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(54) Frictional drive for an elevator and operating method

(57) An elevator drive (9) comprising a motor (8) and a traction sheave (7) wherein the motor engages the traction sheave with a first coefficient of friction (μ1). Accordingly, as the motor (8) is frictionally coupled to the traction sheave (7), a degree of slippage or non-simultaneous rotation therebetween is facilitated.

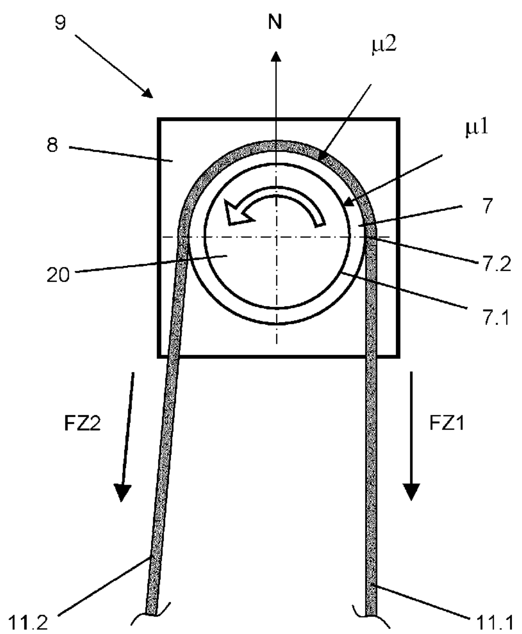

FIG. 2

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Description

[0001] In an elevator installation, an elevator car and a counterweight are conventionally supported on and interconnected by traction means. The traction means is driven through engagement with a motor-driven traction sheave to move the car and counterweight in opposing directions along the elevator hoistway. The drive unit, consisting of the motor, an associated brake and the traction sheave, is normally located in the upper end of the elevator hoistway or alternatively in a machine room directly above the hoistway.

[0002] Traditionally, steel cables have been used as traction means. More recently, synthetic cables and belt-like traction means comprising steel or aramid cords of relatively small diameter coated in a synthetic material have been developed. An important aspect of these synthetic traction means is the significant increase in the coefficient of friction they exhibit through engagement with the traction sheave as compared to the traditional steel cables. This can give rise to a situation called over-traction. Due to this increase in relative coefficient of friction, when the brake is applied in an emergency stop for an elevator employing synthetic traction means there is an significant increase in the deceleration of the car which severely degrades passenger comfort and could even result in injury to passengers.

[0003] Publications WO-A1-2011/069773, GB-A-215 3465, US 5,323,878 and US 5,244,060 all describe methods of controlling the movement of an elevator car during an emergency stop wherein the brake is applied but the degree of the brake force or torque exerted by the brake is dependent on the load of the car. These methods help reduce deceleration of the elevator car during an emergency stop.

[0004] A further important consequence of over-traction is that if the counterweight becomes stuck along the hoistway, so that the section of the traction means between the traction sheave and the counterweight becomes slack, the drive may still be capable of moving the elevator car upwards. In a second converse situation, if the car becomes jammed while being lowered down the hoistway, resulting in slackening of the section of the traction means between the car and the traction sheave, the drive may still be capable of moving the counterweight upwards. Either situation presents a severe risk of injury to any passengers in the car because when the elevator controller eventually directs the drive unit to stop, the elevator car will drop back down the hoistway in the first situation whereas the counterweight will fall back and subsequently jerk the car upwards in the second situation.

[0005] US-A1-2008/0185232 describes an apparatus and method for solving the problems associated with the first situation described above. The drive unit has a motor unit and a deflecting unit. If the counterweight which is supported by the deflecting unit rests on a pit buffer for example, the deflecting unit is unloaded and is raised by means of a spring element of the monitoring device. A sensor of the monitoring device detects the movement of the deflecting unit and switches off the motor of the motor unit via a safety circuit.

[0006] The problems associated with second situation outlined above have conventionally been solved by monitoring the tension in the traction means on the car-side of the traction sheave with a slack rope contact such as described in US-A1-2007/0170009. Because of its complexity, the slack rope contact solution is expensive, time-consuming to install and must be individually tailored to the existing car or car frame during modernization of an existing installation. EP-A1-2292546 describes an alternative method wherein the load of the car is monitored along its downward travel path and it is determined that the car has jammed if the monitored load of the car deviates outside a predetermined range. Accordingly, the elevator controller can automatically instruct the drive unit to commence an emergency stop such that the car can be stopped immediately and thereby minimise the risk of injury to passengers or damage to the car.

[0007] EP-A2-1764335 proposes another solution to over-traction wherein the running surface of the traction sheave, over which the traction means runs, is provided with a friction-reducing coating or subjected to a friction-reducing surface treatment.

[0008] An objective of the present invention is to provide an elevator drive that reduces the effects and stated disadvantages of over-traction. A further objective is to provide an elevator installation and an operating method in which the elevator car cannot be raised further by the traction means if the counterweight becomes jammed along its travel path particularly when it strikes an associated buffer.

[0009] Accordingly, the invention provides an elevator drive comprising a motor and a traction sheave wherein the motor engages the traction sheave with a first coefficient of friction. In a conventional drive where the traction sheave is positively driven by the motor, either directly or through a gear, the result is always simultaneous rotation of traction sheave with the motor. In contrast, in the present invention as defined by the claims the motor is frictionally coupled to the traction sheave and thereby facilitates a degree of slippage or non-simultaneous rotation therebetween.

[0010] Preferably, the motor includes a motor shaft and the traction sheave engages with the motor shaft. Accordingly, the region in which the shaft engages with the traction sheave is external to the motor housing and is therefore easy to inspect and maintain.

[0011] To reduce the overall axial length of the drive, the traction sheave can partially surround the motor shaft.

[0012] Alternatively, the traction sheave can be arranged to engage with an axial end of the motor shaft. In this arrangement, one of the traction sheave and the motor shaft preferably includes a frictional plate mounted for concurrent rotation therewith but axially displaceable therealong. Axial displacement of the frictional plate allows it to be easily replaced during maintenance.

[0013] Preferably, a spring is provided to axially bias the frictional plate. Accordingly, the spring biases the frictional plate with a normal force axially towards and into engagement with the other of the traction sheave and the motor shaft.

[0014] Furthermore, the spring can be axially adjustable. In one example, the spring is retained on one of the traction sheave and the motor shaft by a collar and the collar is adjustable axially therealong. Hence, the force exerted by the spring on the friction plate can be easily adjusted.

[0015] Preferably, the other of the traction sheave and the motor shaft includes a second frictional plate mounted for concurrent rotation therewith.

[0016] The invention also provides an elevator installation comprising a drive as described above together with a car, a counterweight and traction means interconnecting the car and counterweight wherein the traction means engages the traction sheave of the drive with a second coefficient of friction.

[0017] Preferably, the first coefficient of friction is less than the second coefficient of friction. Accordingly, even if the motor begins to slip with respect to the traction sheave, the traction sheave will still retain the traction means.

[0018] To ensure there is no over-traction, the first coefficient of friction can be selected such that if the car or counterweight becomes jammed during downward movement, the traction sheave will not rotate even if the motor continues to rotate. This ensures that there is no over-traction.

[0019] The invention also provides a method of operating an elevator installation having a car, a counterweight, traction means interconnecting the car and the counterweight, a motor and a traction sheave engaging the traction means, the method comprises the step of frictionally driving the traction sheave with the motor and thereby facilitates a degree of slippage or non-simultaneous rotation therebetween

[0020] Preferably, the method further comprises the step of permitting the motor to rotate with respect to the traction sheave when one of the car and the counterweight becomes jammed during downward movement. This reduces the effects of over-traction.

[0021] The invention is herein described by way of specific examples with reference to the accompanying drawings of which:

FIG. 1 is a schematic of an elevator installation;
FIG. 2 is a transverse view of an elevator drive for use in the elevator installation of FIG. 1;
FIG. 3 is a longitudinal view of an alternative elevator drive for use in the elevator installation of FIG. 1; and
FIG. 4 is an exploded view of the frictional coupling from the drive of FIG. 3.

[0022] An elevator installation 1 according to the invention is shown in FIG. 1. The installation 1 is generally defined by a hoistway 3 bound by walls 2 within a building wherein a counterweight 5 and car 4 are movable in opposing directions along guide rails (not shown). Buffers 12, 13 are mounted in a pit of the hoistway 3 underneath the counterweight 5 and car 4, respectively. Suitable traction means 11 supports and interconnects the counterweight 5 and the car 4. The traction means 11 is fastened at either end to termination devices 40 mounted in the upper region of the hoistway 3. The traction means 11 extends from one termination device 40 to a deflection pulley 6 mounted on top of the counterweight 5, over a traction sheave 7, under the car 4 via deflection pulleys 6 and is fastened at the other end in the other termination device 40. Naturally, the skilled person will easily appreciate other elevator roping arrangements are equally possible.

[0023] The traction sheave 7 is driven by a motor 8 which together form the drive 9 of the elevator 1. As shown specifically in FIG. 2, the traction sheave 7 is implemented as a hollow cylinder having a radially outer surface 7.2 and a radially inner surface 7.1. The inner surface 7.1 frictionally engages a shaft 20 of the motor 8, the engagement interface having a first coefficient of friction $\mu 1$. Similarly, the outer surface 7.2 of the of the sheave 7 engages with the traction means 11 with a second coefficient of friction $\mu 2$ for driving the interconnected car 4 and counterweight 5 along guide rails in the hoistway 3.

[0024] As shown in FIG. 2, a first portion 11.1 of the tension means 11 spanning the traction sheave 7 and the deflection pulleys 6 mounted under the elevator car 4 is under a first tension FZ1. Likewise on the other side of the sheave 7, the portion 11.2 of the traction means 11 spanning between the sheave 7 and the deflection pulley 6 mounted on the counterweight 5 experiences a second tension FZ2.

[0025] During normal operation of the elevator installation 1 when the traction sheave 7 is supporting, amongst other things, the load of the counterweight 5 and the load of the car 4, the normal force N exerted by the traction sheave 7 on the motor shaft 20 is sufficient to ensure adequate frictional engagement therebetween and subsequently, rotation of the motor shaft 20 will induce corresponding rotation of the traction sheave 7 to drive the interconnected car 4 and counterweight 5 via the tension member 11.

[0026] If, on the other hand, the counterweight 5 strikes its buffer 12 in the pit of the hoistway 2, a substantial portion of the tension FZ2 in the counterweight span 11.2 of the traction means 11 is relieved since the weight of the counterweight 5 is now supported directly by the buffer 12 rather than by the traction means 11. In these circumstances, the normal force N exerted by the sheave 7 on the motor shaft 20 is greatly reduced. The first coefficient of friction $\mu 1$ between the motor shaft 20 and the sheave 7 is selected so that under this reduced normal force N there is no longer sufficient frictional engagement therebetween. Accordingly, although the motor shaft 20 continues to rotate, it will not induce rotation into the traction sheave 7.

[0027] FIG. 3 illustrates an alternative embodiment of a drive 9 according to the invention. The drive 9 comprises a motor 8 positioned centrally between two end plates 15 and connected thereto by a series of frame elements 14. Such a drive arrangement has previously been described in WO-A1-2009/060037. A first frictional coupling plate 31 is mounted at each of the opposing ends of the motor shaft 20.

[0028] The drive 9 also includes two discrete traction sheaves 7. Each of the traction sheaves 7 is rotatably mounted and supported at one end in the end plate 15 and a second frictional coupling plate 32 is provided at the opposing end of the traction sheave 7 for engagement with the neighbouring first frictional coupling plate 31 mounted to the motor shaft 20. Each pair of engaging frictional coupling plates 31,32 forms a frictional coupler 30 which will be described in greater detail with reference to FIG. 4. Each of the traction sheaves 7 supports two discrete traction means 11 and as in the previous embodiment, each traction sheave 17 engages with the traction means 11 with a second coefficient of friction $\mu 2$ for driving the interconnected car 4 and counterweight 5 along guide rails in the hoistway 3. An intermediate bearing 16 is securely mounted to the frame elements 14 to support each traction sheave 7 at a position between the second frictional coupling plate 32 and neighbouring traction means 11.

[0029] FIG. 4 further illustrates the frictional coupler 30 positioned to the left of the motor 8 as shown in FIG. 3. The second frictional plate 32 is securely fastened to the end of the traction sheave 7. In contrast, the first frictional plate 31 comprises a cavity 33 into which the end of the motor shaft 20 is inserted. Splines 34 provided around the wall of the cavity 33 mate with corresponding splines 34 on the motor shaft 20 thereby ensuring concurrent rotation of the first frictional plate 31 with the motor shaft 20. A spring 35 is positioned between the first frictional plate 31 and an adjustment collar 21 mounted on the motor shaft 20. The spring 35 biases the first frictional plate 31 with a normal force N axially into engagement with second frictional plate 32. This engagement exhibits a first coefficient of friction $\mu 1$. The collar is adjustable axially along the motor shaft 20 and thereby the magnitude of the normal force N can be varied.

[0030] It will be appreciated that the above situation can be reversed by providing the spring 35, adjustment collar 21 and splines 34 on the traction sheave 7 to axially bias the second frictional plate into engagement with the first friction plate securely mounted to the end of the motor shaft 20.

[0031] As in the previous embodiment, during normal operation of the elevator installation 1 when the traction sheaves 7 are supporting, amongst other things, the load of the counterweight 5 and the load of the car 4, the normal force N exerted by the spring 35 is sufficient to ensure adequate frictional engagement between the first and second frictional plates 31,32. Subsequently, rotation of the motor shaft 20 will induce corresponding rotation of the traction sheaves 7 to drive the interconnected car 4 and counterweight 5 via the tension members 11.

[0032] If, on the other hand, the counterweight 5 strikes its buffer 12 in the pit of the hoistway 2, a substantial portion of the tension in the counterweight span of the traction means 11 is relieved since the weight of the counterweight 5 is now supported directly by the buffer 12 rather than by the traction means 11. The first coefficient of friction $\mu 1$ is selected and the normal force N exerted by the spring 35 can be adjusted to ensure that, in these circumstances, the normal force N exerted by the spring 35 is insufficient to deliver the greater torque required through the frictional coupler 30 to drive the now unbalanced car 4. Accordingly, although the motor shaft 20 continues to rotate, it will not induce rotation into the traction sheave 7.

[0033] Although both embodiments have been described as overcoming the problems associated with over-traction when the counterweight becomes stuck while moving downwards in the hoistway, and specifically when it strikes its buffer, it will be apparent to those skilled in the art that the invention can be easily adopted to alleviate the previously described problems associated with over-traction during emergency stops and the over-traction that can occur if the car becomes jammed while being lowered down the hoistway.

[0034] Although the present invention is has been developed, in particular, for use in conjunction with synthetic traction means, it can equally be applied to any elevator to reduce problems associated with over-traction and thereby improve passenger comfort.

Claims

1. An elevator drive (9) comprising a motor (8) and a traction sheave (7) wherein the motor engages the traction sheave with a first coefficient of friction ($\mu 1$).

2. An elevator drive (9) according to claim 1 wherein the motor includes a motor shaft (20) and the traction sheave engages with the motor shaft.

3. An elevator drive (9) according to claim 2 wherein the traction sheave partially surrounds the motor shaft.

4. An elevator drive (9) according to claim 2 wherein the traction sheave engages with an axial end of the motor shaft.

5. An elevator drive (9) according to claim 4 wherein one of the traction sheave and the motor shaft includes a frictional plate (31) mounted for concurrent rotation therewith but axially displaceable.

6. An elevator drive (9) according to claim 5 further comprising a spring (35) to axially bias the frictional plate (31).

7. An elevator drive (9) according to claim 6 wherein the spring is axially adjustable.

8. An elevator drive (9) according to any of claims 5 to 7 wherein the other of the traction sheave and the motor shaft includes a second frictional plate (33) mounted for concurrent rotation therewith.

9. An elevator installation (1) comprising a drive (9) according to any preceding claim and further comprising a car (4), a counterweight (5) and traction means (11) interconnecting the car and counterweight wherein the traction means engages the traction sheave of the drive with a second coefficient of friction ($\mu 2$).

10. An elevator installation (1) according to claim 9 wherein the first coefficient of friction ($\mu 1$) is less than the second coefficient of friction ($\mu 2$).

11. An elevator installation (1) according to claim 9 or claim 10 wherein the first coefficient of friction ($\mu 1$) is selected such that if the car or counterweight becomes jammed during downward movement, the traction sheave will not rotate even if the motor rotates.

12. A method of operating an elevator installation (1) having a car (4), a counterweight (5), traction means (11) interconnecting the car and the counterweight, a motor (8) and a traction sheave (7) engaging the traction means, comprising the step of frictionally driving the traction sheave with the motor.

13. A method according to claim 11 further comprising the step of permitting the motor to rotate with respect to the traction sheave when one of the car and the counterweight becomes jammed during downward movement.

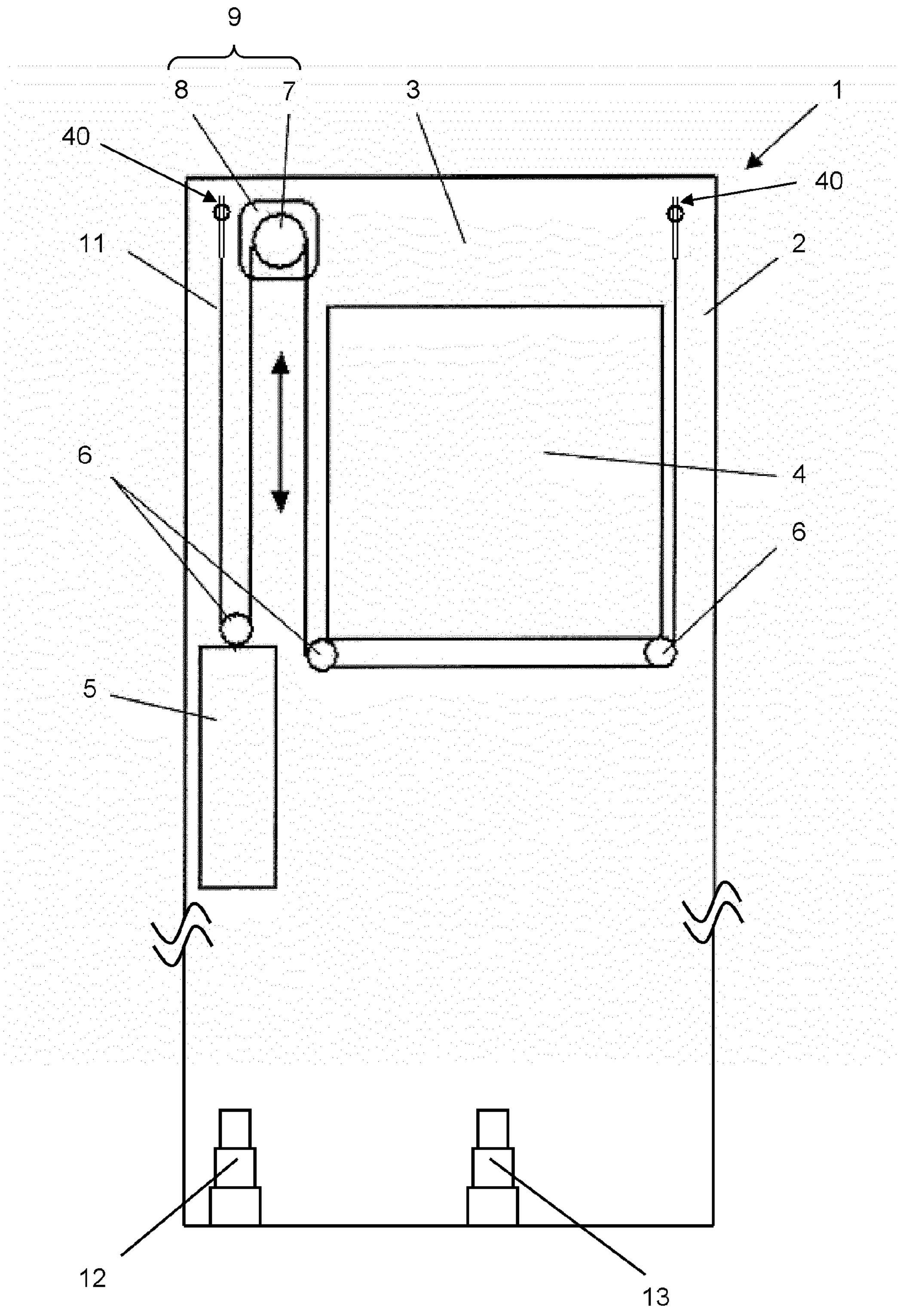

FIG. 1

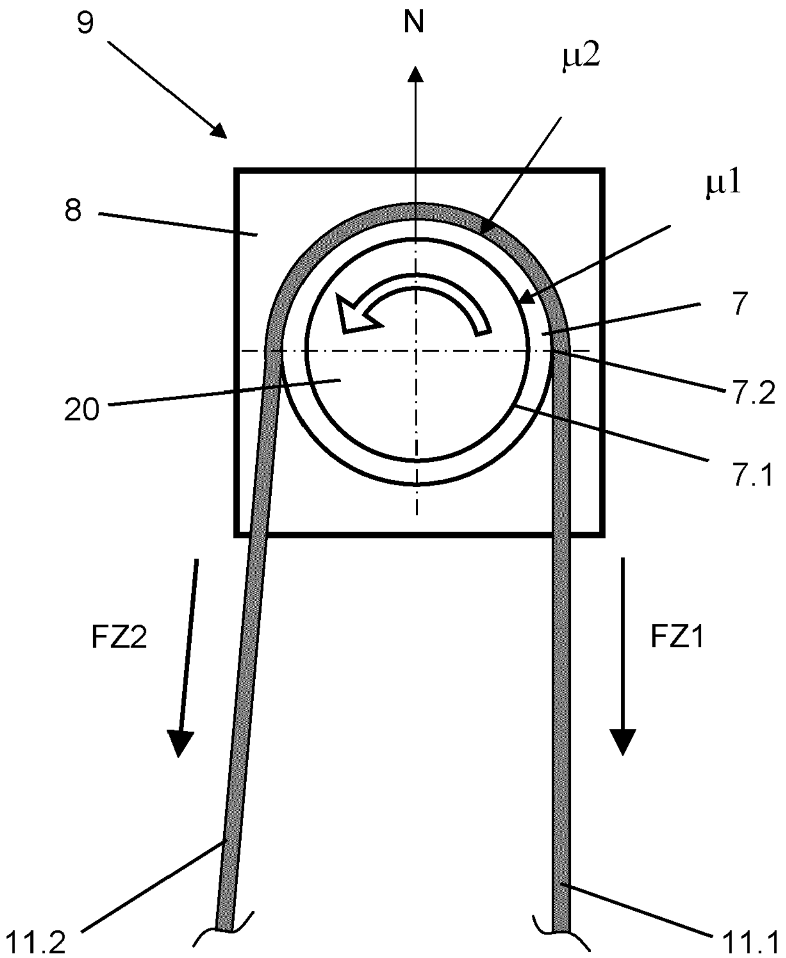

FIG. 2

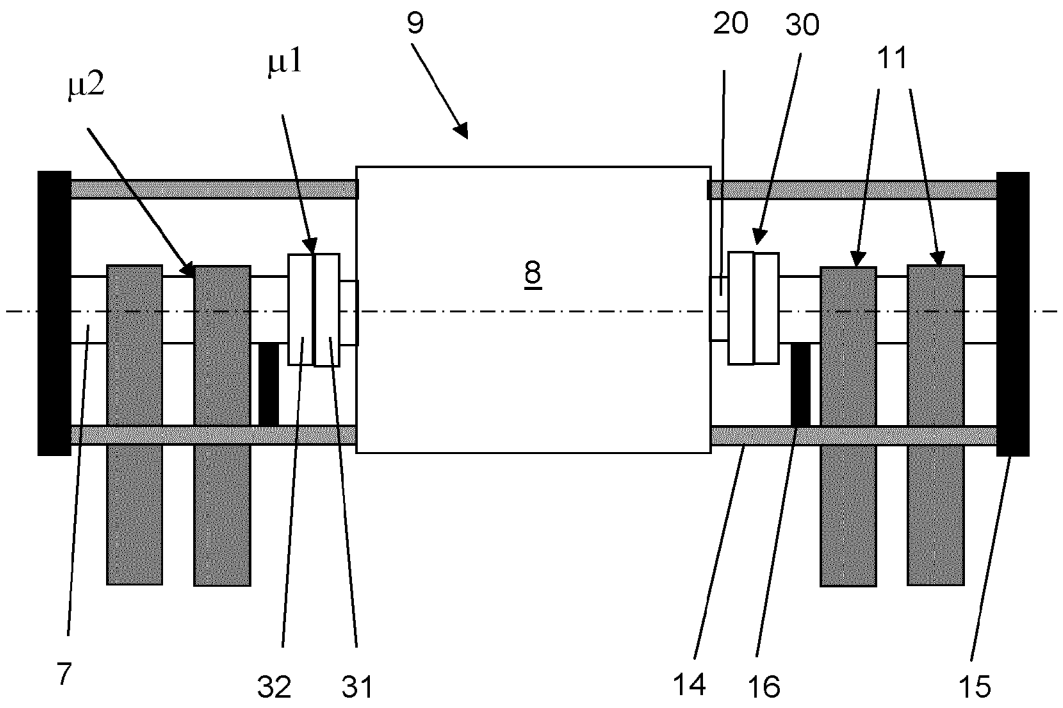

FIG. 3

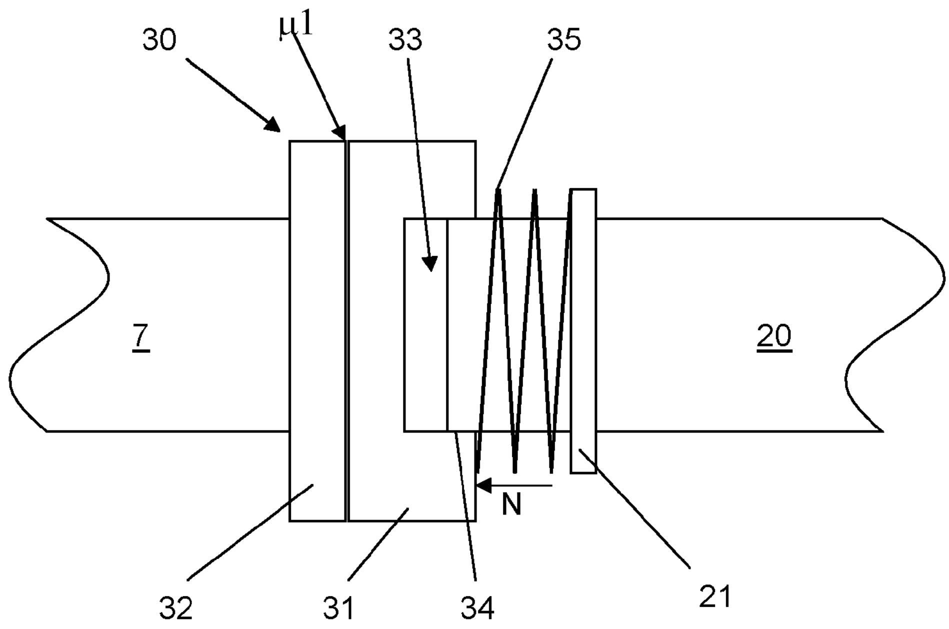

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 11 18 3573

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 February 2012	Bleys, Philip

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CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 18 3573

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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