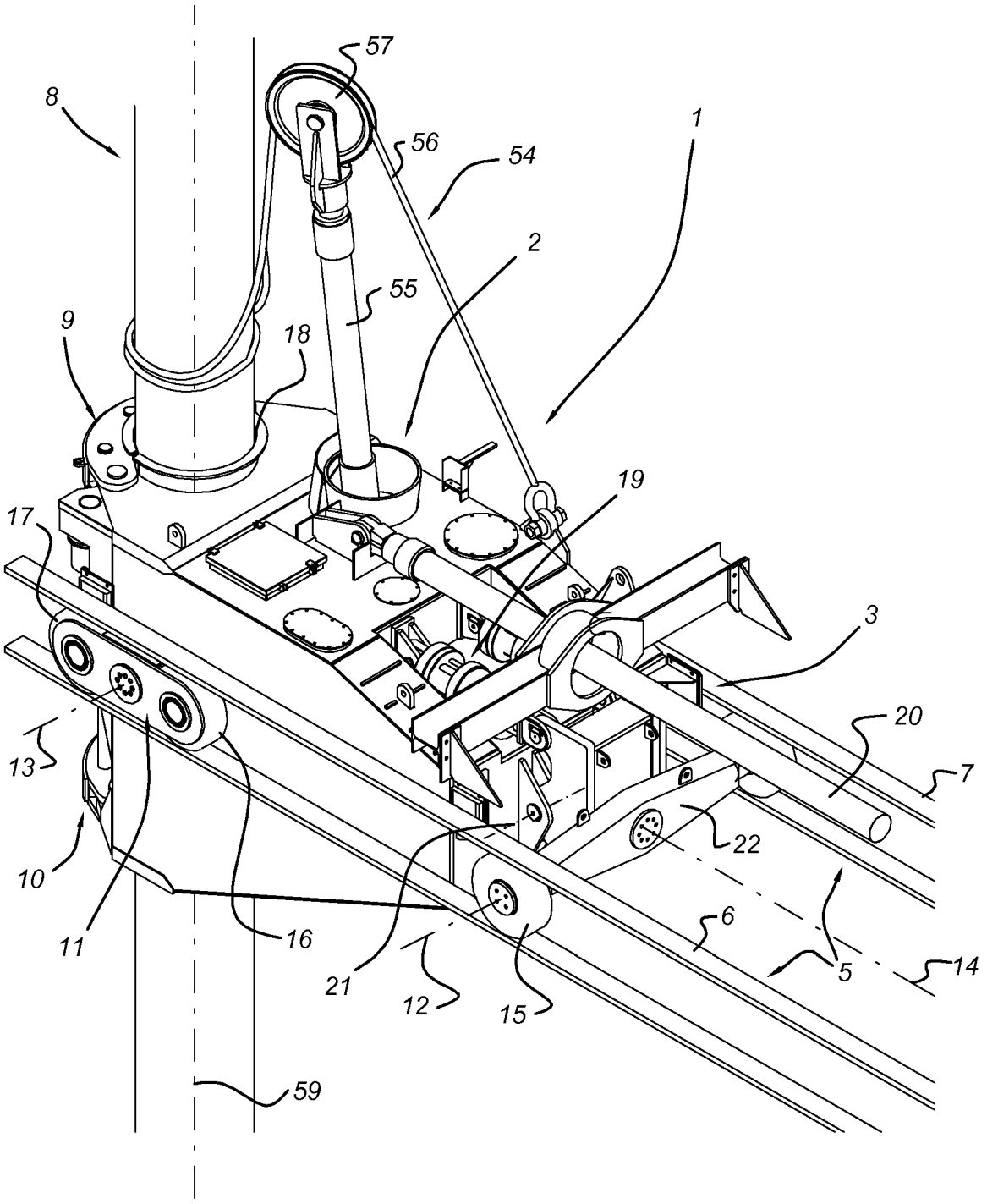


Fig 2

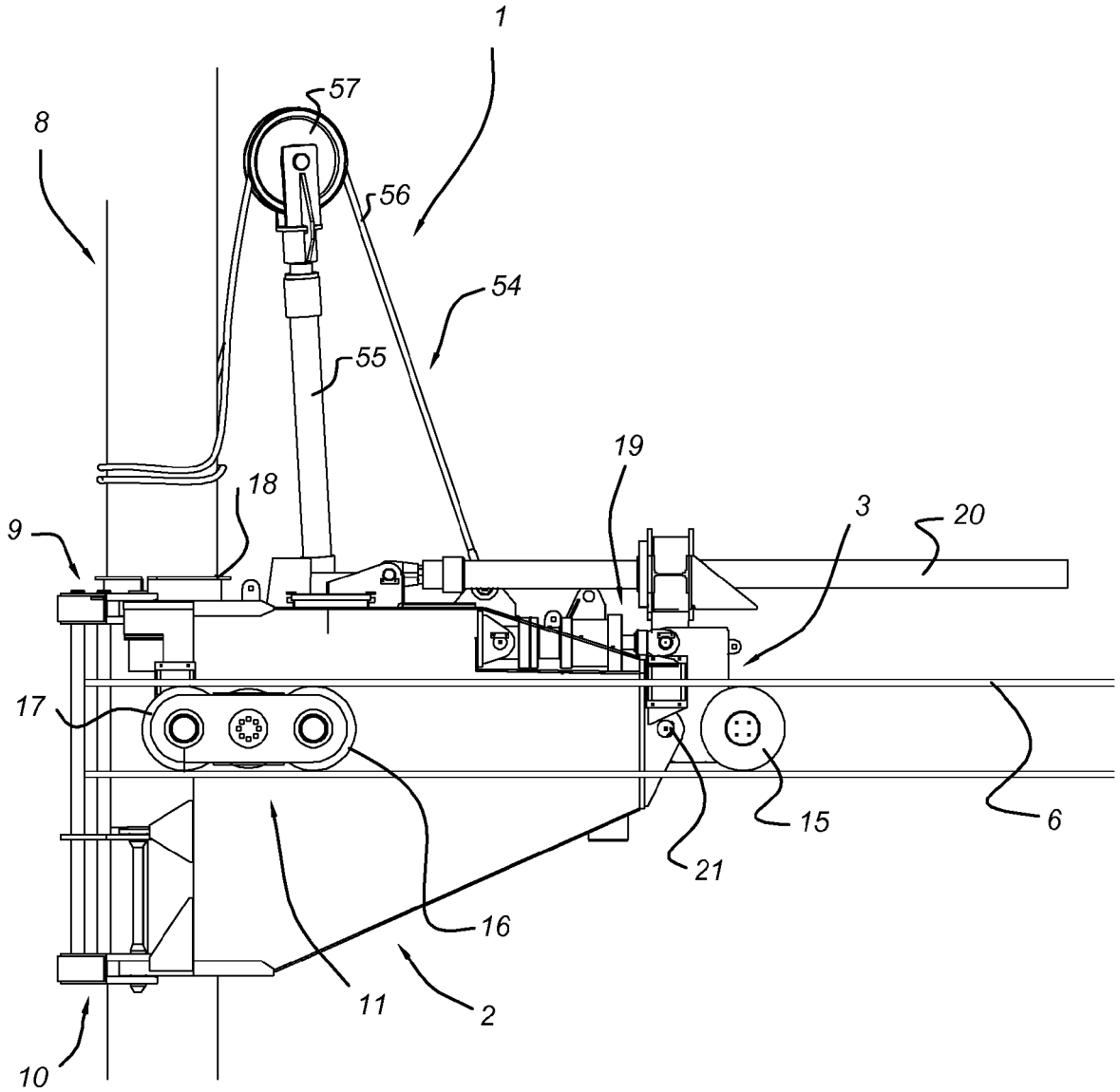


Fig 3

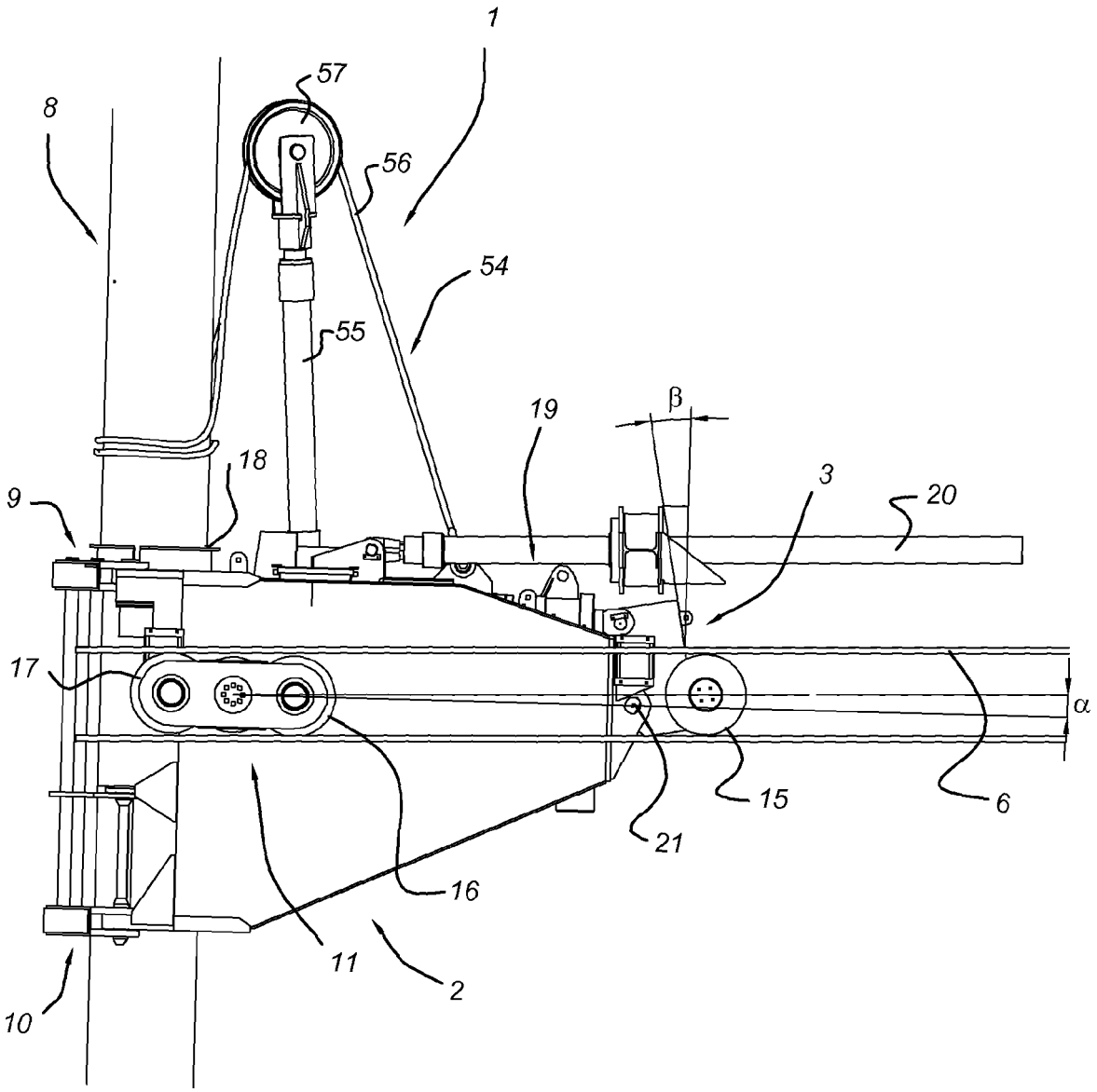


Fig 4

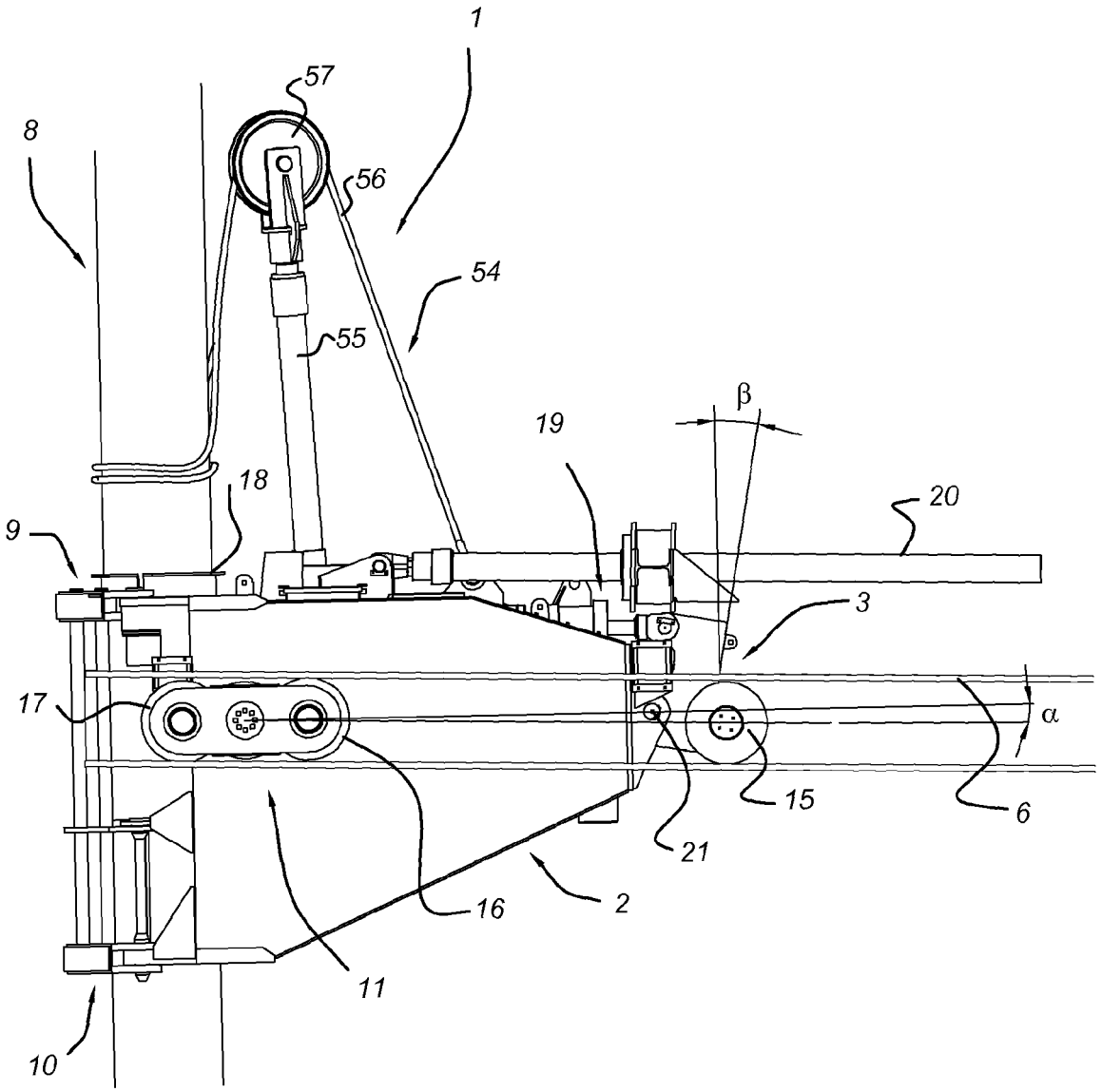


Fig 5

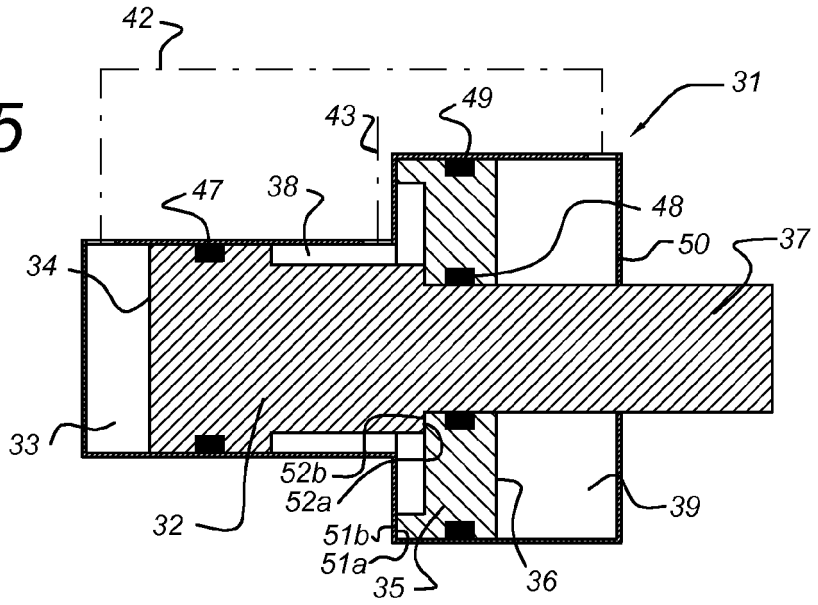


Fig 6

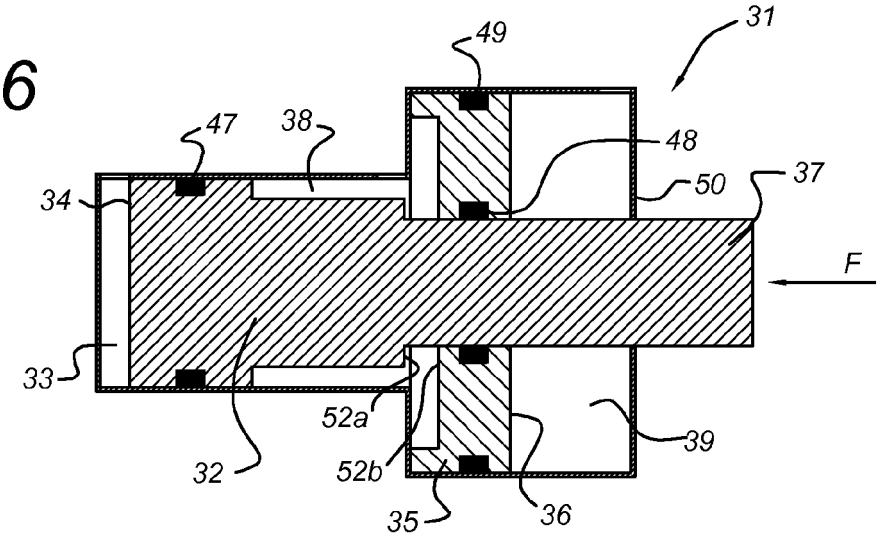


Fig 7

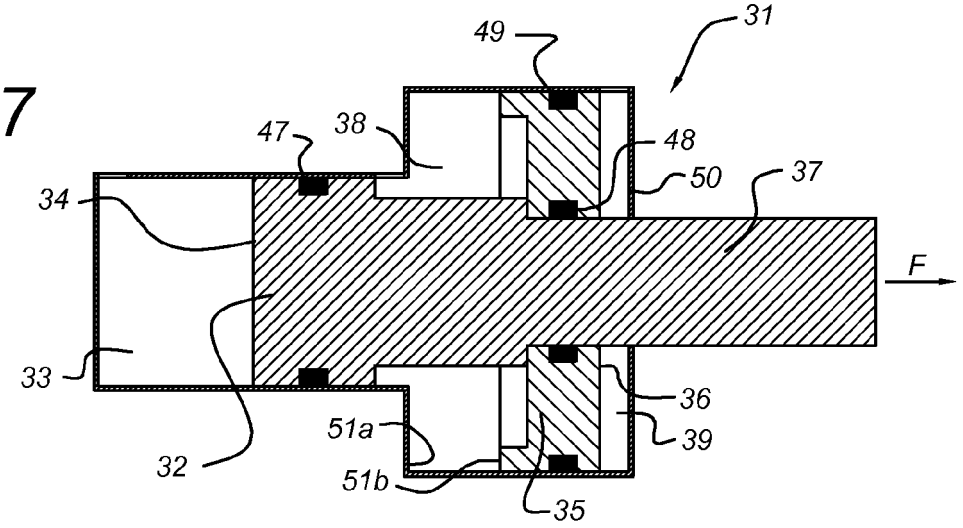


Fig 8

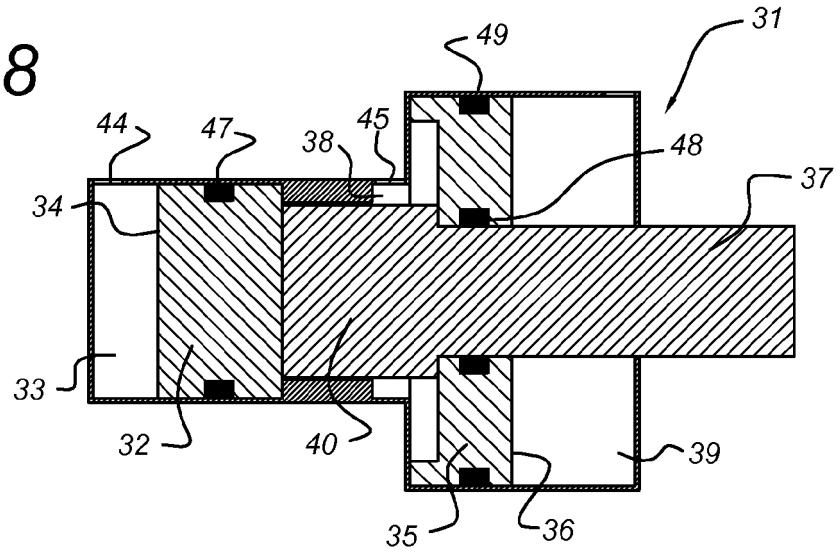


Fig 9

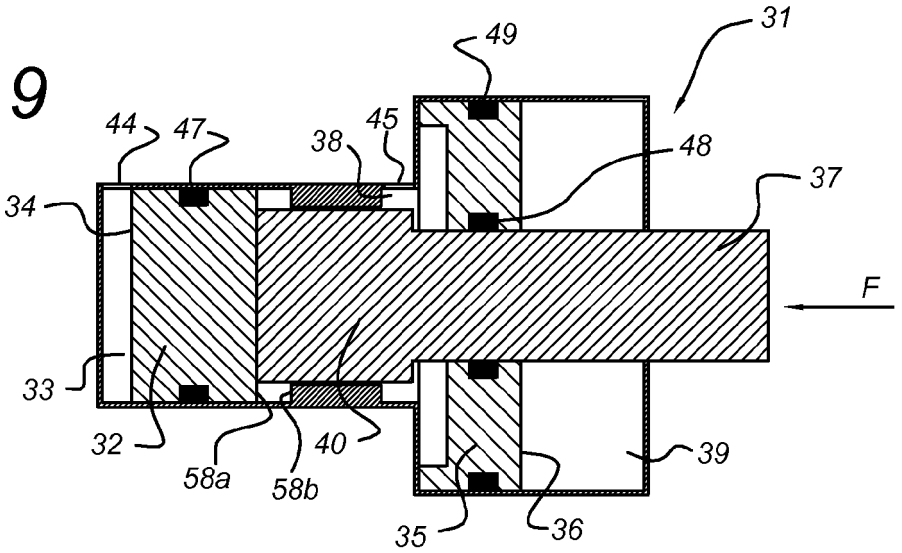
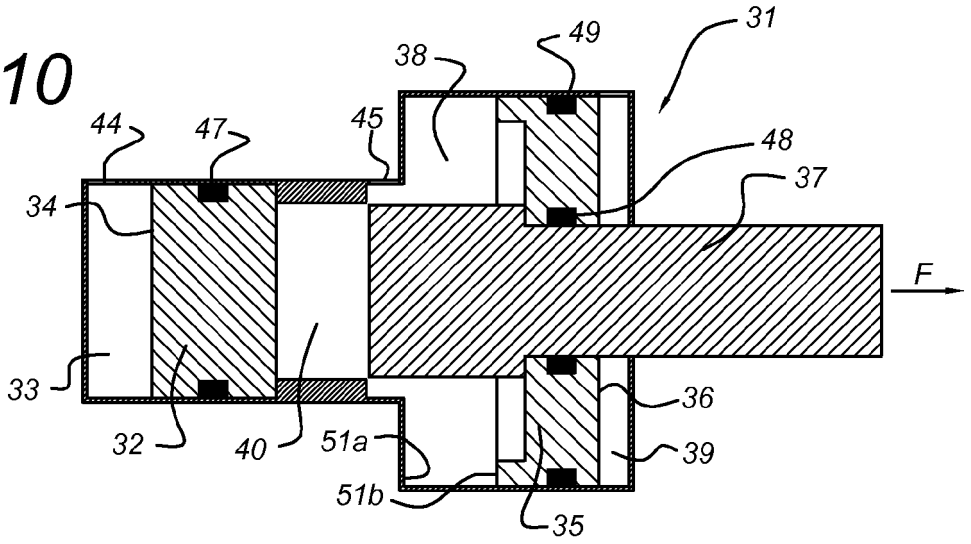


Fig 10



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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 4601

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Place of search	Date of completion of the search	Examiner
The Hague	27 August 2010	Guthmuller, Jacques

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