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(54) **Jack-up offshore platform and method for reducing lateral oscillating movements thereof**

(57) The invention relates to a jack-up offshore platform (1). The platform comprises a work deck (2) supported by spud poles (3) and adjustable in height above the water surface, wherein at least one spud pole comprises means (20) for reducing lateral oscillating move-

ments of the platform. The jack-up platform can be utilized at greater water depths than the known platform. The invention also relates to a method for operating a jack-up offshore platform in a water mass with strong current.

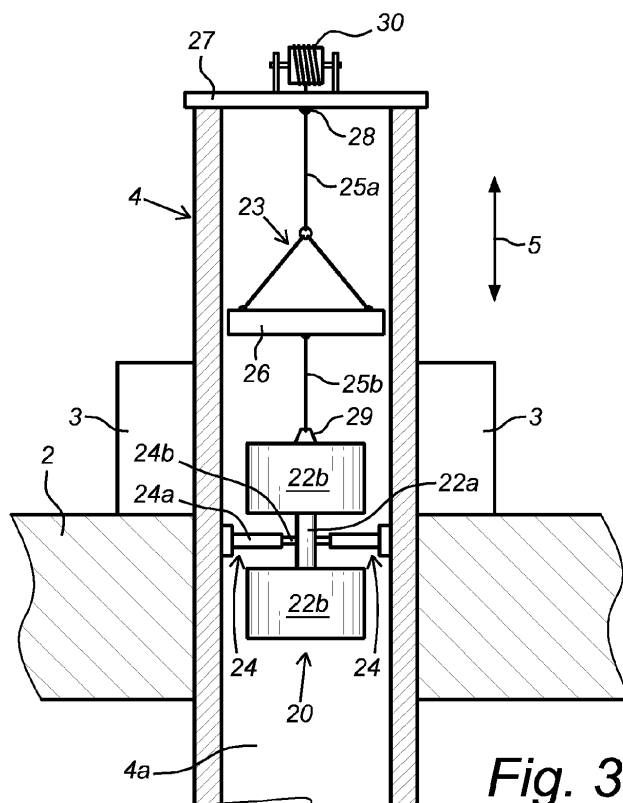


Fig. 3

Description

[0001] The invention relates to a jack-up platform comprising a work deck supported by spud poles and adjustable in height above the water surface. The invention also relates to a method for operating the platform in a water mass with strong current.

[0002] A jack-up platform of the above stated type is utilized for carrying out work operations at sea. The spud poles, which are generally situated at the corner points of the work deck of the platform, can be raised or lowered relative to the work deck by jacks provided on the work deck. The platform can thus be easily transported, with the spud poles in raised position, to the location of the operations to be performed. Once the platform has been moved to the desired position, the platform is anchored on or in the seabed by lowering the spud poles with the jacks until they find support on or in the seabed. The work deck is then carried by means of the jacks to a position above the water surface in which the work deck is supported by the spud poles and is clear of the water surface. If desired, the height of the work deck above the water surface can be adjusted by further jacking up the work deck relative to the spud poles (whereby the work deck is raised relative to the water surface) or by lowering the work deck (whereby the work deck is lowered relative to the water surface).

[0003] It will be apparent that a jack-up platform of the known type can only be employed in relatively shallow waters. This is because the maximum feasible water depth is determined by the spud pole length, which must after all exceed the water depth in order to enable placing of the work deck at different height positions relative to the water surface. The length of the spud poles is however limited by structural considerations. If they were to be given a structurally stronger form, for instance by increasing the wall thickness, they can then become too heavy, whereby transport of the platform is made more difficult or becomes uneconomic.

[0004] An object of the present invention is to provide a jack-up platform which can be utilized at greater water depths. An additional object of the present invention is to provide a platform which can be applied in water masses with a strong current.

[0005] These and other objects are achieved by providing a platform according to the appended main claim. Particularly provided according to the invention is a jack-up offshore platform comprising a work deck supported by spud poles and adjustable in height above the water surface, wherein at least one spud pole comprises means for reducing lateral oscillating movements of the platform. Providing at least one spud pole of the platform with means according to the invention achieves that the spud poles can have a greater length than is the case in the known platform. It is hereby possible to work at locations with greater water depth.

[0006] A further advantage of the invented platform is that it can be applied for the same known spud pole length in a water mass with strong current where it is no longer possible to work with the known platform in such a current. Halting operations on a platform is very costly and must therefore be avoided.

[0007] Water flowing along the spud poles of a platform can cause vortices on the downstream side of the spud pole. This vortex formation is periodic and causes oscillating forces in the longitudinal direction of the spud pole (these forces are relatively limited) and in the lateral direction of the spud pole (substantially perpendicularly of the spud pole). The lateral forces provide for an oscillating lateral movement of the spud poles and the platform. The frequency of the vortex formation is given by:

$$f_K = S_n \cdot V/D \quad (1)$$

wherein: f_K = Von Karman or vortex formation frequency [Hz]

D = external diameter of the spud pole [m]

V = average speed of the current [m/s]

S_n = Strouhal number

[0008] The value of the Strouhal number varies slightly with the Reynolds number but typically equals about 0.2.

[0009] The periodic vortex formation causes an oscillating lifting force on the spud pole in a direction perpendicularly of the current. The maximum force is given by:

$$F_K = (C_K \cdot 0.5 \cdot \rho \cdot V^2 \cdot A) \cdot \sin \omega t \quad (2)$$

wherein: F_K = Von Karman force [N]

C_K = coefficient of force [-]

V = average speed of the current [m/s]

A = projection of the spud pole volume in a plane perpendicularly of the current [m²]

ρ = density of the water [kg/m³]

$\omega = 2\pi \cdot f_K$

[0010] These lateral movements in a direction perpendicularly of the current can occur with a high frequency in the case of strong current such that they approach the eigenfrequency of the platform and thus cause problems. By providing the spud poles of the platform with means according to the invention operation of the platform, and in particular of the spud poles, remains substantially unaffected and lateral oscillating movements of the platform, in particular of the work deck of the platform, particularly also in the case of strong current, are better reduced than if such means were to be provided elsewhere in the platform.

[0011] In a preferred embodiment of the platform according to the invention the means for reducing lateral oscillating movements of the platform are accommodated in an internal cavity of the spud pole. In this embodiment the height adjustment of the work deck relative to the spud poles can take place in essentially the same manner as is the case with the known platform. If the means are arranged externally, they have to be removed, possibly temporarily, during raising and lowering of the work deck relative to the spud poles, which is time-consuming and can even be dangerous in strong current. Such embodiment is also found to be less susceptible to damage. A further advantage of the present embodiment is that the lifting forces on the spud pole do not increase relative to the known spud pole.

[0012] In a further preferred embodiment of the invention a platform is provided in which the means for reducing lateral oscillating movements of the platform comprise a mass and damping means which connect the mass to the spud pole and which damp lateral oscillating movements of the mass.

[0013] The damping means can in principle be embodied in any known manner. It is thus possible to distribute the damping means over the side surface of the mass, as for instance would be the case if a rubber cylinder were to fill the space between the mass and the internal casing surface of the spud pole. In a preferred embodiment according to the invention the damping means comprise a dashpot. In the context of the present invention a dashpot is understood to mean a mechanical device which resists movements by means of viscous friction. The force resulting from a movement is generally proportional to the velocity of the movement but acts in the opposite direction, wherein the movement is slowed and energy is absorbed. The present embodiment is not limited to a particular type of dashpot, and both linear and rotary dashpots can be applied. Linear dashpots generally comprise a cylinder in which the hydraulic fluid is situated and in which a piston is movably received. The movement of the hydraulic fluid can, if desired, be limited by forcing it through relatively small openings during movement of the piston. Suitable dashpots are chosen subject to the desired linear displacement (stroke) and damping factor (the force to be exerted for a determined piston velocity). Rotary dashpots comprise a rotating piston wherein the damping factor is expressed in the torque to be exerted for a determined angular velocity of the piston. It is also possible to apply an eddy current damper. Such a damper comprises a housing of a non-magnetic but conductive material in which a magnet of sufficient dimensions is received. As is the case with a usual viscous dashpot, an eddy current damper generally produces a resistive force proportional to the velocity of movement of the piston. Proportionality is however not a prerequisite for the present invention. For good operation the dashpot must preferably connect the mass to the spud pole. For a linear dashpot this can for instance take place by connecting the dashpot cylinder to the internal casing surface of the spud pole, for instance by welding or bolting, and the free outer end of the dashpot piston to the mass, or vice versa.

[0014] In a further preferred embodiment of the invention a platform is provided in which the damping means comprise spring means which resist lateral oscillating movements of the mass. In such an embodiment the spring means and the damping means preferably act in parallel and are both attached to the mass. The spring and damping means can comprise two or more separate mechanical devices or, if desired, can be combined in one mechanical device. It is also possible to distribute the spring (and damping) means over the side surface of the mass, as for instance would be the case if a rubber cylinder were to fill the space between the mass and the internal casing surface of the spud pole. Parallel operation of the spring and damping means is understood in the context of the present invention to mean that the spring and damping means undergo substantially the same or proportional displacements during displacement of the mass. Parallel action is distinguished from series action, wherein the spring and damping means undergo substantially the same force during displacement of the mass.

[0015] For good operation the spring means must preferably connect the mass to the spud pole. In a preferred embodiment of the platform according to the invention the spring means comprise a suspension cable for the mass, which suspension cable allows lateral movements of the mass with a spring constant. The suspension cable connects the mass to the spud pole, for instance by providing the spud pole on the upper side with a fixing means (a suspending means) for the suspension cable, likewise providing the mass with a fixing means for the suspension cable and tensioning the suspension cable between the two fixing means. The combination of spring means and mass in the present embodiment forms a pendulum which can oscillate relatively freely relative to or in the spud pole. The freedom of oscillation is limited in combination with damping means such as dashpots acting on the mass. The fixing means can be chosen subject to the desired degrees of freedom of oscillation. It is thus possible for the suspension means to have only one degree of freedom, for instance by applying a flat hinge connection. Because the direction of the current around a spud

pole is variable, a suspension means with at least two degrees of freedom is more preferably applied, such as for instance a ball joint. If desired, the fixing means of the mass can also comprise at least two degrees of freedom. In embodiments with multiple degrees of freedom it is advantageous for the spring and/or the damping means to be adapted such that they can absorb movements of the mass in multiple (lateral) directions. This can for instance take place by providing

multiple dashpots in regular distribution in peripheral direction over the internal or external casing surface of the spud pole. **[0016]** A particularly advantageous embodiment of the platform according to the invention has the feature that the position of the mass is adjustable in the longitudinal direction of the spud pole. The mass can in this way be set at optimum height in the case of a variable spud pole length. The spud pole length will indeed depend on the specific conditions at the location of operations. If desired, it is possible to provide multiple masses at different heights.

[0017] Yet another preferred embodiment relates to a platform in which the weight of the mass is adjustable. The mass can in this way be set to optimum weight in the case of a variable spud pole length. If desired, it is possible to provide multiple masses at different heights, wherein the masses can have a different weight. Varying the weight of a mass is for instance possible by connecting additional masses thereto or by filling a hollow mass to a determined level with a liquid such as water. The relevant mass is provided for this purpose with connection points for liquid conduits.

[0018] The invention also relates to a method for operating a jack-up offshore platform in a water mass with strong current, the platform comprising a work deck supported by spud poles and adjustable in height above the water surface. In the method according to the invention at least one spud pole is provided with means for reducing the lateral oscillating movements. The advantages of such a method have already been discussed above in the context of the device and will not be repeated here.

[0019] Preferred embodiments of the method according to the invention comprise methods wherein the means are received in an internal cavity of the spud pole; wherein the means comprise a mass which is connected to the spud pole by damping means which damp lateral oscillating movements of the mass; wherein the damping means comprise a dashpot; wherein the damping means comprise spring means which resist lateral oscillating movements of the mass; wherein the spring means comprise a suspension cable for the mass, and the mass is suspended from the suspension cable, the suspension cable allowing lateral movements of the mass with a spring constant; wherein the position of the mass is adjusted in the longitudinal direction of the spud pole; and wherein the weight of the mass is adjusted.

[0020] The present invention is further elucidated hereinbelow with reference to the accompanying figures but without being limited thereto. In the figures:

figure 1 is a schematic side view of a jack-up platform according to the invention;
figure 2 is a schematic top view of a spud pole provided with damping means according to the invention; and
figure 3 is a schematic cross-sectional view of a spud pole provided with a specific embodiment of the damping means according to the invention.

[0021] Referring to figure 1, a jack-up platform 1 is shown. In the shown embodiment the jack-up platform 1 substantially comprises a work deck 2 and four spud pole jacks 3 (of which only two are visible) at the corner points of work deck 2. Each jack 3 operates a spud pole 4 which can be lowered in the vertical direction 5 until the associated spud pole finds support on or in the seabed 6. Work deck 2 is provided, by way of example, with a lifting crane 7 with an arm pivotable in the direction R. For reasons of clarity a number of structures normally present on a jack-up platform are omitted from the figure. Platform 1 is anchored at the desired position on or in the seabed 6 by lowering the spud poles 4 with jacks 3 until they find support on or in seabed 6. Work deck 2 is then carried by means of jacks 3 into a position above water surface 8 in which work deck 2 is supported by spud poles 4 and is clear of the water surface 8 as shown in figure 1. Spud poles 4 here run partially underwater and another part protrudes above the water surface. Depending on the operations to be performed and the local conditions, the height of work deck 2 is set above water surface 8 by jacking up work deck 2 further relative to spud poles 4, whereby work deck 2 is raised relative to water surface 8 or by lowering the work deck, whereby work deck 2 is lowered relative to water surface 8. If desired, the spud poles are provided with insertion openings 9 for the purpose of anchoring spud poles 4 relative to jacks 3.

[0022] Water flowing along spud poles 4 of platform 1 in a flow direction 11 can cause vortices 10 on the downstream side of spud pole 4 (see figure 2). The periodic vortex formation 10 causes, among other things, oscillating forces in the lateral direction 12 of the spud pole (the direction substantially perpendicularly of flow direction 11). The lateral forces provide for an oscillating lateral movement 13 of spud poles 4, and therefore also of work deck 2 of platform 1, which is after all supported by spud poles 4.

[0023] According to the invention at least one spud pole 4 comprises means 20 for reducing the above stated lateral oscillating movements 13 of platform 1. As shown conceptually in figure 2, means 20 comprise in the shown embodiment a mass 22 received in an internal cavity 4a of spud pole 4. The internal cavity 4a generally runs over almost the whole length of spud pole 4, although this is not essential. Means 20 comprise springs 23 which are connected on either side to (the internal casing surface of) spud pole 4 and to (the external casing surface of) mass 22, and which resist lateral oscillating movements of mass 22; and dashpots 24 which resist these movements by means of viscous friction. Springs

23 and dashpots 24 are arranged mutually in parallel, whereby they undergo the same lateral displacement. The lateral movements 13 of spud pole 4 are transmitted by means of springs 23 and dashpots 24 with delay to mass 22, wherein dashpots 24 partially absorb the kinetic energy. The linear dashpots 24 comprise a cylinder 24a (see figure 3) in which a hydraulic fluid is present and in which a piston 24b is movably received. Each dashpot 24 is connected with the cylinder portion 24a to (the internal casing surface of) spud pole 4, for instance by welding, and with piston 24b to (the external casing surface of) mass 22.

[0024] In another embodiment as shown in figure 3 the means 20 comprise a mass 22 which, by means of spring means 23 in the form of suspension cables (25a, 25b), is suspended in relatively freely oscillating manner in an internal cavity 4a of the associated spud pole 4. If desired, a spacer plate 26 is arranged between cables 25a and 25b in order to shorten the pendulum arm. Suspension cables 25a, 25b allow lateral movements of mass 22 with a spring constant which depends on the pendulum arm length. Suspension cables 25a, 25b connect mass 22 to spud pole 4 by providing spud pole 4 on the upper side with a support plate 27 with an eye or ball joint 28 to which the suspension cable 25a is attached. Cable 25b is attached to mass 22 by means of an eye or ball joint 29. The freedom of oscillation of mass 22 is limited by springs 23 and in particular by dashpots 24 arranged on either side of mass 22 on the internal casing surface of the associated spud pole 4. In the shown embodiment dashpots 24 are welded with cylinder side 24b to this casing surface and connected with piston side 24b to mass 22. Because the direction of the current 11 around a spud pole 4 is variable, it is recommended to make the mass 22 swingable in different directions. Mass 22 itself has the form of a two-sided 'mushroom' and comprises two widened portions 22b connected on either side to a central stem part 22a. The portions 22b leave clear sufficient space from the internal casing surface of the spud pole so that mass 22 is movable in the hollow space 4a of spud pole 4.

[0025] The position of mass 22 in the lengthwise direction 5 of spud pole 4 is easily adjustable by varying the length of cables 25a and/or 25b by means of jacks 30 arranged on support plate 27 and/or on spacer plate 26. Mass 22 can in this way be set at optimum height in the case of a variable spud pole length, wherein it is advantageous to set the position of mass 22 as high as possible, and preferably at the height of work deck 2 as shown in figure 3.

[0026] Using the above described device it becomes possible to operate a jack-up offshore platform in a water mass with strong current. By applying the means 20 the lateral oscillating movements of platform 1 excited by the current are damped such that it is less dangerous to work under such conditions. This is particularly the case for operations at great water depths.

Claims

1. Jack-up offshore platform, comprising a work deck supported by spud poles and adjustable in height above the water surface, wherein at least one spud pole comprises means for reducing lateral oscillating movements of the platform.
2. Platform as claimed in claim 1, wherein the means are accommodated in an internal cavity of the spud pole.
3. Platform as claimed in claim 1 or 2, wherein the means comprise:
 - a mass;
 - damping means which connect the mass to the spud pole and which damp lateral oscillating movements of the mass.
4. Platform as claimed in claim 3, wherein the damping means comprise a dashpot.
5. Platform as claimed in claim 3 or 4, wherein the damping means comprise spring means which resist lateral oscillating movements of the mass.
6. Platform as claimed in claim 5, wherein the spring means comprise a suspension cable for the mass, which suspension cable allows lateral movements of the mass with a spring constant.
7. Platform as claimed in any of the foregoing claims, wherein the position of the mass is adjustable in the longitudinal direction of the spud pole.
8. Platform as claimed in any of the foregoing claims, wherein the weight of the mass is adjustable.
9. Method for operating a jack-up offshore platform in a water mass with strong current, the platform comprising a work

deck supported by spud poles and adjustable in height above the water surface, wherein at least one spud pole is provided with means for reducing the lateral oscillating movements.

5 10. Method as claimed in claim 9, wherein the means are received in an internal cavity of the spud pole.

11. Method as claimed in claim 9 or 10, wherein the means comprise a mass which is connected to the spud pole by damping means which damp lateral oscillating movements of the mass.

10 12. Method as claimed in claim 11, wherein the damping means comprise a dashpot.

13. Method as claimed in claim 11 or 12, wherein the damping means comprise spring means which resist lateral oscillating movements of the mass.

15 14. Method as claimed in claim 13, wherein the spring means comprise a suspension cable for the mass, and the mass is suspended from the suspension cable, the suspension cable allowing lateral movements of the mass with a spring constant.

20 15. Method as claimed in any of the claims 9-14, wherein the position of the mass is adjusted in the longitudinal direction of the spud pole.

25 16. Method as claimed in any of the claims 9-15, wherein the weight of the mass is adjusted.

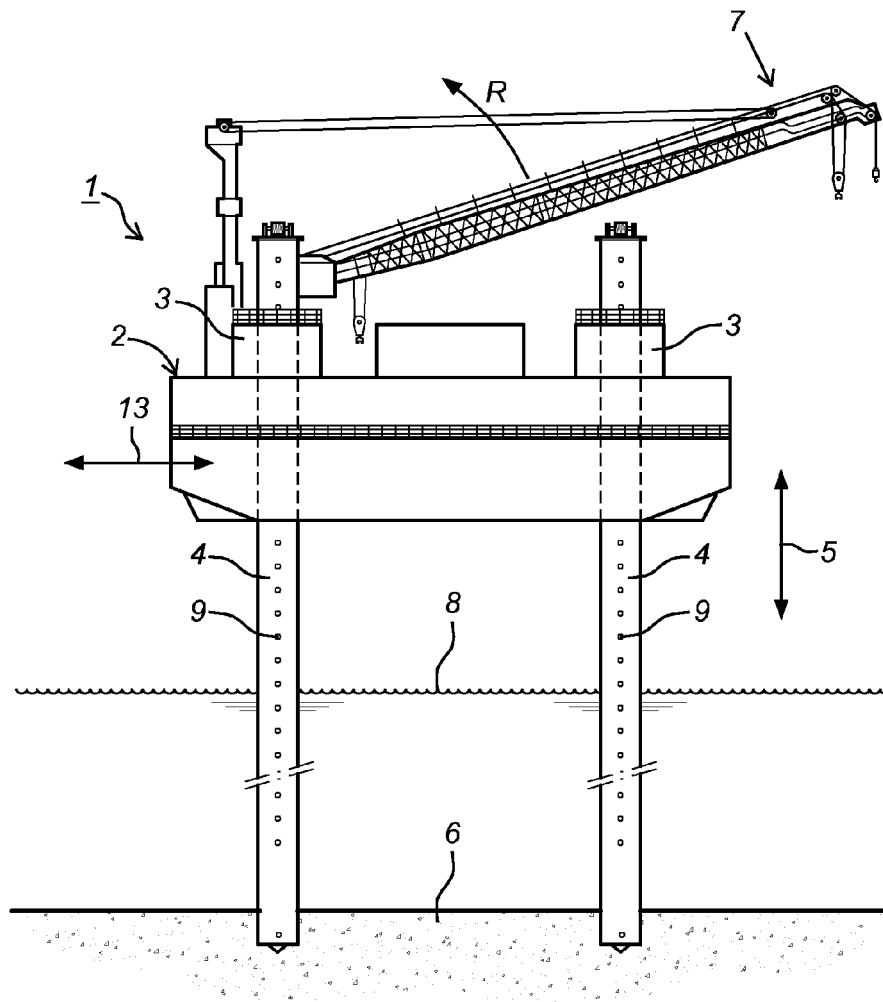
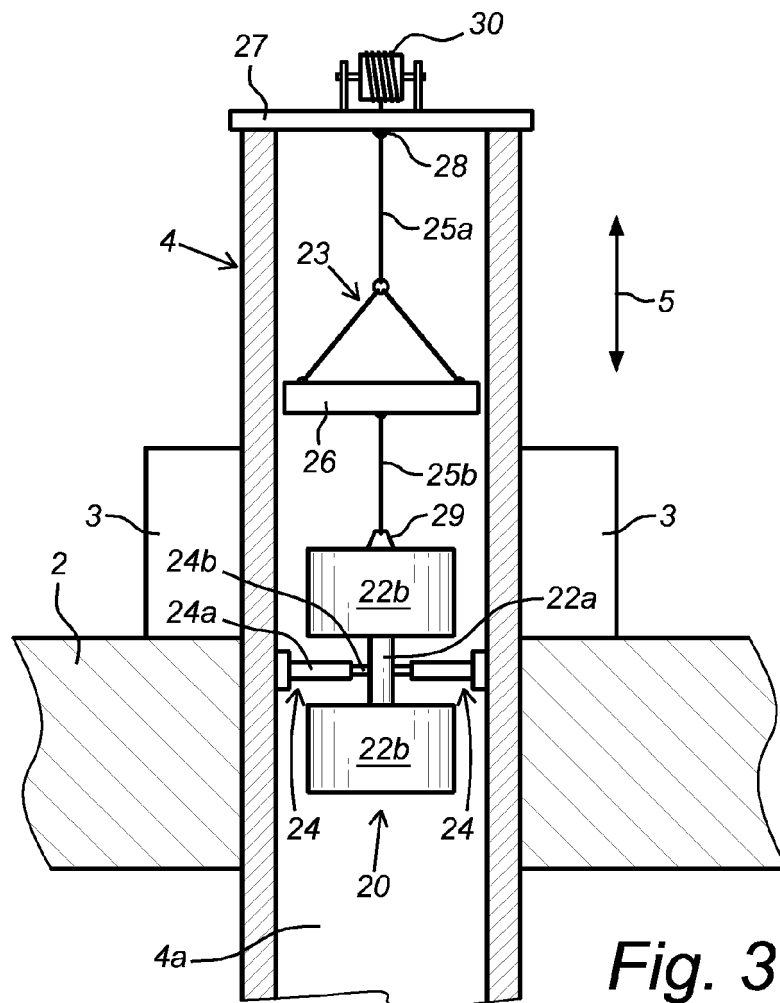
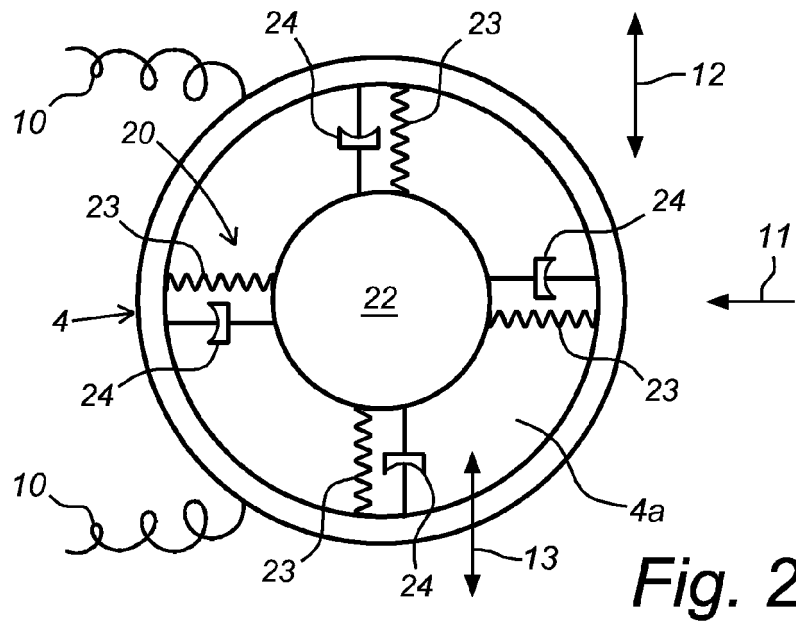


Fig. 1





EUROPEAN SEARCH REPORT

Application Number
EP 12 16 4510

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	US 4 270 877 A (POST ADRIANUS J) 2 June 1981 (1981-06-02)	1,3,4, 7-9,11, 12,15,16	INV. E02B17/00 E02B17/02
A	* column 2, line 62 - column 3, line 29; figures 1-6 * -----	2,5,6, 10,13,14	E04B1/98
X	US 4 443 000 A (HARVARD JEAN F [FR]) 17 April 1984 (1984-04-17) * column 2, line 3 - line 48; figures 1,2 * -----	1,3,5,9, 11,13	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02B E04B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 July 2012	Examiner Zuurveld, Gerben
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 4510

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-07-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4270877 A	02-06-1981	AU 4236078 A	14-06-1979
		BE 872580 A2	07-06-1979
		BR 7808044 A	07-08-1979
		DE 2849394 A1	13-06-1979
		DK 554578 A	10-06-1979
		FR 2411270 A1	06-07-1979
		GB 2009825 A	20-06-1979
		IT 1105684 B	04-11-1985
		NL 7713674 A	12-06-1979
		NL 7811219 A	12-06-1979
		US 4270877 A	02-06-1981
		ZA 7806648 A	31-10-1979
US 4443000 A	17-04-1984	DE 3169124 D1	28-03-1985
		EP 0056551 A1	28-07-1982
		FR 2497248 A1	02-07-1982
		JP 57133917 A	18-08-1982
		NO 814478 A	01-07-1982
		US 4443000 A	17-04-1984