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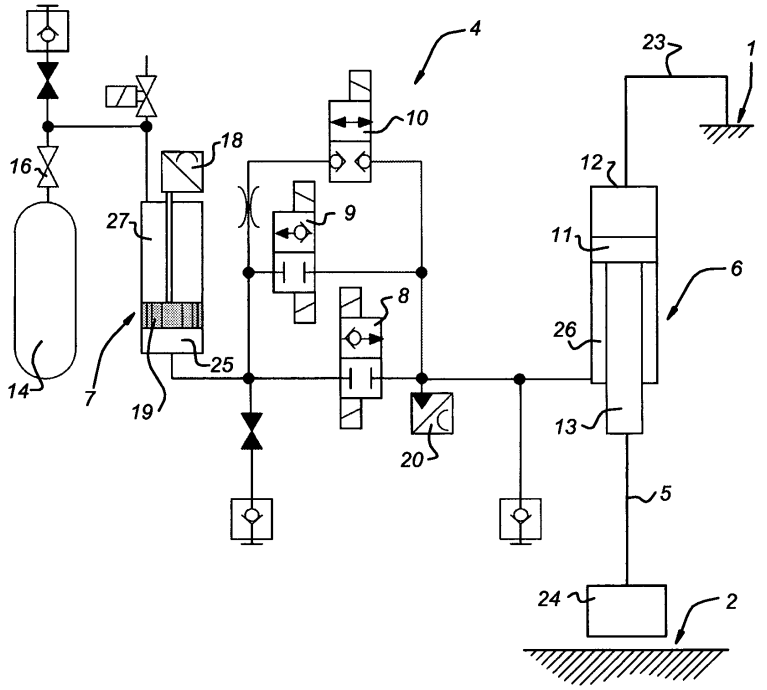
(54) **Method for transferring the load between objects subjected to swell, and heave compensator**

(57) A method for transferring a load between objects, such as a fixed structure (1) and a vessel (2), subjected to relative heave motions as a result of swell, comprises the steps of:
- providing one of the objects, such as the fixed structure (1), with a hoisting means (3) and a heave compensator (4) which cooperates with said hoisting means (3),
- providing the other object with a load,
- connecting said heave compensator (4) to the load by means of a hoist (5) which is in a slack condition,
-diminishing the amount of slack in the hoist (5),
- making the hoist (5) become taut,
- making the heave compensator (4) follow the heave motion while the hoist (5) is taut,
- establishing the occurrence of an upward hoist motion,
- making the heave compensator (4) become blocked during said upward hoist motion so as to prevent downward hoist motions while allowing upward hoist motions.

Fig 1



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Description

[0001] The invention is related to the field of transferring a load between objects which are moving with respect to each other due to swell which results from the heave motions of a wave. Such conditions prevail in many different areas, in particular while transferring a load between an offshore platform or rig and a supply vessel etc. Usually, the vessel is subjected to more or less severe heave motions, while the hoist suspended from a crane on the platform is in a usually stationary condition.

[0002] This relative motion between the load on board the supply vessel and the crane hoist may inadvertently result in severe overloadings on the crane structure. These overloadings have a dynamic character and are generated by the impact of the load on the hoist. Such impact can easily occur when the load, while moving down with the ship as a result of the swell, suddenly makes the hoist become tensioned or taut. The dynamic phenomena which are thereby generated within the crane structure may lead to severe overstressing and thus to structural damage. In this connection, in particular the boom or jib of the offshore crane poses a risk. However, also other components such as the slewing ring for rotating the offshore crane can become severely damaged as a result of such dynamic overloadings. As the offshore crane in question represents in fact the only means for transferring loads onto or from the platform, it will be clear that damages resulting in offshore crane downtime would severely hamper the platform operations. In this connection offshore cranes are dimensioned in such a way that they can accommodate such dynamic loadings, which however results in a heavy construction.

[0003] With the aim of avoiding such a heavy crane construction and thus of preventing or reducing dynamic impacts while transferring loads, so-called heave compensators have been proposed. Reference is made to the wave motion compensating apparatus for use in conjunction with an offshore crane as disclosed in the United States patent 4.098.082. The aim of said wave motion compensating apparatus is to pick up the load at the crest of a wave and two subsequently continue the upward motion thereof, so as to lift the load clear of the supply vessel in question. Subsequently, the crane takes over and hoists the load onto the platform or rig.

[0004] Although this prior art heave motion compensating apparatus provides some alleviation of the offshore crane loadings while hoisting, still the problem of selecting the proper point in time for lifting the load clear from the supply vessel deck occurs. In particular, the point in time at which the transfer from a slack hoisting wire to wave motion compensation and a taut wire should take place, still poses problems. Conversely, also problems occur while attempting to position the load onto an object while heave motion occurs. Precisely these phases in the process of lifting or posing a load which are crucial in avoiding dynamic overloadings in an offshore crane structure.

[0005] The object of the invention is therefore to improve the existing methods of transferring loads between objects subjected to relative motions as a result of swell by providing a solution for the problem which still occurs in selecting the proper point in time for lifting the load clear, or posing the load onto, for example the deck of a supply vessel. Also, selecting the point in time for transferring from a slack hoisting wire to wave motion compensation and a taut wire should be made possible. According to the invention, these problems are solved by a method for transferring a load between objects, such as a fixed structure and a vessel, subjected to relative heave motions as a result of swell, comprising the steps of:

- providing one of the objects, such as the fixed structure, with a hoisting means and a heave compensator which cooperates with said hoisting means,
- providing the other object with a load,
- connecting said heave compensator to the load by means of a hoist which is in a slack condition,
- diminishing the amount of slack in the hoist,
- making the hoist become taut,
- making the heave compensator follow the heave motion while the hoist is taut,
- establishing the occurrence of an upward hoist motion,
- making the heave compensator become blocked during said upward hoist motion so as to prevent downward hoist motions while allowing upward hoist motions.

[0006] According to this first embodiment of the method according to the invention, a smooth transfer is obtained from the slack condition of the hoist to the taut or tensioned condition thereof. This is obtained by the step of simply making the hoist, once being tensioned, follow the heave motion of the load while maintaining said tensioned condition. In this mode of operation, the heave compensator function is adjusted in such a way that upward hoist motions remain possible, but downward motions are prevented. As soon as a heave top occurs, and the load almost starts to descend again, the heave compensator forbids the hoist to descend as well while transferring the loadings from the ship's deck to the hoist in a very gradual fashion. This very gradual transfer of the loading prevents the occurrence of severe dynamic effects, and is protecting the offshore crane structure against overloadings and damages.

[0007] With the aim of further improving the gradual character of the transition from slack to taut of the hoist, the method according to the invention may optionally comprised the steps of:

- detecting the heave motion,
- making the hoist follow the heave motion before the taut condition thereof is obtained.

[0008] By individually taking up the slack in the hoist,

said hoist can be brought in a slightly tensioned condition while following heave motion of the load. Once this slightly tensioned condition of the hoist has been reached, the process of lifting the load clear from the deck of the supply vessel can be carried out as described before.

[0009] In this connection, the method of the invention may furthermore comprise the steps of:

- providing a hydraulic piston/cylinder device and a source with pressurized hydraulic liquid,
- providing oppositely oriented, closeable check valves connecting the source with pressurized hydraulic liquid and the hydraulic piston/cylinder device,
- closing the check valve which controls the flow of hydraulic liquid from the source with pressurized hydraulic liquid to the piston/cylinder device, while the check valve which controls the flow from the piston/cylinder device to the source with pressurized hydraulic liquid is open,
- upon detection of hoist motions opening the check valve which controls the flow of hydraulic liquid to the piston/cylinder device from the source with pressurized hydraulic liquid so as to make the heave compensator follow said hoist motions.

[0010] As described before, the method according to the invention, in a first embodiment, is related to lifting the load clear from an object on which said load has been posed before. However, the invention is not limited to this embodiment and also encompasses an embodiment wherein the load hanging from the hoist can be posed on another moving object. According to the invention, this is obtained by means of a second embodiment for transferring a load between objects, such as a fixed structure and a vessel, subjected to relative heave motions as a result of swell, comprising the steps of:

- providing one of the objects, such as the fixed structure, with a hoisting means and a heave compensator which cooperates with said hoisting means,
- suspending the load from said hoist which is in a taut condition,
- making the heave compensator follow the heave motion while the hoist is taut,
- establishing the occurrence of a heave top by making the load contact the other object,
- bringing the heave compensator in an idle condition essentially simultaneously with the occurrence of a heave top so as to transfer the load from the hoist to said other object.

[0011] According to this second embodiment of the method according to the invention, the load which hangs from the hoist is gradually lowered towards the moving object. In this connection, the hoist and thereby the load may be brought in a heave motion fashion as well, tuned with respect to the heave motion of the object. Thus, a soft contact may be established between the load and the deck of the supply vessel.

[0012] In particular, to that end the method according to the invention may comprise the steps of:

- providing a hydraulic piston/cylinder device and a source with pressurized hydraulic liquid,
- providing oppositely oriented, closeable check valves connecting the source with pressurized hydraulic liquid and the hydraulic piston/cylinder device,
- upon detection of a heave top bringing the heave compensator in an idle condition by opening the check valve which controls the flow of hydraulic liquid from the piston/cylinder device to the source with pressurized hydraulic liquid.

[0013] In the foregoing, it has been described that the detection of the heave motion is of importance. In particular, it has been described that the heave motion is detected by the hoist itself. However, this is not always necessary so and instead thereof the method in question may comprise the step of detecting the heave motion by means of a taut auxiliary cable which stretches between both objects.

[0014] The invention is also related to a heave compensator for use in the method described before. Said heave compensator comprises a hydraulic piston/cylinder device for tensioning a hoist, an accumulator, oppositely oriented, closeable check valves by means of which said piston/cylinder device and the accumulator are interconnected, as well as a control device for controlling said check valves.

[0015] The check valves may be carried out in different ways. According to a first possibility, two parallel check valves are provided, each of said check valves being switchable between an open and the closed position. According to a second, alternative embodiment, a multiple check valve is provided, said the multiple check valve being switchable between three positions, two of which opposite check valve positions and one of which defining a closed position.

[0016] Furthermore, the heave compensator make comprise an auxiliary valve interconnecting the piston/cylinder device and the accumulator parallel to the pair of check valves, said auxiliary valve upon opening allowing the piston of the piston/cylinder device to move slowly with respect to the cylinder while the check valves are closed.

[0017] Additionally, a second hydraulic piston/cylinder device may be provided for tensioning an auxiliary cable which is connectable to an object.

[0018] The invention will now be described further with reference to some embodiments of the heave compensator according to the invention as shown in the drawings.

Figure 1 shows a first embodiment of the heave compensator according to the invention.

Figure 2 shows a second embodiment.

Figures 3a, b show a series of conditions of the heave compensator, in a schematic fashion, while lifting a load clear.

Figure 4 shows a series of conditions of the heave compensator, in a schematic fashion, while posing a load.

[0019] The heave compensator according to the invention as shown in figure 1 comprises a hydraulic piston/cylinder device 6 consisting of the cylinder 12 and the piston 11, which forms a unity with the piston rod 13. The cylinder 12 is suspended from an offshore crane 23 positioned on e.g. a platform 1. The hoist cable 5 has been connected to the piston rod 13, from which hoist cable 5 a load 24 is suspended. The supply vessel, in particular the deck 2 thereof, has been shown right under the load 24.

[0020] The cylinder 12 is connected to an accumulator 7 through the check valves 8 and 9. The accumulator 7 comprises a cylinder 19. The hydraulic space 25 underneath said cylinder 19 is connected, through said check valves 8, 9, to the hydraulic space 26 of the piston/cylinder device 6. The pneumatic space 27 above the cylinder 19 of the accumulator 7 is connected to a pressurised gas source 14 through the valve 16. A position sensor 18 is connected to the cylinder 19 of the accumulator 7. A pressure sensor 20 is connected to the hydraulic space 26 of the piston/cylinder device 6.

[0021] The mode of operation of the heave compensator 4 described before it is shown in the sequence of figures 3a, b, showing the process of making the hoist 5 become taut (steps 1-20) and of lifting the load 24 free (steps 21-24). At the start of this process, check valve 8 is closed and check valve 9 is open. Initially, the hoist 5 is in a slack condition between the heave compensator 4, in particular the piston/cylinder device 6 thereof, and the load to 24. Gradually, the heave compensator 4 is lifted somewhat so as to diminish the slack in the hoist 5. At some point in time, indicated by sequence step 7, the hoist 5 becomes taut. Up to that sequence step, the hydraulic valve 9 has been in the open position so as to allow the hydraulic liquid to flow from the piston/cylinder device 6 towards the accumulator 7, Thus, the piston rod 13 with the hoist 5 connected thereto may move downwardly into a wave trough.

[0022] As soon as the downward movement is detected (e.g. by the increasing hydraulic fluid pressure as measured by the pressure sensor 20 at step 8), check valve 8 is switched to the open position. In the compensation mode thus achieved with both check valves 8, 9 in the open position, the load 24 is allowed to move up and down several times with taut hoist 5, and takes place between the steps 16 and 18. After the decision has been made to lift the load 24, the check valve 9 is closed. This decision is based on the detection of an upward movement of the load 24 and the hoist 5 and takes place between the steps 16 and 18. Having regard to the fact that the check valve 8 is still in the open position, the piston 11 is allowed to move upwardly (while the hoist 5 is taut). However, after the next wave top and subsequent downward movement of the wave, the piston 11 and the load 24 are prevented from moving downwardly as well, and the load is lifted free.

[0023] In this way, it is possible to shift the loading from the deck of the supply vessel 2 in a fairly moderate and regular fashion onto the hoist 5. The dynamic and transient loadings which can occur in the crane structure at 23 as a result of this mode of operation of the heave compensator 4, are less than without use of the present heave compensator 4.

[0024] Figures 4a,b show the process of posing a load, hanging on the hoist cable 5, onto the deck of a moving vessel. In steps 1-4, the load is gradually lowered and touches the deck. During this descending movement, the valve 8 remains closed. Subsequently, the load and follows the heave motion of the ship, as shown in steps 5-16.

[0025] An alternative embodiment of the heave compensator according to the invention is as shown in figure 2. To a large extent, this second embodiment is similar to the first embodiment. However, an auxiliary cable 22 has been applied for detecting the heave motions of the supply vessel 2. This auxiliary cable 22 is kept under tension by means of the second piston/cylinder device 21, and enables accurate control of the load transfer process, in particular during lowering the load.

Claims

1. Method for transferring a load between objects, such as a fixed structure (1) and a vessel (2), subjected to relative heave motions as a result of swell, comprising the steps of:

   - providing one of the objects, such as the fixed structure (1), with a hoisting means (3) and a heave compensator (4) which cooperates with said hoisting means (3),
   - providing the other object with a load,
   - connecting said heave compensator (4) to the load by means of a hoist (5) which is in a slack condition,
   - diminishing the amount of slack in the hoist (5),
   - making the hoist (5) become taut,
   - making the heave compensator (4) follow the heave motion while the hoist (5) is taut,
   - establishing the occurrence of an upward hoist motion,
   - making the heave compensator (4) become blocked during said upward hoist motion so as to prevent downward hoist motions while allowing upward hoist motions.

2. Method according to claim 1, comprising the steps of:

- detecting the heave motion,
- making the hoist follow the heave motion before the taut condition thereof is obtained.

3. Method according to any of the preceding claims, comprising the steps of:

- providing a hydraulic piston/cylinder device (6) and a source (7) with pressurized hydraulic liquid,
- providing oppositely oriented, closeable check valves (8, 9) connecting the source (7) with pressurized hydraulic liquid and the hydraulic piston/cylinder device (6),
- closing the check valve (8) which controls the flow of hydraulic liquid from the source (7) with pressurized hydraulic liquid to the piston/cylinder device (6), while the check valve (9), which controls the flow of hydraulic liquid from of hydraulic liquid from the piston/cylinder device (6) to the source (7) with pressurized hydraulic liquid is open,
- upon detection of hoist motions opening the check valve (8) which controls the flow of hydraulic liquid to the piston/cylinder device (6) from the source (7) with pressurized hydraulic liquid so as to make the heave compensator follow said hoist motions.

4. Method according to claim 3, comprising the steps of:

- detecting an upward hoist motion,
- closing the check valve (9) which controls the flow of hydraulic liquid from the piston/cylinder device (6) to the source (7) with pressurized hydraulic liquid so as to lift the load (24) free after or at occurrence of the next wave top.

5. Method for transferring a load between objects, such as a fixed structure (1) and a vessel (2), subjected to relative heave motions as a result of swell, comprising the steps of:

- providing one of the objects, such as the fixed structure (1), with a hoisting means (3) and a heave compensator (4) which cooperates with said hoisting means (3),
- suspending the load from said hoist (5) which is in a taut condition,
- making the heave compensator (4) follow the heave motion while the hoist (5) is taut,
- establishing the occurrence of a heave top by making the load contact the other object,
- bringing the heave compensator (4) in an idle condition essentially simultaneously with the occurrence of a heave top so as to transfer the load from the hoist to said other object.

6. Method according to claim 5, comprising the steps of:

- providing a hydraulic piston/cylinder device (6) and a source (7) with pressurized hydraulic liquid,
- providing oppositely oriented, closeable check valves (8, 9) connecting the source (7) with pressurized hydraulic liquid and the hydraulic piston/cylinder device (6),
- upon detection of a heave top bringing the heave compensator (4) in an idle condition by opening the check valve (9) which controls the flow of hydraulic liquid from the piston/cylinder device (6) to the source (7) with pressurized hydraulic liquid.

7. Method according to any of the preceding claims, comprising the step of:

- detecting the heave motion by means of a taut auxiliary cable which stretches between both objects.

8. Method according to any of the preceding claims, comprising the steps of:

- providing an auxiliary valve (10) parallel to the check valves (8, 9),
- closing the check valves (8, 9)
- opening the auxiliary valve (10) so as to allow the piston (11) of the piston/cylinder device (6) to move slowly with respect to the cylinder (12).

9. Method according to any of the preceding claims, comprising the step of:

- providing a pressure accumulator (7),
- adjusting the pressure accumulator (7) to a predetermined preload.

10. Heave compensator (4) for use in the method according to any of the preceding claims, comprising a hydraulic piston/cylinder device (6) for tensioning a hoist (5), an accumulator (7), oppositely oriented, closeable check valves (8, 9) by means of which said piston/cylinder device (6) and the accumulator (7) are interconnected, as well as a control device for controlling said check valves (8, 9).

11. Heave compensator according to claim 10, wherein two parallel check valves are provided, each of said check valves (8, 9) being switchable between an open and the closed position.

12. Heave compensator according to claim 10, wherein a multiple check valve is provided, said the multiple check valve being switchable between three positions, two of which opposite check valve positions

and one of which defining a closed position.

13. Heave compensator (4) according to any of claims 10-12, comprising an auxiliary valve (10) interconnecting the piston/cylinder device (6) and the accumulator (7) parallel to the check valves (8, 9), said auxiliary valve (10) upon opening allowing the piston (11) of the piston/cylinder device (6) to move slowly with respect to the cylinder (12) while the check valves (8, 9) are closed.

14. Heave compensator (4) according to claim 13, wherein the accumulator (7) is a hydro-pneumatic accumulator, at least two pressurized gas sources (14, 15) being provided the gas pressures of which are different, said gas sources (14, 15) being connected to the hydro-pneumatic accumulator (7) through respective valves (16, 17) which are controllable for adapting the preload of the piston/cylinder device (6).

15. Heave compensator (4) according to any of claims 10-14, comprising a second hydraulic piston/cylinder device (21) for tensioning an auxiliary cable (22) which is connectable to an object (2).

16. Heave compensator (4) according to claim 14 or 15, wherein a position sensor (18) is provided for determining the position of the hoist (5).

17. Heave compensator (4) according to any of claims 10-16, wherein a pressure sensor (20) is provided which is connected to piston/cylinder device (6).

Fig 1

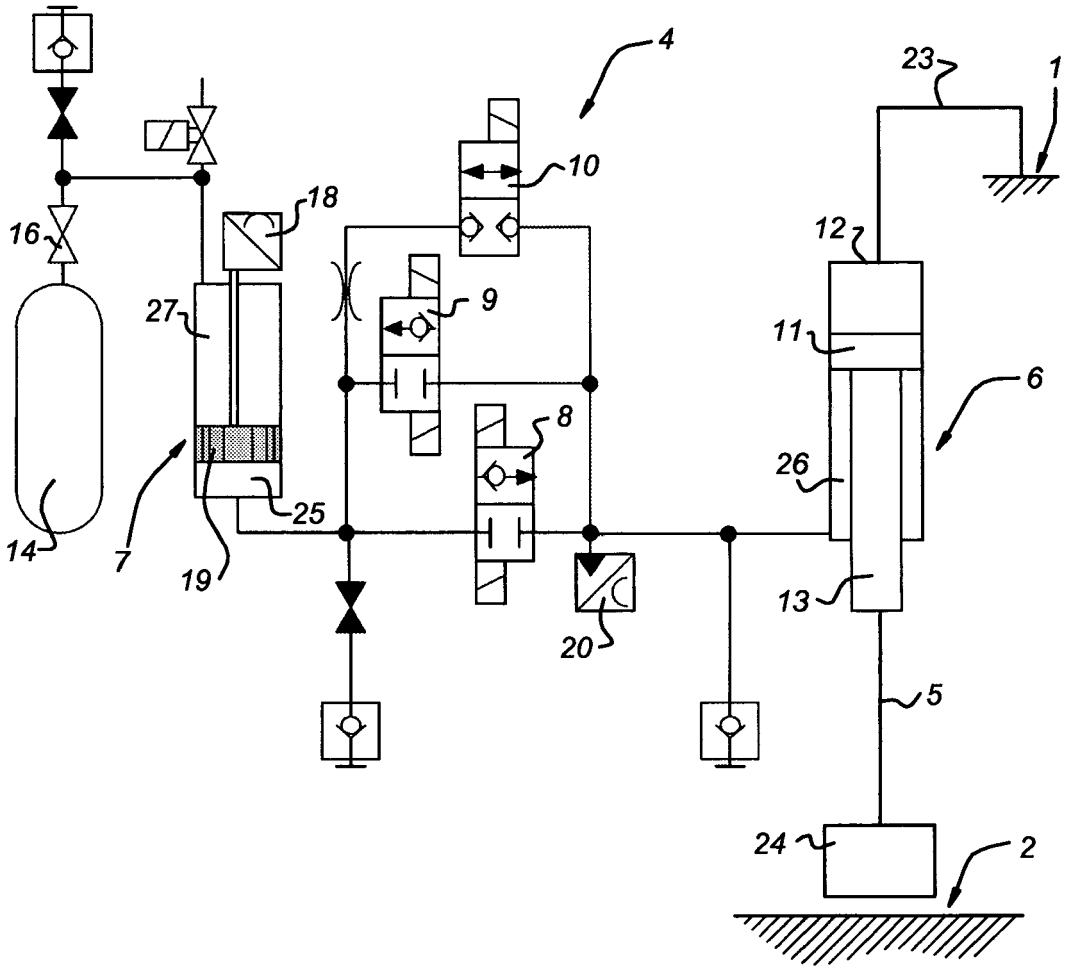


Fig 2

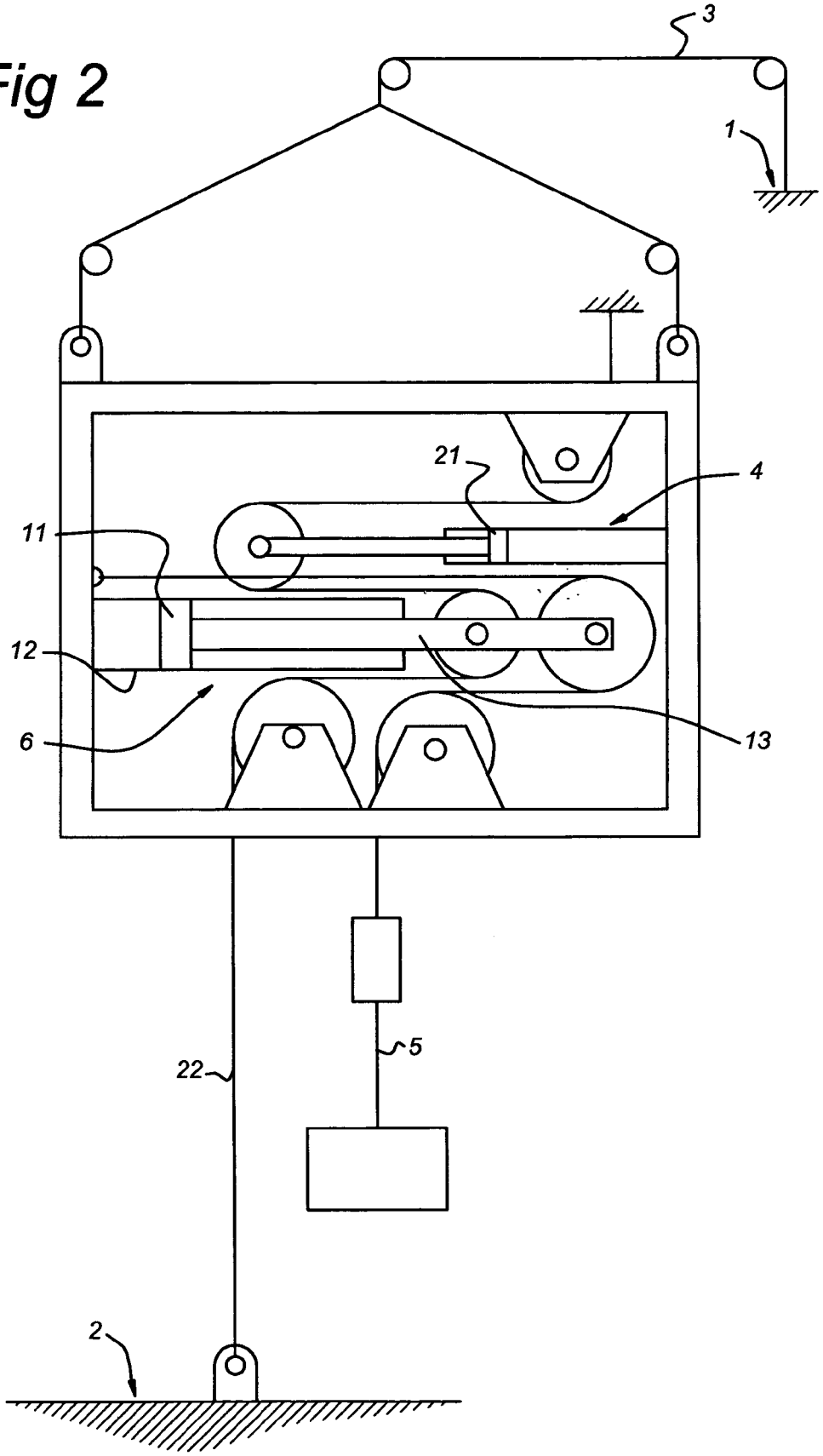


Fig 3a

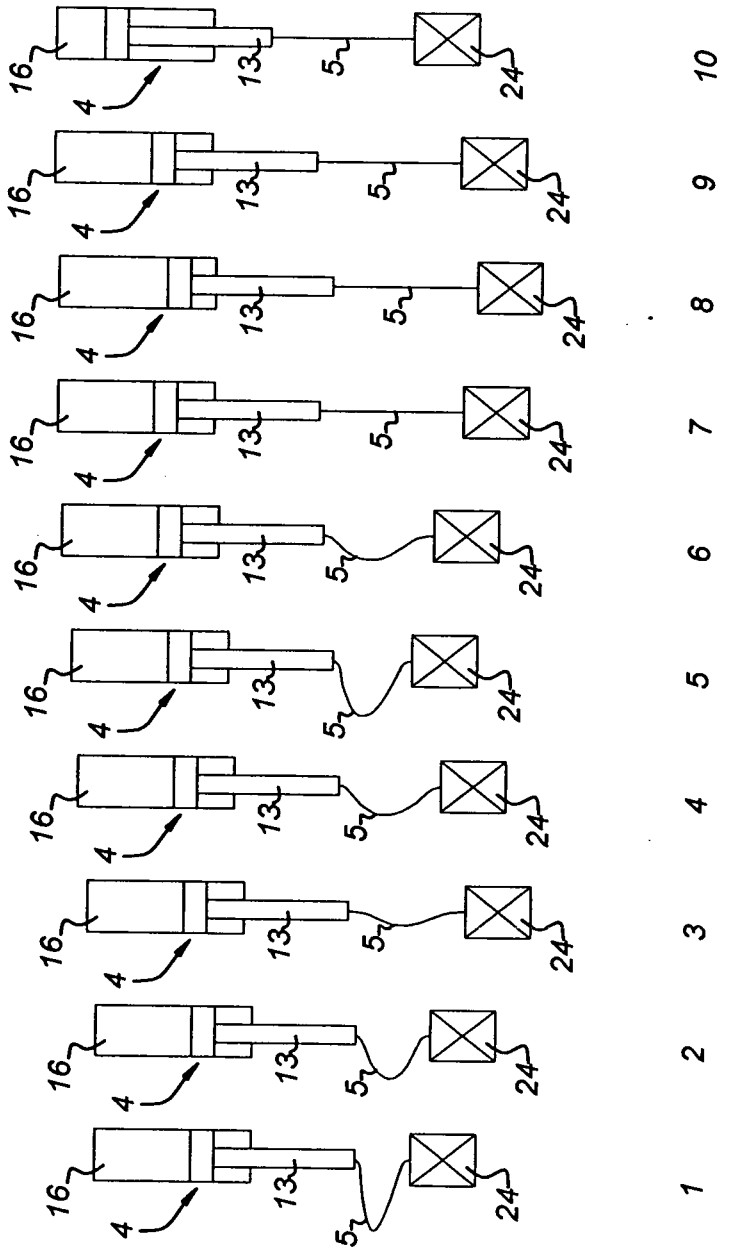


Fig 3b

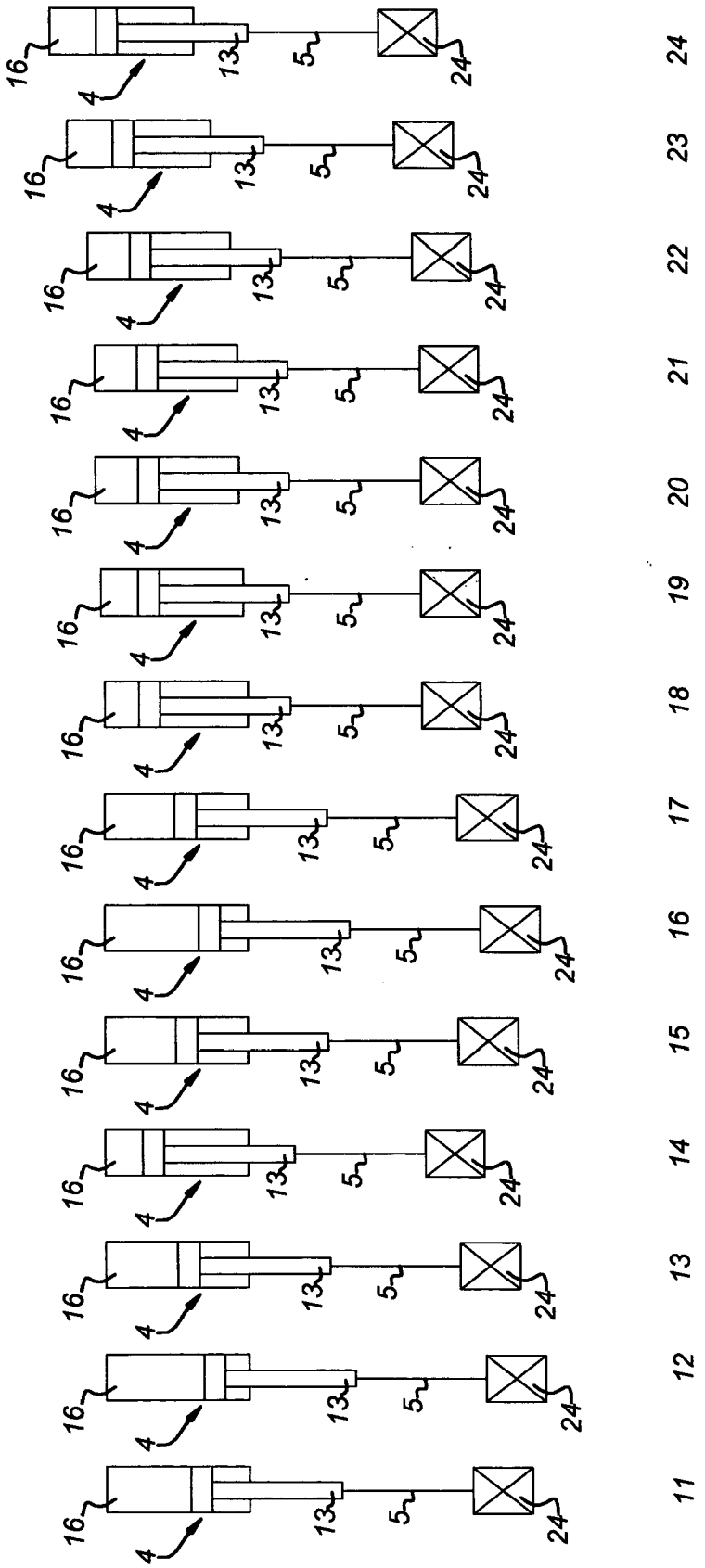
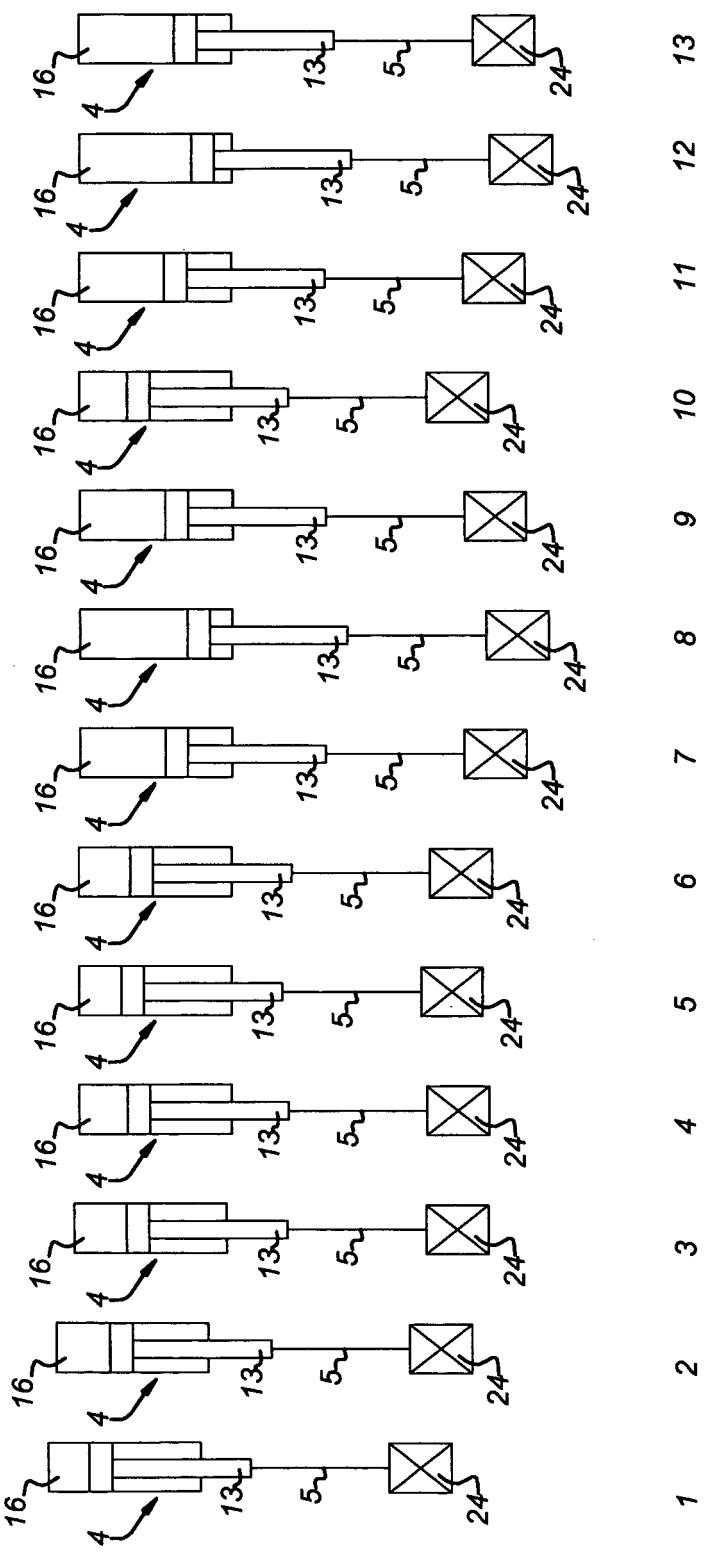


Fig 4a



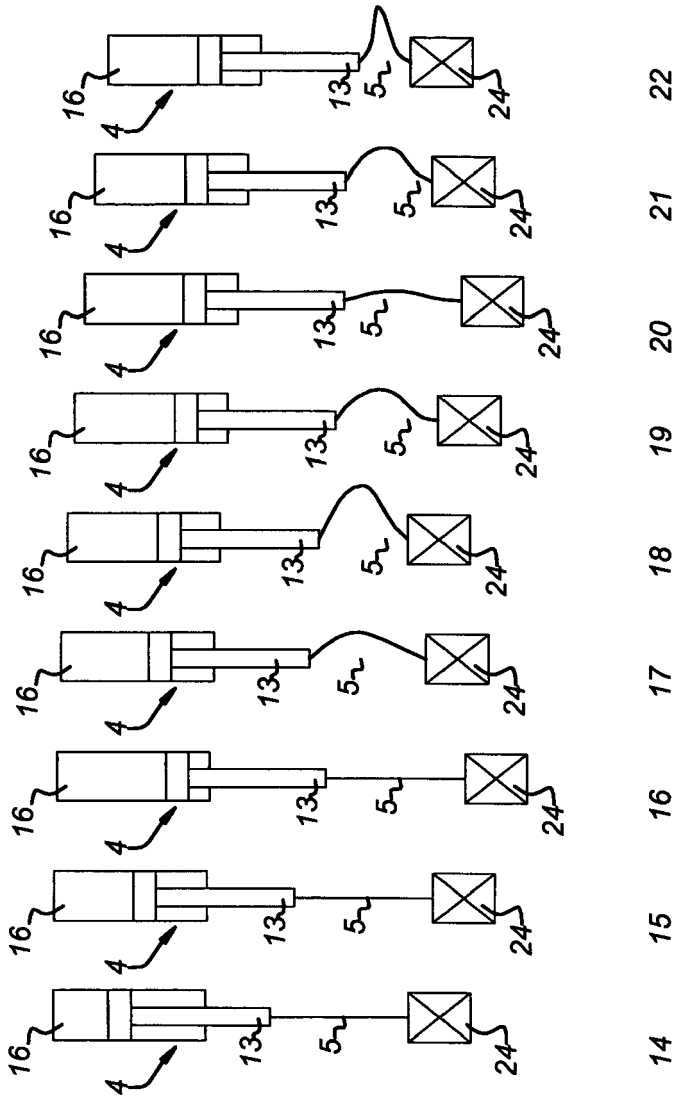


Fig 4b

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EUROPEAN SEARCH REPORT

Application Number
EP 05 11 1803

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	GB 2 096 563 A (SEALIFT LTD) 20 October 1982 (1982-10-20) * the whole document *	1-4, 10-14 15-17	INV. B66D1/52 B66C13/02
D,X A	US 4 098 082 A (PACKER ET AL) 4 July 1978 (1978-07-04)	10 1,5	
Y A	US 3 189 196 A (CARL WELLINGTON C ET AL) 15 June 1965 (1965-06-15) * column 5, line 73 - column 7, last line ; figure 1 *	15-17 1,5	
A	AU 22423 70 A (FAVELLE MORT LIMITED) 25 May 1972 (1972-05-25) * page 7, paragraph 5 - page 8, last paragraph; figures 1-6 *	1,5,10	
A	US 4 324 385 A (COJEAN ET AL) 13 April 1982 (1982-04-13) * column 3, line 48 - column 5, line 40; figures 1-7 * * abstract *	1,5,10	

TECHNICAL FIELDS SEARCHED (IPC)

B66C
B66D
E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 May 2006	Ferrien, Y

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2096563 A	20-10-1982	NONE	
US 4098082 A	04-07-1978	NONE	
US 3189196 A	15-06-1965	NONE	
AU 2242370 A	25-05-1972	NONE	
US 4324385 A	13-04-1982	FR 2401868 A1	30-03-1979
		GB 2006151 A	02-05-1979
		NO 782886 A	01-03-1979

EPO FORM P0459

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Patent documents cited in the description

- US 4098082 A **[0003]**