



(51) International Patent Classification:
B66B 7/10 (2006.01) **B66B 5/02** (2006.01)

(74) Agent: **KONE CORPORATION/PATENT DEPARTMENT**; PI 677, FI-05801 Hyvinkää (FI).

(21) International Application Number:
PCT/FI2010/050895

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
5 November 2010 (05.11.2010)

(25) Filing Language: Finnish

(26) Publication Language: English

(30) Priority Data:
20090410 5 November 2009 (05.11.2009) FI

(71) Applicant (for all designated States except US): **KONE CORPORATION** [FI/FI]; Kartanontie 1, FI-00330 Helsinki (FI).

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

(72) Inventors; and

(75) Inventors/Applicants (for US only): **KALLIOMÄKI, Jaakko** [FI/FI]; Viirikuja 7 B 2, FI-01670 Vantaa (FI). **SALORANTA, Jarkko** [FI/FI]; Agricolankuja 6 D 98, FI-00530 Helsinki (FI).

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR REDUCING THE SWINGING OF THE ROPES OF AN ELEVATOR, AND AN ELEVATOR

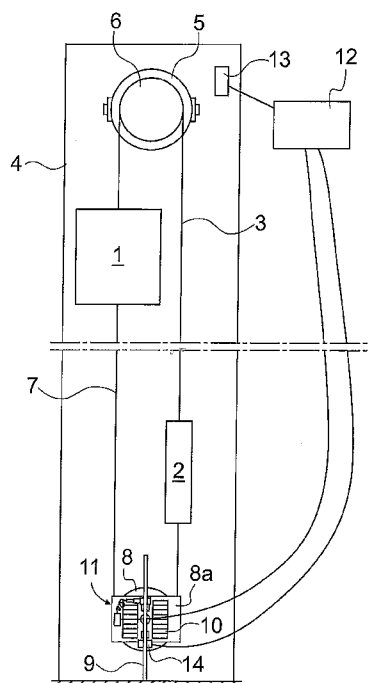


Fig. 1

(57) Abstract: The object of the invention is a method and apparatus for reducing the swinging of the ropes of an elevator, in which method and apparatus an elevator that is provided with a control system of an elevator and sensing elements (13) that determine rope swinging comprises at least an elevator hoistway (4) and an elevator car (1) suspended to rest on the hoisting roping (3) and fitted to move in essentially the vertical direction in the elevator hoistway (4), and also compensating ropes (7) and a compensator pulley (8) fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway (4), below which compensator pulley the compensating ropes (7) are arranged to pass. When the rope swinging detected by the sensing elements (13) exceeds a certain pre-defined limit, the locking means (11, 22) are activated to prevent or at least to essentially limit the movement of the compensator pulley (8) to above a certain height and to permit free downward movement of the compensator pulley (8) to below the aforementioned height. The object of the invention is also an elevator, which comprises the aforementioned apparatus.

WO 2011/055020 A1



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, **Published:**
GW, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

METHOD AND APPARATUS FOR REDUCING THE SWINGING OF THE ROPES
OF AN ELEVATOR, AND AN ELEVATOR

The object of the invention is a method as defined in the
5 preamble of claim 1 and an apparatus as defined in the
preamble of claim 12 for reducing the swinging of the ropes
of an elevator, and also an elevator as defined in the
preamble of claim 18.

10 In elevators with large travel heights, i.e. so-called high-
rise elevators or mega-high-rise elevators, the hoisting
ropes are very long and consequently weigh a lot. Generally
compensating ropes must thus be used in high-rise elevators
to compensate the weight of the hoisting ropes. A problem in
15 these types of elevators is that, owing to the large length
of the ropes, the ropes swing rather a lot in the elevator
hoistway when the wind sways the building. Swinging of the
ropes can be a safety risk, especially if the ropes fall
into resonance with the building. While swinging, the ropes
20 can hit or stick to other shaft structures and break these
structures. If the swinging of the ropes cannot be prevented
or reduced, it can be necessary to stop the elevator when
the building is swaying so that the structures would not be
damaged and the safety of the passengers would not be
25 endangered. Stopping of the elevator causes nuisance to
passengers, among other things.

The compensating ropes do not usually hang freely in the
elevator hoistway, but instead, e.g. in an elevator
30 suspended with a suspension ratio of 1:1, a diverting pulley
is normally fitted in the bottom part of the elevator
hoistway, below which diverting pulley the compensating
ropes are guided to pass. The diverting pulley of the
compensating ropes, which diverting pulley hereinafter is
35 referred to as a compensator pulley, is generally fitted to
the guide rails, guided by which it can move in the vertical

direction. When the ropes are swinging, the compensator pulley moves back and forth in the vertical direction. It is also necessary to permit vertical movement of the compensator pulley so that the compensating ropes could be kept at the desired tension, because the length of the compensating ropes varies depending, among others, on the temperature, humidity, wearing of the ropes, etc. Additionally, there are usually also tensioning weights in connection with the compensator pulley, which tensioning weights pull the compensator pulley downwards and consequently help to keep the compensating ropes at the desired tension.

One prior art solution to reduce the swinging of the hoisting ropes and/or of the compensating ropes of an elevator and to prevent them from falling into resonance with the building is to increase the number of tensioning weights, which increases the tension of the ropes. Usually the tensioning weights, however, cannot be increased or at least it is not reasonable or advantageous to increase them so much that the weight would be sufficient to prevent swinging of the ropes adequately if the building sways a lot. In high-rise elevators so many of these weights would need to be used that the weight would be too much for the elevator and its structures. The structures and parts of the elevator would have to be measured again according to the tensioning weights, which would not be reasonable and would add costs.

US patent no. US5861084 presents a solution, in which the tension of the compensating ropes is increased by means of a hydraulic apparatus when the building sways. A problem of this solution is, however, that it requires control of the amount of additional tension produced on the ropes in relation to the swaying of the building. For this reason the solution is complex and difficult to implement and therefore

is not advantageous either. Another drawback of this solution is that the tension of the ropes can only be increased to a certain limit. If the building sways a lot and the ropes swing a lot, it may not be possible to
5 increase the tension sufficiently and the elevator may have to be stopped also in this solution.

The aim of this invention is to eliminate the aforementioned drawbacks and to achieve a simple and inexpensive method and
10 apparatus for reducing the swinging of the ropes of an elevator, by means of which solution falling of the ropes of the elevator into permanent resonance with the building when the building sways can be prevented. The method according to the invention is characterized by what is disclosed in the
15 characterization part of claim 1. The apparatus according to the invention is characterized by what is disclosed in the characterization part of claim 12. The elevator according to the invention is characterized by what is disclosed in the characterization part of claim 18. Other embodiments of the
20 invention are characterized by what is disclosed in the other claims. Some inventive embodiments are also discussed in the descriptive section of the present application. The inventive content of the application can also be defined differently than in the claims presented below. The
25 inventive content may also consist of several separate inventions, especially if the invention is considered in the light of expressions or implicit sub-tasks or from the point of view of advantages or categories of advantages achieved. In this case, some of the attributes contained in the claims
30 below may be superfluous from the point of view of separate inventive concepts. Likewise the different details presented in connection with each embodiment of the invention can also be applied in other embodiments. In addition, it can be stated that at least some of the subordinate claims can at
35 least in suitable situations be deemed to be inventive in their own right.

An advantage of the solution according to the invention is that the swinging of the ropes in the elevator hoistway can be reduced sufficiently, in which case the ropes do not fall
5 into permanent resonance with the building and the risk of the ropes hitting the shaft structures diminishes. Another advantage is that there is no need to stop the elevator in all major swaying situations but instead the elevator can also be used during greater swaying of the building compared
10 to the situation in which the solution according to the invention would not be in use. A further advantage is that in normal drive, i.e. when the building does not sway, the tension of the compensating ropes can be kept normal, in which case there is no need for additional tensioning weight
15 in case of a possible swaying situation. A problem of the additional weight is, among other things, that it unnecessarily stresses the machinery, bearings and support structures, which for this reason must be made to withstand more stress, in which case the costs are increased again. An
20 additional advantage is that there is no need to actively control the tension of the ropes according to the amount of swaying. Active devices preventing the swinging of the ropes are complex, vulnerable to defects and expensive. A further advantage is that the solution is operationally reliable,
25 simple and inexpensive to implement.

According to the invention in the method for reducing the swinging of the ropes of an elevator, in which method an elevator that is provided with a control system of the
30 elevator and sensing elements determining rope swinging comprises at least an elevator hoistway and an elevator car suspended to rest on the hoisting roping and fitted to move in essentially the vertical direction in the elevator hoistway, and also compensating ropes and a compensator
35 pulley fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway, below which

compensator pulley the compensating ropes are arranged to pass, when the rope swinging determined by the sensing elements exceeds a certain pre-defined limit the locking elements are activated to prevent or at least to essentially
5 limit the movement of the compensator pulley to above a certain height and to permit free downward movement of the compensator pulley to below the aforementioned height. In this way the aforementioned advantages are achieved. There can be one or more of the aforementioned locking elements.

10

In one preferred embodiment upward movement of the compensator pulley is prevented or at least limited and downward movement is permitted at the moment when the compensator pulley is essentially in the bottom position of
15 its vertical backwards and forwards movement caused by the swinging.

In one preferred embodiment movement of the compensator pulley to above a certain height is prevented by locking the
20 locking device preventing the upwardly-directed movement of the compensator pulley to at least one fixed element.

In one preferred embodiment movement of the compensator pulley to above a certain height is prevented by locking the
25 locking device preventing the upwardly-directed movement of the compensator pulley to at least one guide rail of the compensator pulley.

In one preferred embodiment while the locking device is open
30 it is moved upwards on the guide rail of the compensator pulley by means of the upwardly-directed movement of the compensator pulley and downwards by means of gravity.

In one preferred embodiment the aforementioned movement of
35 the compensator pulley to above a certain height is

prevented or at least limited hydraulically with a locking element.

In one preferred embodiment the swinging of the compensating
5 ropes is determined on the basis of the swaying of the building and when the swaying exceeds a pre-defined limit, the movement of the compensator pulley to above a certain height is prevented with locking elements.

10 In one preferred embodiment the locking height of the compensator pulley is determined by the aid of the means measuring the vertical position of the compensator pulley.

In one preferred embodiment in addition to the prevention of
15 the upwardly-directed movement of the compensator pulley, rotational movement of the compensator pulley is limited or rotation is fully prevented by the aid of a brake means.

In one preferred embodiment when the rope swinging
20 determined by the sensing elements (13) decreases to below a certain pre-defined limit the locking of the locking elements is released and free movement of the compensator pulley to above the aforementioned certain height is permitted.

25

In one preferred embodiment the locking elements are additionally arranged to be activated in order to prevent or at least to limit the upward movement of the compensator pulley when the speed of the upward movement of the pulley
30 exceeds a certain limit.

The apparatus according to the invention for reducing the swinging of the ropes of an elevator, in which apparatus an elevator that is provided with a control system of the
35 elevator and sensing elements determining the rope swinging comprises at least an elevator hoistway and an elevator car

suspended to rest on the hoisting roping and fitted to move in essentially the vertical direction in the elevator hoistway, and also compensating ropes and a compensator pulley fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway, below which compensator pulley the compensating ropes are arranged to pass, comprises at least one locking element which is arranged, if necessary, to prevent the movement of the compensator pulley to above a certain height when the ropes are swinging, but to permit movement of the compensator pulley downwards.

In one preferred embodiment the locking element is provided with a locking device, which is fitted to be locked to at least one guide rail of the compensator pulley or to some other fixed element.

In one preferred embodiment the locking device is fitted to be freely supported on the upper surface of the guide of the compensator pulley and to move upwards on the guide rail by means of the upwardly-directed movement of the compensator pulley and downwards by means of gravity.

In one preferred embodiment the locking element is provided with at least one hydraulic actuator, which comprises at least a hydraulic cylinder, a piston moving reciprocally in the hydraulic cylinder, which piston is connected to the compensator pulley, and a hydraulic circuit provided with valves controlling the circulation of the hydraulic liquid, which hydraulic circuit is connected at its first end to a part of the cylinder above the piston and at its second end to a part of the cylinder below the piston.

In one preferred embodiment the apparatus comprises position identification means connected to the control system of the elevator for determining the vertical position of the

compensator pulley and for conveying the position information to the control system of the elevator.

In one preferred embodiment the apparatus comprises a brake
5 means limiting and/or preventing rotational movement of the compensator pulley, which brake means is connected to the control system of the elevator.

In one preferred embodiment the aforementioned one or more
10 locking elements are arranged to be activated when the rope swinging determined by the sensing elements exceeds a certain pre-defined limit. This activation can be performed, e.g. by the aforementioned control system.

15 An elevator according to the invention comprises a control system and sensing elements for determining the rope swinging, and an elevator hoistway and an elevator car suspended to rest on the hoisting roping and fitted to move in essentially the vertical direction in the elevator
20 hoistway, and also compensating ropes and a compensator pulley fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway, below which compensator pulley the compensating ropes are arranged to pass. The elevator comprises an apparatus for reducing the
25 swinging of the ropes of the elevator, which apparatus comprises at least one locking element, which is arranged, if necessary, to prevent or at least to limit the movement of the compensator pulley to above a certain height when the ropes are swinging, but to permit movement of the
30 compensator pulley downwards. In this way an elevator is achieved, the rope behavior of which is advantageous in the aforementioned manner.

In one preferred embodiment the aforementioned one or more
35 locking elements are arranged to be activated when the rope swinging determined by the sensing elements exceeds a

certain pre-defined limit. This activation can be performed, e.g. by the aforementioned control system.

In the following, the invention will be described in more detail by the aid of an example of its embodiment with reference to the attached drawings, wherein

Fig. 1 presents a simplified and diagrammatic side view of an elevator according to the invention, in which elevator one embodiment of the solution according to the invention is used,

Fig. 2 presents a magnified and simplified side view of a compensator disposed in the bottom part of the elevator hoistway of the elevator according to Fig. 1,

Fig. 3 presents a compensator according to Fig. 2 as viewed from the direction of the plane of rotation of the diverting pulley of the compensating ropes,

Fig. 4 presents a simplified and diagrammatic side view of a locking solution of a compensator pulley according to a second preferred embodiment in a situation, in which no excessive swinging of the ropes occurs, and

Fig. 5 presents a locking solution according to Fig. 4 in a situation, in which so much swinging of the ropes occurs that upward movement of the compensator pulley is prevented.

Fig. 6 presents a locking solution according to Fig. 4, which locking solution also comprises a jump prevention function.

Fig. 1 presents a simplified and diagrammatic side view of an elevator according to the invention, in which elevator one embodiment of an apparatus according to the invention is used. The elevator according to the embodiment is a traction sheave elevator with counterweight, the suspension ratio of

which elevator is 1:1. The elevator car 1 and the counterweight 2 are suspended to rest on the hoisting roping 3 and they are fitted to move in the elevator hoistway 4 in an essentially vertical direction. A hoisting machine 5 with its traction sheave 6, which hoisting machine is controlled by the control system 12 of the elevator, are fitted in the top part of the elevator hoistway 4. The hoisting roping 3 is fixed at its first end to the top part of the elevator car 1, from which it is guided upwards to pass over the traction sheave 6, after which downwards to the counterweight 2, to the top part of which the second end of the hoisting roping 3 is fixed. The elevator receives its lifting force from the hoisting machine 5 as a result of the friction between the traction sheave 6 and the hoisting roping 3.

The elevator also comprises compensating ropes 7, which are fixed at their first ends to the bottom part of the elevator car 1, from where they are guided to pass below the compensator pulley 8 that functions as a diverting pulley and that is fitted in the bottom part of the elevator hoistway 4, after which the compensating ropes 7 rise upwards to the counterweight 2, to the bottom part of which the compensating ropes 7 are fixed at their second ends. The compensator pulley 8 is fitted in its casing 8a onto the vertical guide rails 9 fixed to the bottom of the elevator hoistway 4 such that in a normal situation the compensator pulley 8 is allowed to move freely in the vertical direction guided by the guide rails 9. A normal situation here refers to a situation, in which the building does not sway. Tensioning weights 10 are additionally connected to the compensator pulley 8, which tensioning weights are arranged to keep the compensating ropes 7 at a suitable tension.

Locking elements 11 connected to the control system 12 of the elevator and fitted to function according to the

instructions of the control system 12, which locking elements in a normal situation are arranged to move in the vertical direction along with the compensator pulley 8, are also fitted in connection with the guide rails 9 of the compensator pulley 8. There is at least one locking element 11, but there can also be two of them, in which case there is one in connection with each guide rail 9. In a swaying situation the locking elements 11 are arranged to grasp the guide rails 9 of the compensator pulley by the aid of the locking means and to prevent movement of the compensator pulley 8 at least upwards. In this way the swinging of the ropes in resonance with the building is disturbed. Thus the compensator pulley 8 is still able to move normally downwards in a swaying situation. In this case the ropes are not able to slacken owing to the arrangement. During swaying the elevator car is in use and, owing to the rope elongations caused by load changes, transfer of the compensator pulley 8 downwards must be permitted all the time.

20

The prevention of the upwardly-directed movement of the compensator pulley 8 maintains the required tension in the compensating ropes 7, which tension prevents the compensating ropes 7 from falling into permanent resonance with the building. When the swaying of the building ends, the locking means of the locking elements 11 are opened and the compensator pulley 8 is again able to move freely upwards and downwards in the vertical direction. On the other hand, the invention can, however, also be applied such that the locking is released and re-activated during swaying, i.e. the locking point is changed during rope swinging.

In a swaying situation it is endeavored to lock the locking elements 11 to the guide rails 9 when the compensator pulley 8 is as low as possible, in which case the tension of the

compensating ropes 7 would be as high as possible. For this reason, the apparatus comprises position identification means 14 connected to the control system 12 of the elevator for determining the vertical position of the compensator pulley 8. The means 14 are e.g. fitted in connection with the compensator pulley 8, where they move along with the compensator pulley 8 and can directly measure the vertical position of the compensator pulley 8. In a swaying situation the means 14 are arranged to notify the control system 12, when the compensator pulley 8 is at a suitably low position. After receiving the notification the control system 12 is arranged to lock the locking elements 11 to the guide rails 9.

For detecting a swaying situation the apparatus also comprises sensing elements 13 connected to the control system 12 of the elevator, which sensing elements are disposed in the machine room of the elevator or in another suitable place, and which sensing elements are arranged to identify possible swaying of the building and to convey the information thereof to the control system 12 immediately after the swaying has started. If the sensing elements 13 detect swaying, on the basis of which the system assumes that the compensating ropes are swinging too heavily, the control system 12 after receiving the notification is arranged, preferably with an actuator, to activate the locking elements 11 at the moment notified by the position identification means 14 that measure the vertical position of the compensator pulley 8 when the compensator pulley 8 is as low as possible. According to the invention, the swinging of the ropes 3, 7 is determined with the sensing elements 13 either indirectly by measuring the swaying of the building and calculating from that, or directly by measuring the swinging of the ropes 3, 7.

One locking arrangement of the compensator pulley 8 implementing the concept of the invention is described in more detail in Figs. 2 and 3. In Figs. 2 and 3 the locking element 11 is only connected to one guide rail 9, but as previously mentioned, each guide rail 9 can have its own locking element 11. The locking elements 11 can be e.g. electrical, hydraulic or pneumatic, and e.g. a cylinder, a screw or also a spring can be as a power transmission means. The embodiment presents a hydraulic locking element 11 which comprises a hydraulic unit 11a, a flexible hydraulic hose 11b and e.g. a locking prong 11c operating as a locking device, to be locked to the guide rail 9 by means of a hydraulic cylinder. The hydraulic unit 11a of the locking element is connected to the control system 12 of the elevator, according to the instructions of which control system the unit 11a is arranged to lock the locking prong 11c to the guide rail 9 and to unlock the locking.

The locking prong 11c is disposed as a floating structure e.g. on top of the frame of the upper guide 8b of the casing 8a of the compensator pulley 8. The frame of the upper guide 8b comprises an upwardly-directed detent surface, on top of which the locking prong 11c freely rests. When the locking prong 11c is open, its clearance to the guide rail 9 is so large that it rises upwards pushed by the detent surface when the compensator pulley 8 ascends and lowers downwards by means of gravity when the compensator pulley 8 descends. In this way while the locking prong 11c is open it rests all the time on top of the detent surface of the frame of the guide 8b.

When a command comes from the control system 12 of the elevator to lock the locking prong 11c to the guide rail 9, the hydraulic unit 11a implements the locking, in which case the locking prong 11c grips hold of the guide rail 9 and

prevents movement of the compensator pulley 8 from the locking point upwards. In this case the compensator pulley 8 can only move downwards from the locking point, in which situation the locking prong 11c detaches from the detent surface and remains in its locking position on the guide rail 9. The structure of the locking prong 11c itself is not described in more detail, but it can be e.g. a scissors-shaped prong or also a pincers-type prong.

10 Figs. 4 and 5 present a different type of solution for preventing or limiting the rising of the compensator pulley 8 in order to prevent excessive swinging of the ropes 3, 7. A hydraulically-operated locking element 22 is now used instead of mechanic locking elements 11, which locking
15 element 22 comprises one or more cylinders 16 provided with a piston 17, which cylinders are fixed e.g. at their top ends to a fixed support. The piston 17 traveling inside the cylinder 16 is fixed from the bottom end of its arm to the compensator pulley 8 such that the piston 17 moves in the
20 cylinder 16 upwards and downwards along with the movement of the compensator pulley 8. The cylinder 16 is additionally provided with a hydraulic circuit 18, which connects the part of the cylinder above the piston 17 and the part of the cylinder below the piston 17. In addition, the hydraulic
25 circuit 18 comprises a shut-off valve 19 acting on the liquid flow and a throttle check valve 20, which valves are connected to the hydraulic circuit 18 in parallel with each other.

30 The throttle check valve 20 comprises a check valve and also a choke 21, which choke is not, however, necessary from the viewpoint of the operation of the device. The choke 21 is, however, a preferred solution because in this case the locking element 22 does not permanently lock the compensator
35 pulley 8 into the bottom space, in which case the whole roping arrangement can slightly alter and due to this

interfering factor the ropes 3, 7 do not have time to fall into resonance with the swaying of the building. Since the choke 21 permits slow and essentially limited movement of the compensator pulley 8 from the bottom position upwards, 5 the repeated changes in the loading situation of the elevator car during the active phase of the device do not cause over-tightening either.

When excessive swinging of the ropes 3, 7 is verified with 10 the sensing elements 13, either e.g. directly by measuring or on the basis of the swaying of the building, the shut-off valve 19, which has been open according to Fig. 4, is activated e.g. by means of the control system 12, which can be the control system of an elevator, preferably with an 15 actuator, in which case the shut-off valve switches to a state according to Fig. 5 preventing a by-pass flow.

When the compensator pulley 8 now tries to rise upwards the piston 17 tries to push hydraulic liquid from the space 20 above the piston into the hydraulic circuit 18. When the shut-off valve 19 is closed the throttle check valve 20 connected in parallel with the shut-off valve 19 remains as the only flow channel for the hydraulic liquid, but the throttle check valve 20 does not permit flow from the space 25 above the piston 17 to the space below the piston. The flow is only possible in the opposite direction. In this case the compensator pulley 8 is not able to rise upwards, but its movement downwards is free.

30 The control of the upward movement of the compensator pulley 8 can be adjusted by means of the choke 21. If the choke 21 is fully closed or there is no choke whatsoever, upward movement of the compensator pulley 8 is fully prevented, but downwardly-directed movement is free. If, on the other hand, 35 the choke 21 is fitted to let hydraulic liquid through it in a limited manner, the upward movement of the compensator

pulley 8 only slows down according to the adjustment level while the downward movement continues to be free.

An apparatus according to a preferred embodiment also
5 comprises a brake means 15 for preventing or limiting
rotational movement of the compensator pulley 8. The brake
means 15 is also connected to the control system 12 of the
elevator, from which it receives its control. The brake
means 15 is fixed e.g. to the casing 8a of the compensator
10 pulley 8 and it is fitted to brake the rotation of the
compensator pulley 8 from both side surfaces of the
compensator pulley 8. The limiting or full stopping of the
rotational movement of the compensator pulley 8 is used as
an additional aid in reducing the swinging of the
15 compensating ropes 7. This function is used when the
elevator car is already stopped, in which case the swinging
ropes 3,7 try to move the compensator pulley 8 in the
vertical direction and also to rotate it owing to the
friction. By limiting the rotational movement of the
20 compensator pulley 8 by the aid of the brake means 15 the
change of tension acting on the ropes is made more efficient
and the balancing of the tension of the ropes between the
counterweight side and car side is prevented.

25 The swinging of the ropes 7 is reduced with the method
according to the invention e.g. as follows. The swaying of
the building is monitored and detected essentially
continuously by means of the sensing elements 13 connected
to the control system 12 of the elevator. When the sensing
30 elements 13 detect that the building starts to sway and the
swaying exceeds the pre-defined permitted limit, the
occurrence of the swinging of the compensating ropes 7 is
deduced by the aid of a mathematical model. If the swinging
of the compensating ropes 7 is detected to be such that at a
35 certain height of the elevator car the ropes can fall into
resonance with the swaying of the building, the sensing

elements 13 convey the information about the swaying and swinging to the control system 12 of the elevator. After this a suitable locking height, which is as low as possible, is determined for the locking elements 11, 22 of the compensator pulley 8 with the position identification means 14 intended for this purpose and when the compensator pulley 8 is at its lowest possible height position permitted by the situation, the control system 12 activates the locking elements 11, 22 of the compensator pulley 8 in order to prevent the compensator pulley 8 from moving to above the locking height. If necessary, the rotational movement of the compensator pulley 8 is also limited or it is fully prevented by means of a brake device 15 according to the control of the control system. The sensing elements 13 further monitor the swaying of the building and when the building no longer sways too much according to the sensing elements 13, the sensing elements 13 send information thereof to the control system 12 of the elevator, which system after receiving the information gives a command to unlock the locking elements 11, 22, in which case the compensator pulley 8 is again able to move freely in the vertical direction also upwards in addition to the downwardly-directed movement.

25 An elevator according to the invention comprises a control system 12 and sensing elements 13 for determining the rope swinging, and an elevator hoistway 4 and an elevator car 1 suspended to rest on the hoisting roping 3 and fitted to move in essentially the vertical direction in the elevator hoistway 4, and also compensating ropes 7 and a compensator pulley 8 fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway 4, below which compensator pulley 8 the compensating ropes 7 are arranged to pass. The elevator comprises an apparatus for reducing the swinging of the ropes (3,7) of the elevator, which apparatus comprises at least one locking

element (11, 22), which is arranged, if necessary, to prevent or at least to limit the movement of the compensator pulley 8 to above a certain height when the ropes (3, 7) are swinging, but to permit movement of the compensator pulley 8 downwards. Fig. 1 presents an elevator according to the invention, which comprises an apparatus according to Figs. 2-3. The elevator according to the invention can alternatively be formed to comprise an apparatus according to Figs. 4, 5 or 6, by means of which apparatus the compensator pulley 8 can be disposed corresponding to what is presented in Fig. 1.

The certain height mentioned in the application is the height at which the compensating pulley is at the locking moment, and which aforementioned certain height is lower than the upper limit of the vertical movement margin of the compensating pulley, i.e. in a normal situation when the reduction arrangement of the rope swinging is not in use the compensating pulley is able to move, on behalf of the support of the compensating pulley, higher than the aforementioned certain height. The certain height is most preferably the lowest height to which the compensating pulley goes owing to its vertical back and forth movement caused by the rope swinging prevailing at the time in question.

The locking device 11 presented above can, if necessary, also be arranged to essentially limit upward movement to above the aforementioned certain height. This can be arranged e.g. such that the locking force of the locking, e.g. the friction force caused by the compressive force exerted on the guide rail, fails if the compensating pulley is pulled upwards hard enough. In this way the device is able to adapt to different loading situations, among others. Limiting the upward movement in this way creates variety in

the swinging rope system, which variety prevents from getting into resonance.

The locking elements 11, 22 are preferably arranged to be
5 activated irrespective of the speed of the upward pull of
the pulley 8, but the system can also alternatively be
implemented such that in the method, in addition to being
activated, the locking elements 11,22 can, in a rope
swinging situation, be arranged to be activated to prevent
10 or at least to limit the aforementioned upward movement of
the compensating pulley when the speed of the upward
movement of the pulley 8 exceeds a certain limit. In this
way a function preventing the jump of the elevator car
and/or of the counterweight in a braking situation can also
15 be integrated into the same structure. There is no need to
limit the speed of the downward movement, i.e. the downward
movement can be freely permitted also in this situation. The
speed can be achieved with some detection means of the speed
of the upward movement of the pulley 8, such as e.g. with
20 means 14 or by placing in series with the valve 19 in
parallel with the valve 20 a control, such as a valve 25,
which disconnects the flow when the flow velocity exceeds a
certain limit (flow fuse valve). Fig. 6 presents otherwise
the solution according to Fig. 4-5, but the aforementioned
25 jump prevention function (part 25) is also mentioned in it.
As presented, the part 25 and the part 19 can be made
separately or their characteristics can be integrated
(without a separate valve 25) by guiding the channel 26
directly to the valve 19, which then tries to close the
30 valve 19 when the compensating pulley 8 moves rapidly
upwards. The jump prevention apparatus in a hydraulic
solution does not necessarily require a separate actuator in
order to be activated. Correspondingly, the locking elements
(11,22) in the apparatus according to the invention are also
35 arranged to be activated to prevent or at least to limit
upward movement of the compensating pulley when the speed of

the upward movement of the pulley (8) exceeds a certain limit.

As described above, the locking element (11,22) of the apparatus is arranged, if necessary, to prevent or at least to essentially limit the movement of the compensator pulley 8 to above a certain height when the ropes (3, 7) are swinging, but to permit the movement of the compensator pulley 8 downwards. Here the term means that, if necessary, the apparatus can be activated according to need to behave in a determined manner. The need can be determined preferably by means of the sensing elements 13, e.g. by the control system. In this case when the rope swinging determined by the sensing elements 13 exceeds a certain pre-defined limit, the locking elements (11, 22) are activated.

It is obvious to the person skilled in the art that the different embodiments of the invention are not limited solely to the examples described above, but that they may be varied within the scope of the claims presented below. Thus, for instance, the solution according to the invention can also be used in different elevators than the elevator of the embodiment presented above. The suspension ratio of the elevator can also be e.g. other than 1:1, such as e.g. 2:1.

It is also obvious that the means intended for determining the vertical position of the compensator pulley can be of other types than those based on measuring presented above. For instance, means that calculate at which height the compensator pulley is, e.g. on the basis of the swinging of the compensating ropes, can be used for determining the position of the compensator pulley. It is also obvious to the person skilled in the art that the locking of the compensator pulley can also be made to another fixed object than to the vertical guide rails of the compensator pulley.

It is further obvious that the rotational movement of the compensator pulley can also be limited and guided with other

devices than the aforementioned brake means. For instance, a motor or other corresponding actuator, by means of which the rotational movement is limited and guided, can be in connection with the compensator pulley. It is also obvious
5 that the aforementioned rope can be of a desired shape in its cross-section, e.g. belt-like or round.

CLAIMS

1. Method for reducing the swinging of the ropes of an elevator, in which method an elevator that is provided with
5 a control system (12) of the elevator and sensing elements (13) that determine rope swinging comprises at least an elevator hoistway (4) and an elevator car (1) suspended to rest on the hoisting roping (3) and fitted to move in essentially the vertical direction in the elevator hoistway
10 (4), and also compensating ropes (7) and a compensator pulley (8) fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway (4), below which compensator pulley the compensating ropes (7) are arranged to pass, **characterized** in that when the rope
15 swinging determined by the sensing elements (13) exceeds a certain pre-defined limit, the locking elements (11, 22) are activated to prevent or at least to essentially limit the movement of the compensator pulley (8) to above a certain height and to permit free downward movement of the
20 compensator pulley (8) to below the aforementioned height.

2. Method according to claim 1, **characterized** in that upward movement of the compensator pulley (8) is prevented or at least limited and downward movement is permitted at the
25 moment when the compensator pulley (8) is essentially in the bottom position of its vertical backwards and forwards movement caused by the swinging.

3. Method according to claim 1 or 2, **characterized** in that
30 movement of the compensator pulley (8) to above a certain height is prevented by locking the locking device (11c) preventing the upwardly-directed movement of the compensator pulley (8) to at least one fixed element.

35 4. Method according to claim 3, **characterized** in that movement of the compensator pulley (8) to above a certain

height is prevented by locking the locking device (11c) preventing the upwardly-directed movement of the compensator pulley (8) to at least one guide rail (9) of the compensator pulley (8).

5

5. Method according to claim 4, **characterized** in that while the locking device (11c) is open it is moved upwards on the guide rail (9) of the compensator pulley (8) by means of the upwardly-directed movement of the compensator pulley (8) and
10 downwards by means of gravity.

6. Method according to claim 1 or 2, **characterized** in that the aforementioned movement of the compensator pulley (8) to above a certain height is prevented or at least limited with
15 a hydraulic locking element (22).

7. Method according to any of the preceding claims, **characterized** in that the swinging of the compensating ropes (7) is determined on the basis of the swaying of the
20 building and when the swaying exceeds a pre-defined limit, the movement of the compensator pulley (8) to above a certain height is prevented with locking elements (11, 22).

8. Method according to any of the preceding claims,
25 **characterized** in that the locking height of the compensator pulley (8) is determined by the aid of the means (14) measuring the vertical position of the compensator pulley (8).

30 9. Method according to any of the preceding claims, **characterized** in that in addition to the prevention of the upwardly-directed movement of the compensator pulley (8), rotational movement of the compensator pulley (8) is limited or rotation is fully prevented by the aid of a brake means
35 (15).

10. Method according to any of the preceding claims, **characterized** in that when the rope swinging determined by the sensing elements (13) decreases to below a certain pre-defined limit, the locking of the locking elements (11,22) is released and free movement of the compensator pulley (8) to above the aforementioned certain height is permitted.

11. Method according to any of the preceding claims, **characterized** in that the locking elements (11,22) are additionally arranged to be activated in order to prevent or at least to limit the upward movement of the compensator pulley when the speed of the upward movement of the pulley (8) exceeds a certain limit.

12. Apparatus for reducing the swinging of the ropes of an elevator, in which apparatus an elevator that is provided with a control system (12) of the elevator and sensing elements (13) that determine rope swinging comprises at least an elevator hoistway (4) and an elevator car (1) suspended to rest on the hoisting roping (3) and fitted to move in essentially the vertical direction in the elevator hoistway (4), and also compensating ropes (7) and a compensator pulley (8) fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway (4), below which compensator pulley the compensating ropes (7) are arranged to pass, **characterized** in that the apparatus comprises at least one locking element (11, 22) which is arranged, if necessary, to prevent or at least to essentially limit the movement of the compensator pulley (8) to above a certain height when the ropes (3, 7) are swinging, but to permit movement of the compensator pulley (8) downwards.

13. Apparatus according to claim 12, **characterized** in that the locking element (11) is provided with a locking device (11c), which is fitted to be locked to at least one guide

rail (9) of the compensator pulley (8) or to some other fixed element.

14. Apparatus according to claim 12 or 13, **characterized** in that the locking device (11c) is fitted to be freely supported on the upper surface of the guide (8b) of the compensator pulley (8) and to move upwards on the guide rail (9) by means of the upwardly-directed movement of the compensator pulley (8) and downwards by means of gravity.

10

15. Apparatus according to claim 12, **characterized** in that the locking element (22) is provided with at least one hydraulic actuator, which comprises at least a hydraulic cylinder (16), a piston (17) moving reciprocally in the hydraulic cylinder (16), which piston is connected to the compensator pulley (8), and a hydraulic circuit (18) provided with valves (19, 20) controlling the circulation of the hydraulic liquid, which hydraulic circuit is connected at its first end to the part of the cylinder above the piston (16) and at its second end to the part of the cylinder below the piston (16).

16. Apparatus according to any of claims 12-15 above, **characterized** in that the apparatus comprises position identification means (14) connected to the control system (12) of the elevator for determining the vertical position of the compensator pulley (8) and for conveying the position information to the control system (12) of the elevator.

17. Apparatus according to any of claims 12-16 above, **characterized** in that the apparatus comprises a brake means (15) limiting and/or preventing rotational movement of the compensator pulley (8), which brake means is connected to the control system (12) of the elevator.

35

18. Elevator, which comprises a control system (12) and sensing elements for determining rope swinging (13), and an elevator hoistway (4) and an elevator car (1) suspended to rest on the hoisting roping (3), which elevator car is
5 fitted to move in essentially the vertical direction in the elevator hoistway (4), and also compensating ropes (7) and a compensator pulley (8) fitted to move in essentially the vertical direction in the bottom part of the elevator hoistway (4), below which compensator pulley the
10 compensating ropes (7) are arranged to pass, **characterized** in that the elevator comprises an apparatus for reducing the swinging of the ropes (3, 7), which apparatus comprises at least one locking element (11, 22) which is arranged, if necessary, to prevent or at least to limit the movement of
15 the compensator pulley (8) to above a certain height when the ropes (3, 7) are swinging, but to permit movement of the compensator pulley (8) downwards.

19. Elevator according to any of the preceding claims,
20 characterized in that the elevator comprises an apparatus according to any of claims 12-17 above.

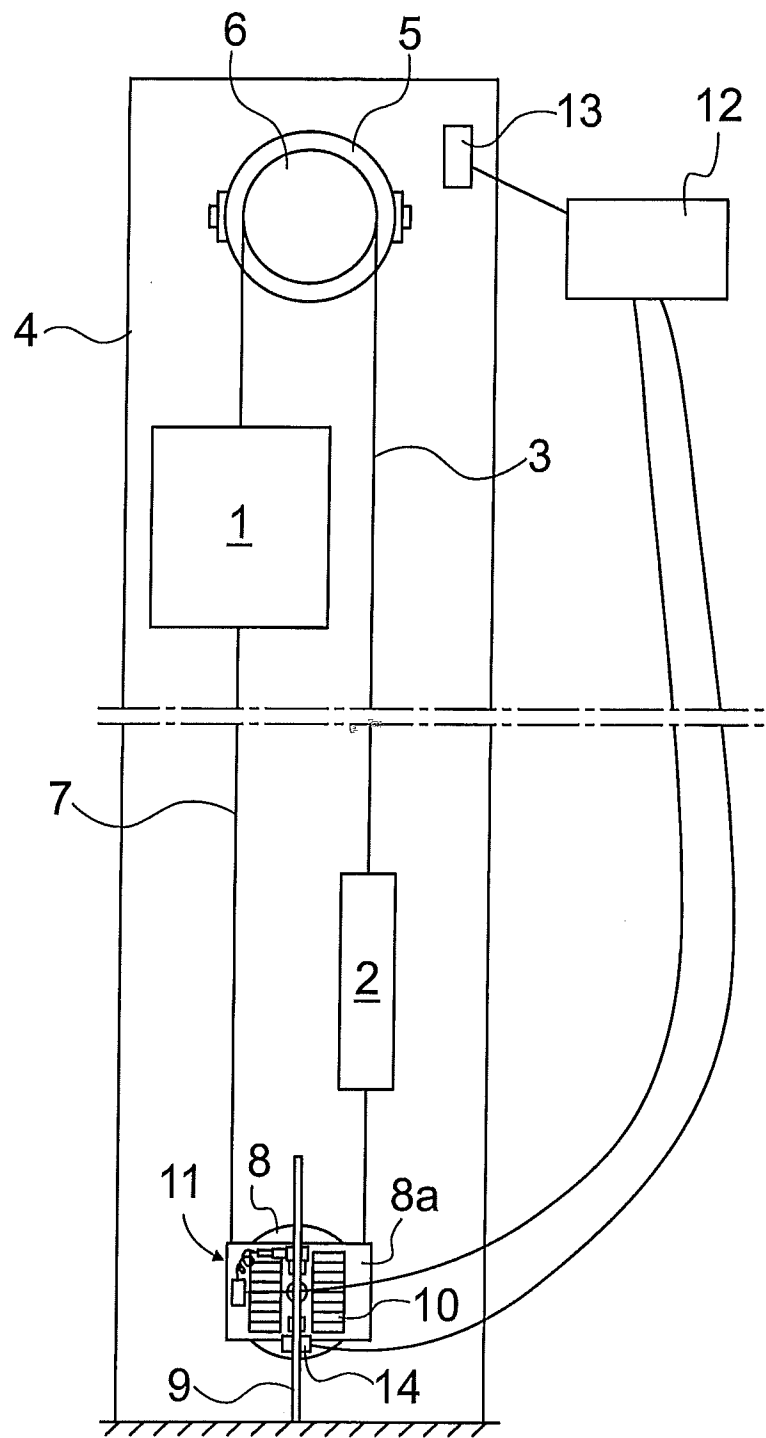


Fig. 1

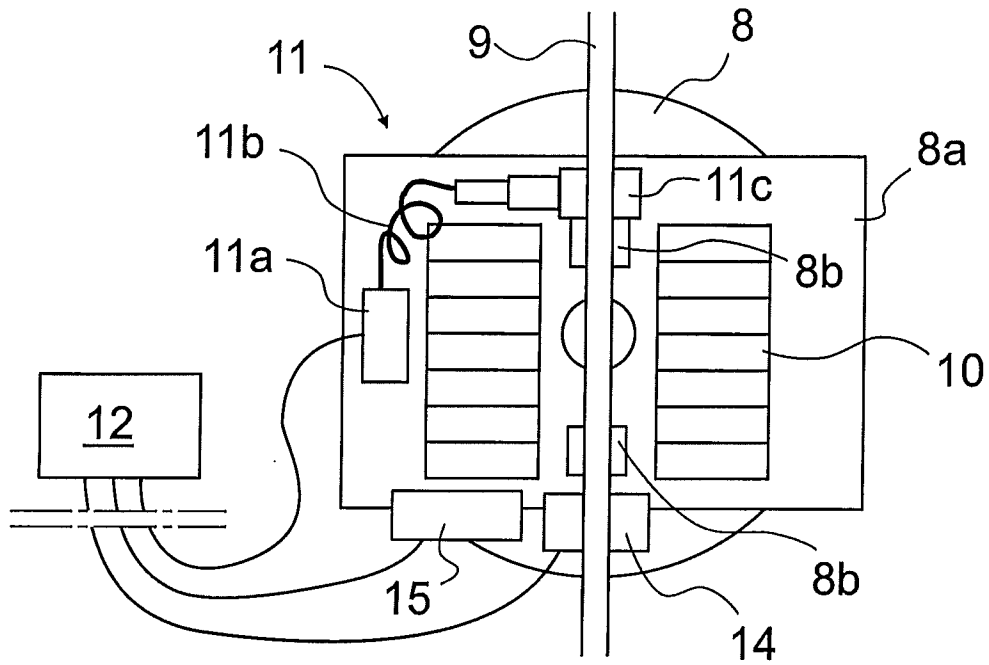


Fig. 2

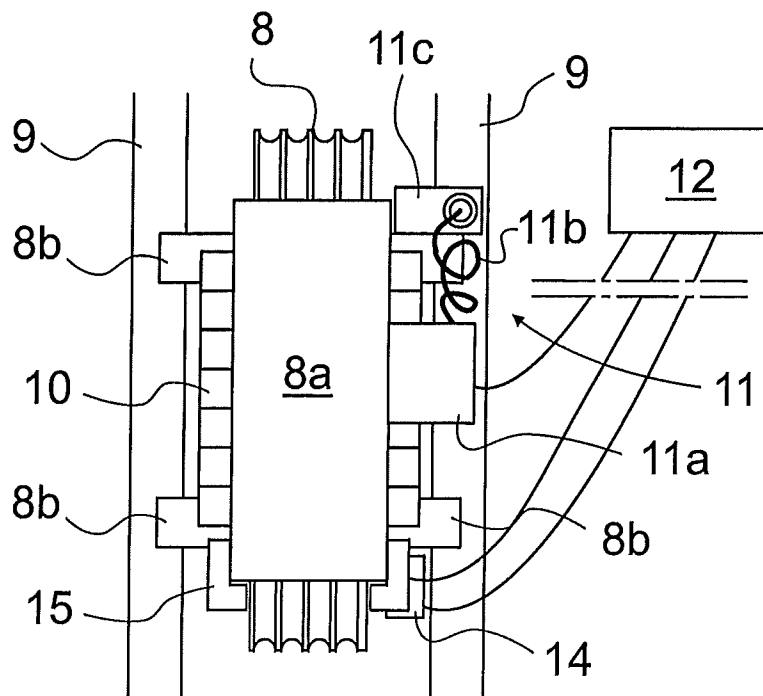


Fig. 3

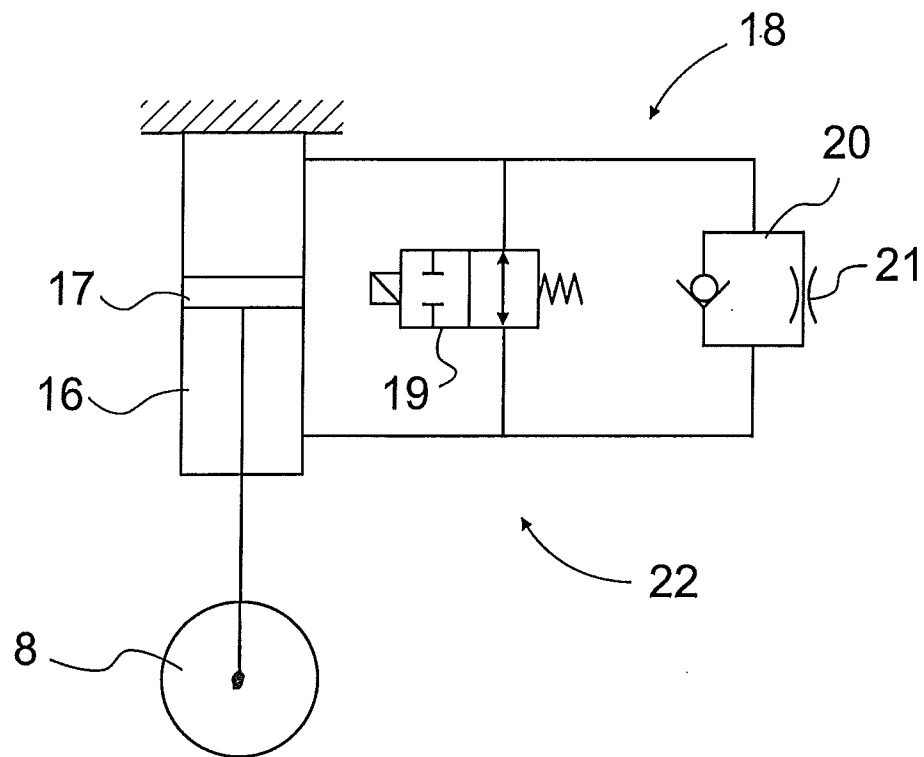


Fig. 4

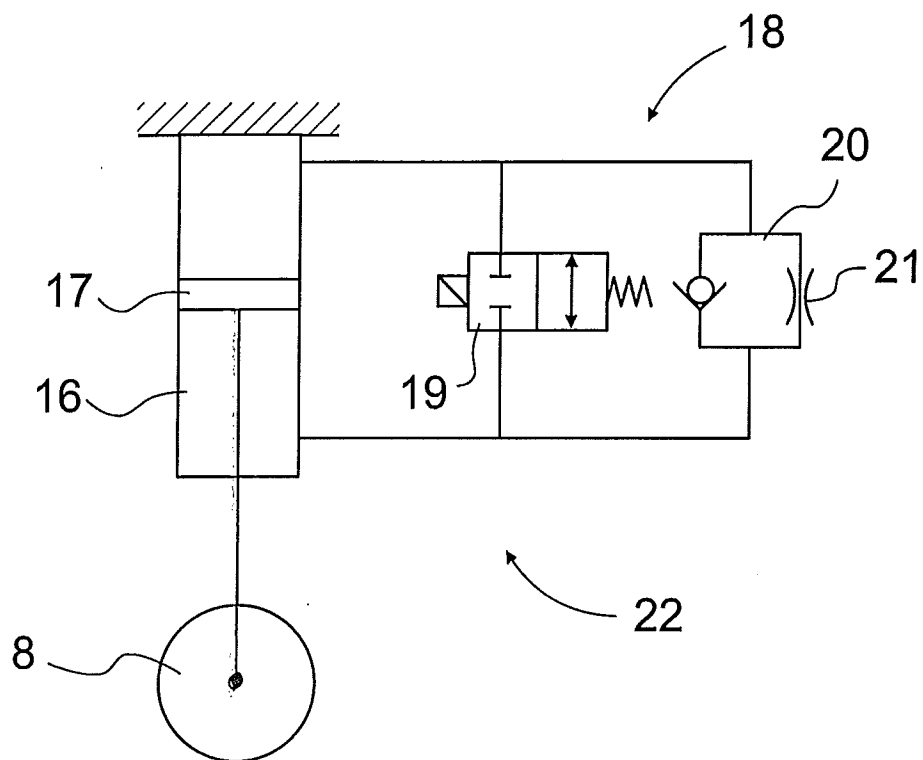


Fig. 5

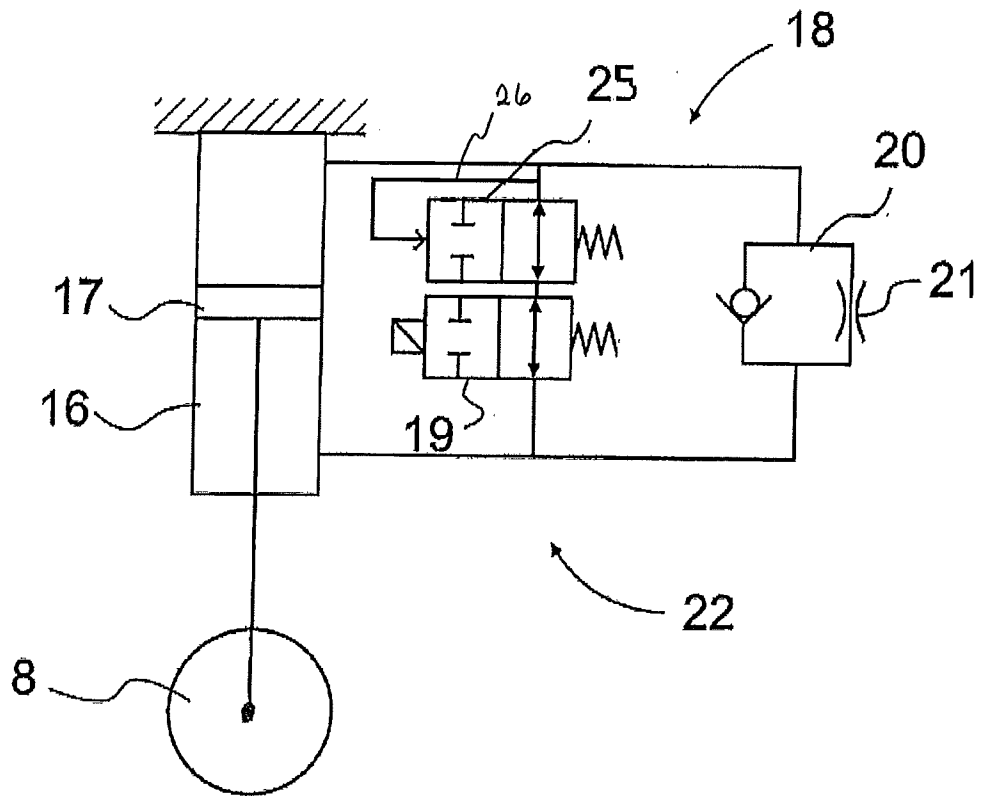


Fig.6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2010/050895

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11106160 A (TOSHIBA CORP) 20 April 1999 (20.04.1999) whole document, especially figures 1 and 2; English abstracts [online] EPOQUENET EPODOC and WPI; machine translation into English by the JPO [online] [retrieved 7.2.2011]	1-19
A	US 2009229922 A1 (SMITH RORY S et al.) 17 September 2009 (17.09.2009) figure 1 and paragraphs [0013 and 0015-0017]	1-19
A	US 3882968 A (SUOZZO JOHN) 13 May 1975 (13.05.1975) figure 1 and column 4, lines 3-21	1-19

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

08 February 2011 (08.02.2011)

Date of mailing of the international search report

25 February 2011 (25.02.2011)

Name and mailing address of the ISA/FI
National Board of Patents and Registration of Finland
P.O. Box 1160, FI-00101 HELSINKI, Finland

Facsimile No. +358 9 6939 5328

Authorized officer

Juha Vuorela

Telephone No. +358 9 6939 500

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2010/050895

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
JP 11106160 A	20/04/1999	None	
US 2009229922 A1	17/09/2009	EP 2197775 A2	23/06/2010
		WO 2009036423 A2	19/03/2009
		CA 2679474 A1	19/03/2009
US 3882968 A	13/05/1975	JP 50021442 A	07/03/1975
		IT 1013914 B	30/03/1977
		FR 2231603 A1	27/12/1974
		ES 426811 A1	16/09/1976
		DE 2426412 A1	19/12/1974
		BE 815782 A1	02/12/1974
		CA 990654 A1	08/06/1976
		GB 1470313 A	14/04/1977
		AU 6917874 A	27/11/1975

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2010/050895

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

B66B 7/10 (2006.01)

B66B 5/02 (2006.01)