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(54) **Elevator rope terminal**

(57) The invention refers to an elevator Elevator rope terminal (32) for an elevator rope (20) comprising a rope fitting (23, 24, 26, 28, 30) for the fixing of the rope end to an elevator component (10), which rope fitting comprises a spring means (30) for elastically fixing the rope end (22) to the elevator component, the rope terminal further comprises a deflection element (34) for deflecting the rope from a first direction before being received by the rope terminal to a second direction in which the rope end is fixed to the elevator component, which deflection element has a circumferential area (ca1, da, ca2) for receiving the rope and is pivotably supported via a pivot axis (16) at the elevator component, characterized in that the circumferential area has
- a first curved contact area (ca1) for receiving the rope, which first contact area is defined by all contact points of the rope with the contact area within the maximum stroke of the spring means,
- a second curved contact area (ca2) for the rope portion connected to the rope fitting, which second contact area is defined by all contact points of the rope with the contact area within the maximum stroke of the spring means,
- a curved deflection area (da) between the first and second curved contact areas, whereby the third radius (r3) of the curvature of the curved deflection area (da) is smaller than the first and second radius (r1, r2) of the curvature of the first and second curved contact areas (ca1, ca2). With the invention a rope terminal with a low height is provided which does not affect the rope lifetime.

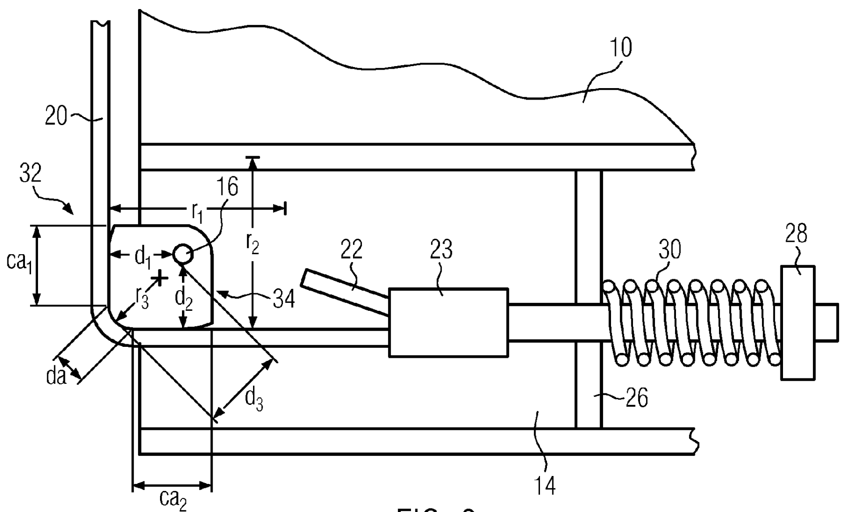

FIG. 2

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Description

[0001] The present invention refers to an elevator rope terminal which is used to fix a rope end of e.g. a hoisting rope, suspension rope or compensation rope of an elevator to an elevator component or to the elevator shaft or machine room or to a mounting structure fixed in these parts of the building.

[0002] Particularly when the ropes are to be fixed to an elevator car or a counterweight the rope terminals sometimes have a deflection element which is usually formed as a diverting pulley around which the elevator rope runs roughly along an angle of 90 degrees so that the elevator rope is deflected from the vertical course in the elevator shaft to a horizontal direction, e. g. under the bottom of the elevator car. By this arrangement the vertical height of the elevator rope fitting is reduced. It is obligatory for an elevator rope terminal that the rope end is flexibly supported by a spring means so that in high load situations of the rope, e. g. in case of an emergency stop of the elevator car, the tension peaks are lowered by the elastic support based on the stroke of the spring means. The function of the spring means is to equalize rope force differences during the operation of the elevator and, in particular, indicate the existence of the differences to a service man, so that he can make balancing adjustments. Accordingly, during normal operation of the elevator there is a certain change in the load impact on the rope, e.g. during acceleration and deceleration of the elevator car or when the elevator car starts or stops or when the load of the elevator car changes.

[0003] Usually the deflection element is a roller supported on a pivot axis at the elevator component. As the elevator rope runs dynamically on said pivoted roller within the maximum stroke of the spring means there is a certain wear of the elevator rope running over said roller with every movement of the rope caused by any deflection of the spring means during the operation of the elevator. Accordingly, in a certain contact area wherein the rope meets the circumferential groove of the roller according to the stroke of the spring means the elevator rope is either straightened or is bent on the pulley. This means that there is a dynamical straightening and bending of the ropes in these areas so that the rope undergoes an increased wear. This wear is further increased when a roller with a small diameter is used as a deflection element. For dynamical use European regulations demand a ratio of the rope diameter to the roller diameter of smaller than 1:40. Thus, in the prior art rope terminal there is a certain conflict between a low vertical height of the rope terminal and a long lifetime of the rope.

[0004] Accordingly, it is object of the invention to provide an elevator rope terminal which has a small vertical height and also provides less wear of the elevator rope than in currently known solutions.

[0005] The object of the invention is solved with an elevator rope terminal according to claim 1. Preferred embodiments of the invention are subject matter of the dependent claims.

[0006] According to the invention the elevator rope terminal comprises a rope fitting for fixing the rope end to an elevator component. The elevator component may be an elevator car, a counterweight or any structure in the elevator shaft or the machine room. The rope fitting comprises a spring means for elastically fixing the rope end to the elevator component. Furthermore, the rope terminal comprises a deflection element for deflecting the rope from a first - usually vertical - direction, into a second - usually horizontal - direction in which the rope end is fixed to the elevator component. The deflection element has a circumferential area for receiving the rope, e. g. a rope groove and is pivotably supported via a pivot axis at the elevator component. The pivot axis can be located directly at the elevator component or via a structure which is part of the elevator rope terminal.

[0007] In this connection it has to be mentioned that an elevator rope usually comprises a set with a plurality of separate ropes. Thus, a rope terminal usually supports the ends of a plurality of ropes, although it may only support one rope, e.g. in small load elevators.

[0008] According to the invention the circumferential area has a first curved contact area for the rope coming from the shaft which first contact area defines all possible contact points of the rope with the circumferential area within the maximum stroke of the spring means during any kind of operation of the elevator.

[0009] Furthermore, the circumferential area has a second curved contact area for the rope connected to the rope fitting, which second curved contact area defines all possible contact points of the rope with the circumferential area within the maximum stroke of the spring means during any kind of operation of the elevator.

[0010] Finally, the circumferential area has a curved deflection area, which is located between the first and the second curved contact areas. In this deflection area the essential part of the deflection of the rope takes place. If the desired deflection angle of the rope is e.g. 90 degrees, the bending angle of the deflection area should be at least 70 degrees, preferably more than 80 degrees. The aim is to minimize the rope deflection in the contact areas so that also the bending of the rope in the contact areas can be minimized.

[0011] Preferably, in the curved deflection area more than 90 % of the deflection of the rope - usually from the vertical to the horizontal direction - takes place. The advantage of this solution is that the upper most part of the rope deflection has been shifted to the deflection area in which the bending of the rope is static, i.e. essentially without wear. By this means in the contact areas where the bending and straightening of the rope, i.e. the dynamical stress of the rope takes place according to the stroke of the spring means the rope is bent only to a very small degree.

[0012] The curved deflection area is preferably abuts to the first and second curved contact areas. However, solutions are possible, wherein a distance may remain between the curved contact areas and the curved deflection area.

[0013] When the invention speaks of the radius of the curvature of an area it is assumed that the area has only one radius. If the radius should change over the length of an area (in running direction of the rope) the arithmetic mean value of the radius of said area is taken as radius instead.

[0014] According to the invention the radius of the curvature of the deflection area is smaller than the radius of the curvatures in the first and second contact areas. This has the effect that based on the larger radius of the curvature in the contact areas only minor bending of the ropes takes place there. Instead, the rope bending is shifted to the deflection area where the rope is bent with an essentially smaller radius than in the contact areas. The bending of the rope with a small radius is not harmful for the ropes because the rope is arranged statically in the deflection area.

[0015] Further by the different radius of the contact areas and the deflection areas a kind of rectangular profile of the deflection element is achieve which prevents the rotation of the deflection element as far as not caused by the change of the status of the spring means. This leads to the fact that the deflection area always remains the area where the rope remains static in the rope grooves in the circumference of the deflection element. This is in contrast to known rollers which may rotate further, particularly if the rope has a certain texture which initiates a movement of the roller in one direction.

[0016] Preferably, the radius of the curvature in the first and second contact areas is at least 40 times the rope diameter, preferably larger. This supports a long lifetime of the rope.

[0017] Preferably, the radius of the curvature in the deflection area is less than 40 times the rope diameter, preferably less than 30 times, most preferably less than 20 times, even less than ten times the rope diameter. As the rope is statically arranged on the deflection area the resulting small bending radius does not affect rope lifetime.

[0018] Preferably at least a middle portion of said first curved area has a first distance to the pivot axis, at least a middle portion of said second curved area has a second distance to the pivot axis, and at least a middle portion of the deflection area has a third distance to the pivot axis, whereby the third distance is larger than the second distance. This leads to a kind of rectangular layout of the deflection element which further reduces the vertical height of the deflection element compared to a known roller. By this measure the vertical height of the rope terminal can be reduced.

[0019] In this context the middle portion preferably designates the exact middle of an area (in running direction of the rope). If this exact middle should deviate from the general curvature of an area also a limited area around the exact middle of e.g. 10 mm can be used as middle portion.

[0020] Preferably, the first radius and/or the second radius is/are larger than the respective first and/or second distance. Accordingly, the vertical height requirement which is based on the second distance can be kept essentially smaller although the bending radius of the rope is kept large, which attributes to a long rope lifetime.

[0021] Preferably the second distance is smaller than 40 times the rope diameter, preferably less than 30 times, most preferably less than 20 times, even less than ten times the rope diameter. Therefore the vertical height of the deflection element is clearly less than that of a known roller.

[0022] Advantageously, the first and/or second radius is between 1,5 to 2,5 times as large as the corresponding first and/or second distance. By this means the vertical height of the deflection element is kept small whereas the bending radius of the rope in the contact areas is kept large.

[0023] By advantageously keeping the third radius between 0,3 to 0,7 times as large as the third distance the required high deflection of the rope in the deflection area is obtained in a comparably small area.

[0024] By the fact, that the second distance can be made essentially smaller than the radius of a known diverting roller according to European regulations the vertical height requirement for the inventive rope terminal is clearly reduced compared to known solutions. The second distance may be only 0.4 to 0.8, preferably 0.5 to 0.7 times as large as a required roller radius (which is according to EN 81-1 about 40 times the rope diameter). As only the second distance is essential for the vertical height of the deflection element an essential reduction of the vertical height of the deflection element and accordingly a corresponding reduction of the vertical height of the complete rope terminal is achieved without affecting the rope wear.

[0025] In the deflection area which has a larger distance to the pivot axis but a shorter bending radius than the contact areas the essential bending of the elevator rope takes place. The bending radius in this area can be kept much smaller than the obligatory 40:1 ratio with respect to the rope diameter as in this area the rope remains in contact with the diverting pulley independent of the stroke of the spring means. Therefore there is no dynamic bending stress for the rope in this area. The EN81-1 1998 and corresponding codes allow a smaller D/d ratio than 40 if it can be proved with a risk assessment that the chosen rope construction provides sufficient life time. This is realized by the invention. The first and second radius r1 and r2 can correspond to D/d ratios 40 or larger or smaller, but the curvature of the third radius in the deflection area which somewhat forms a corner can be tighter in order to achieve space saving benefits. Thus, the deflection area has a small third radius which is preferably essentially smaller than the third distance of the middle of the deflection area to the pivot axis. Preferably, the third radius is 0.3 to 0.8 times as large as the third distance.

[0026] On the contrary in the first and second curved areas the bending radius at least in the middle of said areas is essentially larger than the corresponding distance to the pivot axis. Preferably, the radius of the first and second curved contact areas is in between 1.5 to 2.5 as large as the corresponding first and second distances. Again from this embodiment it is clear that in the first and second contact areas only a very small bending of the ropes occur according to the stroke of the spring means whereas the essential part of the deflection takes part in the deflection area.

[0027] Preferably, the first and second radiuses are identical. Furthermore, preferably the first and second distances are identical. Via these measures the rope stress in both contact areas can be kept on the same level and the manufacture of the deflection element is facilitated.

[0028] Preferably, the pivot axis is located near the edge or border area of the deflection element which is located remote from the second curved deflection area. Whereas in a roller the pivot axis is in the center of the roller the above measure leads to a shifting of the pivot axis to the edge or border area of the deflection element which is remote from the second curved area. Compared to a roller, the necessary vertical height of the deflection element is more or less reduced from the diameter to the radius of the deflection element, i.e a reduction by factor 2. Therefore, according to this embodiment not only the fact that the circumferential area is divided into differently shaped contact and a deflection areas but also the fact that the pivot axis is shifted to the edge of the deflection element clearly reduces the vertical height of the elevator rope terminal without affecting the lifetime of the rope.

[0029] Preferably, the pivot axis is located in the last quarter or third of the vertical extension of the deflection element which is remote from the second contact area. Via this arrangement of the pivot axis the vertical extension of the deflection element only slightly exceeds the second distance d2 of the pivot axis to the second contact area. This reduces the vertical extension of the deflection element and on the other hand ensures that the pivot axis is positioned in a part of the deflection element which maintains a proper function of the deflection element although the pivot axis is no longer located in the center thereof.

[0030] The elevator rope terminal may have the rope fitting and deflection element directly mounted to the elevator component. Preferably, the rope fitting as well as the pivot axis for the deflection element is mounted to a frame of the elevator rope terminal. This frame preferably has a support part of the rope fitting and forms a part of the rope fitting itself. The advantage of a frame comprising all the necessary elements of the elevator rope terminal is that all elements of the rope terminal can simply be mounted to the elevator component by simply fixing the frame of the elevator rope terminal to the elevator component, for example via bolts and/or form fittings.

[0031] Preferably the support part is a plate having a perforation which is preferably mounted to the frame. The rope fitting then preferably includes a threaded bolt connected to the rope end. The bolt penetrates the perforation of the plate and the part of the bolt extending through the plate carries a nut and a compression spring which is fitted between the plate and the nut. This arrangement forms the spring means of the invention. By adjusting the nut on the thread of the bolt the compression force of the compression spring can be adjusted according to the actual need. Preferably the nut is secured by a counter nut. Such kind of rope fitting is per se known and reliable whereby the production costs are comparably low.

[0032] Preferably, the perimeter of the first and second curved areas should preferably be equal to maximum rope travel (between rope in rest and the spring fully compressed). Via this measure it is ensured that the curved areas cover all meeting points of the rope with the circumferential area of the deflection element having a radius large enough to reduce rope wear.

[0033] The invention also refers to an elevator component and/or an elevator having an elevator rope terminal according to the above description.

[0034] In this context is may be emphasized that all the above mentioned embodiments of the invention may be combined with each other as long as no conflicts are caused by such combination.

[0035] The invention is now described by example via the enclosed schematic drawing. Therein

Figure 1 shows an elevator rope terminal according to prior art, and

Figure 2 shows an inventive elevator rope terminal in side view.

[0036] Figure 1 shows in side view a part of an elevator car 10 as an example of an elevator component with a rope terminal 12 mounted to the bottom of the car. The rope terminal 12 comprises a frame 14 with a pivot axis 16 carrying a deflection roller 18 as deflection element. The deflection roller 18 has a circumferential groove around which the elevator rope 20 passes from its vertical course in the elevator shaft to a horizontal direction at the rope end. The rope end is fixed via a rope fitting 22 to a threaded bolt 24. The bolt protrudes a perforation in a perforated support plate 26 which is preferably part of the frame of the elevator rope terminal but may also be mounted to the elevator component, e.g. the car 10. The part of the threaded bolt 24 extending through the perforation carries a nut 28. Between the perforated plate 26 and the nut 28 a compression spring 30 is fitted around the bolt 24 which fixes the rope end elastically to the elevator car 10. The deflection roller 18 has a radius r of a prescribed minimum size to reduce rope wear. The circumferential area of the deflection roller comprises rope grooves and can be divided in three areas.

[0037] A first upper contact area ca1 is defined by the points where the elevator rope from the shaft meets the rope grooves according to the stroke of the compression spring. A second lower contact area ca2 is defined by the points where the elevator rope connected to the rope fitting 22 meets the rope grooves according to the stroke of the compression spring. The maximal stroke of the compression spring is defined between the two extreme positions totally compressed and totally unloaded. In operation any position between those extreme positions are possible which correspond to contact points of the rope in the first and second contact area. Between these two contact areas a deflection area is provided. As the deflection element is a roller the radius of the rope grooves is the same in all areas which means that either a large radius leads to a long service life of the rope but leads to large vertical height of the rope terminal or the radius is small which reduces the vertical height of the rope terminal but reduces the lifetime of the rope.

[0038] In this connection it is essential that in the prior art rope terminal having a roller as deflection element the contact areas and the deflection area have not been experienced as separate areas. The appreciation of these areas as separate areas is already part of the invention.

[0039] Figure 2 shows the inventive rope terminal in the same view as figure 1 whereby identical parts or functionally identical parts are indicated with the same reference numerals.

[0040] In contrast to the elevator rope terminal of figure 1 the deflection element 32 of figure 2 is not a roller as in figure 1 but a kind of rectangular plate which is pivoted around the pivot axis 16 supported at the frame 14 of the inventive elevator rope terminal 32. The deflection element 34 has a first curved contact area ca1 which is defined by the contact points where the rope 20 coming from the shaft runs onto the circumference, particularly a rope groove in the circumference of the deflection element 34 according to the possible stroke of the compression spring 30, a second curved contact area ca2 which is defined by the points of contact of the rope 20 coming from the rope fitting 22 onto the rope groove at the circumference of the deflection element 34. Between and in abutment to both contact areas ca1 and ca2 is the deflection area da.

[0041] The essential difference of this deflection element 34 to the deflection roller 18 of figure 1 is that in the contact areas only very little bending of the rope occurs as the radius of curvature in the contact areas ca1 and ca2 is larger than the radius of the curvature in the deflection area da. On the other hand, the essential deflection of the ropes happens in the deflection area between both contact areas. In this area the rope does not leave the deflection element so that the contact of the rope on the deflection element in this area is continuous. Accordingly, the load on the rope is static and not a dynamic as in the contact areas where the rope enters or leaves the circumferential area according to the actual compression status of the spring means.

[0042] The - in running direction of the rope - middle of the first contact area ca1 has a first distance d1 to the pivot axis 16. The middle of the second curved contact area ca2 has a second distance d2 to the pivot axis, whereas the middle of the deflection area da has a third distance d3 to the pivot axis. The third distance d3 of the middle of the deflection area to the pivot axis 16 is larger than the second distance d2 of the second curved contact area ca2, which leads to the fact, that the vertical extension of the deflection element 34 is small. Preferably, the third distance d3 of the middle of the deflection area d3 is also larger than the first distance d1 of the first contact area ca1 to the pivot axis 16. The first and second distance d1 and d2 may be identical but this is not obligatory.

[0043] Further, the first radius r1 of the curvature the first contact area ca1 is larger than the corresponding first distance d1. Also the second radius r2 of the curvature of the second curved contact area ca2 is larger than the corresponding second distance d2. In contrast thereto the third radius r3 of the curvature of the deflection area is smaller than the corresponding third distance d3. This again leads to the fact that the bending angle of rope in both contact areas is essentially lower than in the deflection area where the bending angle because of the small bending radius is high. This is not harmful for the rope as the rope contact in this area is static without any movement between the deflecting element and the rope.

[0044] Furthermore, the pivot axis 16 is located in the third of the vertical extension of the deflection element 34 which is remote from the second contact area ca2. In the drawing this is the upper third. Via this measure the pivot axis 16 is in located in the area of the upper edge or more general in the region of the remote edge with respect to the second contact area. This also reduces the vertical extension of the deflection element as in the invention more or less only the radius of the deflection element has to be provided whereas in a roller 18 according to figure 1 the diameter, i. e. two times of the radius has to be provided. Accordingly, the rope terminal of the present invention has a very low vertical extension without affecting the lifetime of the rope.

[0045] Preferably, the third distance d3 is larger than the distance d1 as well as the distance d2, which stabilizes the orientation of the deflection element.

[0046] The invention can be varied within the scope of the appended claims.

Claims

1. Elevator rope terminal (32) for an elevator rope (20) comprising a rope fitting (23, 24, 26, 28, 30) for the fixing of the rope end to an elevator component (10), which rope fitting comprises a spring means (30) for elastically fixing the rope end (22) to the elevator component, the rope terminal further comprises a deflection element (34) for deflecting the rope from a first direction before being received by the rope terminal to a second direction in which the rope end is fixed to the elevator component, which deflection element has a circumferential area (ca1, da, ca2) for

receiving the rope and is pivotably supported via a pivot axis (16) at the elevator component, **characterized in that** the circumferential area has

- a first curved contact area (ca1) for receiving the rope, which first contact area is defined by all contact points of the rope with the contact area within the maximum stroke of the spring means,
- a second curved contact area (ca2) for the rope portion connected to the rope fitting, which second contact area is defined by all contact points of the rope with the contact area within the maximum stroke of the spring means,
- a curved deflection area (da) between the first and second curved contact areas, whereby the third radius (r3) of the curvature of the curved deflection area (da) is smaller than the first and second radius (r1, r2) of the curvature of the first and second curved contact areas (ca1, ca2).

2. Elevator rope terminal according to claim 1, wherein the third radius (r3) is between 0,2 to 0,5 times as large as the first and/or second radius (r1, r2).

3. Elevator rope terminal according to one of the preceding claims, wherein the first and second radius (r1, 2) are identical.

4. Elevator rope terminal according to one of the preceding claims, wherein

- at least a middle portion of said first curved area (ca1) has a first distance (d1) to the pivot axis (16),
- at least a middle portion of said second curved area (ca2) has a second distance (d2) to the pivot axis, and
- at least a middle portion of the deflection area (da) has a third distance (d3) to the pivot axis, whereby the third distance (d3) is larger than the second distance (d2).

5. Elevator rope terminal according to claim 4, wherein the first radius (r1) and/or the second radius (r2) is/are larger than the respective first and/or second distance (d1, d2).

6. Elevator rope terminal according to claim 5, wherein the first and/or second radius (r1, r2) is between 1,5 to 2,5 times as large as the corresponding first and/or second distance (d1, d2).

7. Elevator rope terminal according to one of claims 4 to 6, wherein the third radius (r3) is between 0,3 to 0,7 times as large as the third distance (d3).

8. Elevator rope terminal according to one of the preceding claims, wherein the pivot axis (16) is located in a border area of the deflection element (34) remote from the second contact area (ca2).

9. Elevator rope terminal according to one of the preceding claims, comprising a frame (14) for being mounted to the elevator component (10), which frame has with a support part (26) of the rope fitting (23, 24, 26, 28, 30) and a pivot axis (16) for the deflection element (34).

10. Elevator rope terminal according to claim 9, wherein the support part (26) is a plate with a perforation and wherein the rope fitting (23, 24, 26, 28, 30) includes a threaded bolt (24) connected the rope end (22), which bolt penetrates the perforation in the plate, and wherein the bolt carries a nut (28) on its thread, and a compression spring (30) surrounding the bolt (24) is fitted between the plate (26) and the nut (28).

11. Elevator having at least one elevator component with an elevator rope terminal (34) according to one of the preceding claims.

12. Elevator according to claim 11, wherein the elevator rope (20) is a hoisting rope or compensation rope.

13. Elevator according to claim 11 or 12, wherein the elevator component (10) is an elevator car and/or counterweight.

14. Elevator according to one of claims 11 to 13, wherein the elevator component is the elevator shaft or machine room or a fixed structure located therein.

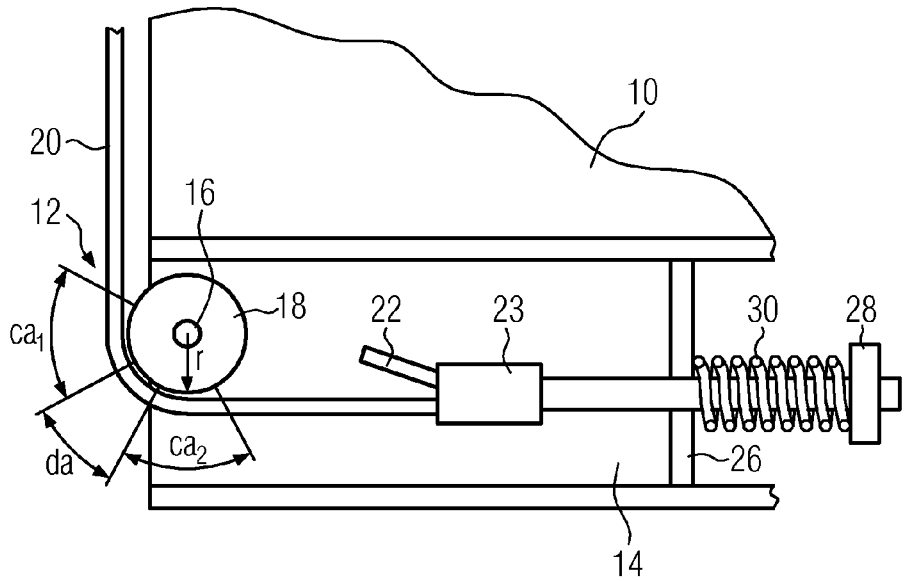

FIG. 1
(prior art)

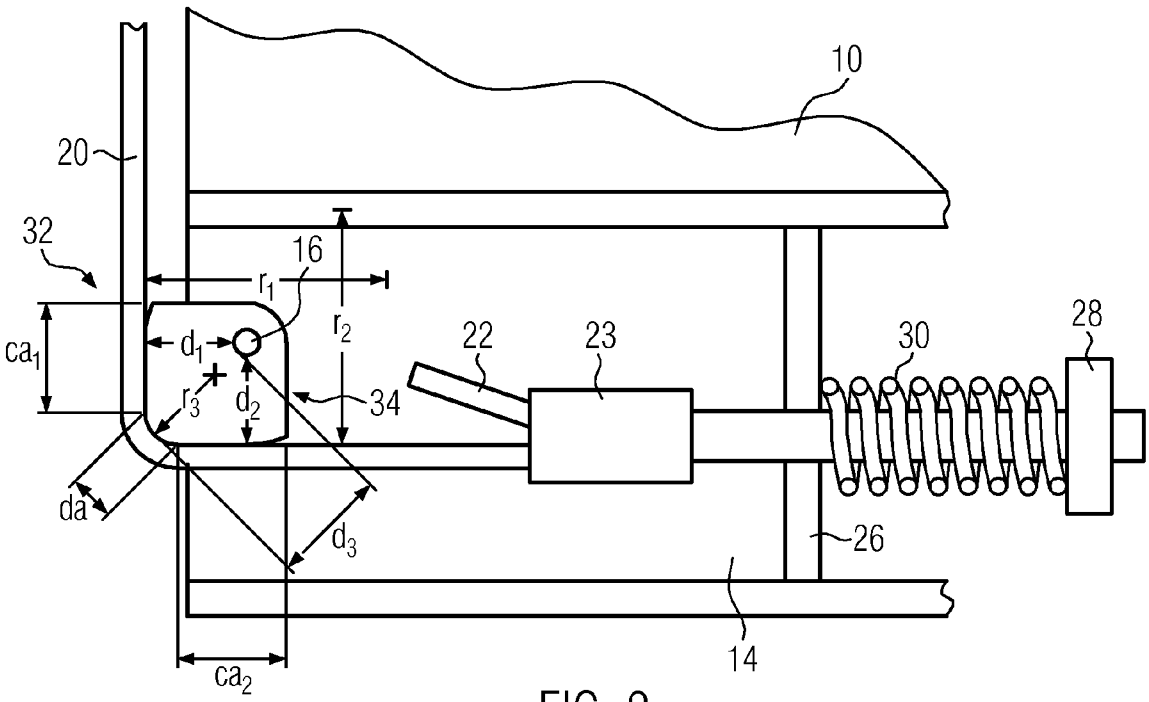

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 4398

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2007/013400 A1 (TOSHIBA ELEVATOR KK [JP]; IZUMI KAZUHIRO [JP]; MURAO YOSUKE [JP]; FUJI) 1 February 2007 (2007-02-01) * abstract; figures 1-10 * -----	1-14	INV. B66B7/08
A	JP 2005 212941 A (HITACHI LTD) 11 August 2005 (2005-08-11) * abstract; figures 1-4 * -----	1-14	
A	JP S60 96363 U (UNKNOWN) 1 July 1985 (1985-07-01) * figures 3-7 * -----	1-14	

TECHNICAL FIELDS SEARCHED (IPC)
B66B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	23 April 2013	Janssens, Gerd

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 19 4398

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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23-04-2013

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