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[Continued on next page]

(54) Title: BUFFERING DEVICE FOR MULTIPLE-CAR ELEVATOR SYSTEM

(57) Abstract: An elevator system includes a first elevator car (14A) supported for vertical movement in a lane (11, 13, 15, 17) of a hoistway (11). A second elevator car (14B) is configured to operate and move vertically in the lane (11, 13, 15, 17) below the first elevator car (14A) independently thereof. At least one buffering device (34) is supported on at least one of the elevator cars (14) to absorb energy upon contact between each buffering device (034) and the other elevator car (14).

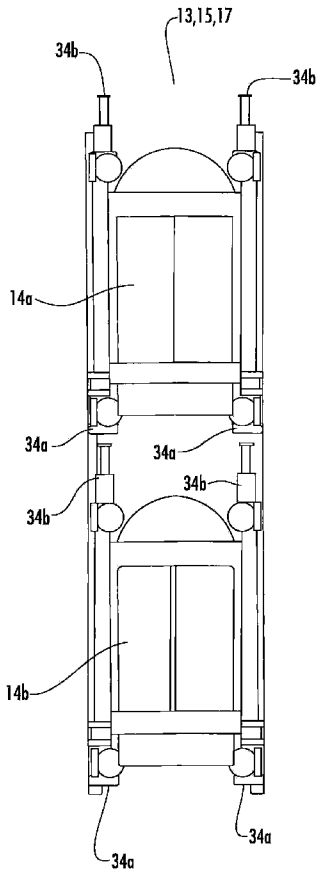

FIG. 2

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

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

BUFFERING DEVICE FOR MULTIPLE-CAR ELEVATOR SYSTEM

FIELD OF INVENTION

[0001] The subject matter disclosed herein relates generally to the field of elevators and, more particularly, to a multi-car elevator system.

BACKGROUND

[0002] Ropeless elevator systems, also referred to as "self-propelled elevator systems," are useful in certain applications (e.g., high-rise buildings) where the mass of the ropes for a roped system is prohibitive and there is a desire for multiple elevator cars to travel in a single lane of a hoistway. There exist ropeless elevator systems in which a first lane is designated for upward-traveling cars and a second lane is designated for downward-traveling cars. A transfer station at each end of the hoistway is used to move cars horizontally between the first lane and second lane.

BRIEF DESCRIPTION OF INVENTION

[0003] According to a non-limiting exemplary embodiment of the invention, an elevator system includes a first elevator car supported for vertical movement in a lane of a hoistway. A second elevator car is configured to operate and move vertically in the lane below the first elevator car independently thereof. At least one buffering device is supported on at least one of the elevator cars to absorb energy upon contact between each buffering device and the other elevator car.

[0004] In an aspect of the embodiment, at least one buffering device is positioned on at least a top portion of the second elevator car and facing toward the first elevator car, and/or at least one buffering device is positioned on at least a bottom portion of the first elevator car and facing toward the second elevator car. In a version of this aspect, at least one buffering device is positioned at least at an upper or a lower part of a linear motor system of at least one of the elevator cars.

[0005] In another aspect, at least one first buffering member is positioned on a bottom portion of the first elevator car, and/or at least one second buffering member is positioned on a top portion of the second elevator car. In a version of this aspect, at least one first buffering member is positioned on a bottom portion of the first elevator car, at least one corresponding second buffering member is positioned on a top portion of the second elevator car, and corresponding ones of the first and second buffering members contact each other upon

contact between the first and second elevator cars. In an example of this version, the first buffering member includes a reaction plate, and the second buffering member includes a buffer.

[0006] In still another aspect, each buffering device is mechanical, electric, magnetic, or any combination thereof. In a version of this aspect, the buffering device includes a spring, a shock absorber (including fluid or not), an electromechanical device, or a repulsive-magnetic-force-generating component.

[0007] In yet another aspect, the buffering device is equipped with a sensor to detect the contact, integrity, and/or operability (in a non-contacting state) of the buffering device. The detection and/or a condition of the buffering device are/is readable by a sub-system of the elevator system.

[0008] Each buffering device dissipates or minimizes the energy transmitted from one of the elevator cars to the other if the elevator cars contact each other in the lane during operation of the elevator system. In this way, the buffering device manages the mechanical energy of the contact, allowing for safe operation of the elevator system and travel of the elevator cars to respective successive floors of, for example, a high-rise building. Also, reactive forces between the elevator cars are generated, and resetting of the buffering device(s) is not required.

BRIEF DESCRIPTION OF DRAWING

[0009] The subject matter that is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawing in which:

[0010] FIG. 1 schematically depicts a non-limiting exemplary embodiment of a multiple-car, ropeless elevator system;

[0011] FIG. 2 schematically depicts operation of a buffering device of a multiple-car, ropeless elevator system according to a non-limiting exemplary embodiment of the invention;

[0012] FIG. 3 depicts the buffering device according to the embodiment illustrated in FIG. 2 implemented with a frameless car; and

[0013] FIG. 4 depicts the buffering device according to the embodiment illustrated in FIG. 2 implemented with a framed car.

DETAILED DESCRIPTION OF INVENTION

[0014] FIG. 1 depicts a non-limiting exemplary embodiment of a multi-car, ropeless elevator system **10**. However, it should be understood that the elevator system **10** is not limited to being ropeless. By way of example only, the elevator system **10** can be roped such that buffering devices described below and shown in the figures can be implemented with a roped multi-car system. Also, the buffering devices can be implemented with a ropeless multi-car system that does not include a linear motor.

[0015] As shown in FIG. 1, the elevator system **10** includes a hoistway **11** having a plurality of lanes **13**, **15**, **17**. While three lanes **13**, **15**, **17** are shown in FIG. 1, it should be understood that other embodiments of the elevator system **10** may have any suitable respective number of lanes. In each lane **13**, **15**, **17**, one or more elevator cars **14** travel in one direction (i.e., up or down). For example, in FIG. 1, the cars **14** in lanes **13** and **15** travel up, and the cars **14** in lane **17** travel down.

[0016] Above the top floor of the hoistway **11** is an upper transfer station **30** to impart horizontal (or lateral) motion to the cars **14** to move the cars **14** between and among the lanes **13**, **15**, **17**. It should be understood that the upper transfer station **30** may be located at the top floor rather than above the top floor. Below the first floor of the hoistway **11** is a lower transfer station **32** to impart horizontal motion to the cars **14** to move the cars **14** between and among the lanes **13**, **15**, **17**. It should be understood that the lower transfer station **32** may be located at the first floor rather than below the first floor. Although not shown in FIG. 1, at least one intermediate transfer station may be used between the first and top floors. Each intermediate transfer station is similar to the upper and lower transfer stations **30**, **32**.

[0017] The cars **14** are propelled using a linear-magnetic-motor system having a primary, fixed portion **16** and a secondary, moving portion **18**. The primary portion **16** includes windings or coils mounted at at least one side of each lane **13**, **15**, **17**. The primary portion **16** also is supplied with drive signals to control movement of the cars **14** in their respective lanes. The secondary portion **18** includes permanent-magnet arrays mounted to at least one side of each car **14** and is designed to react to large loads.

[0018] As shown in FIG. 1, adjacent lanes **13**, **15**, **17** share a guiderail such that, for example, an interior side of the car **14** in lane **13** and a corresponding side of the car **14** in lane **15** travel along a common guiderail. Also as shown in FIG. 1 and described below, in each lane **13**, **15**, **17**, at least one lower car **14** is positioned below an upper car **14**, both cars **14** configured to move within the lane **11** as known.

[0019] It should be understood that the elevator system **10**, in general, and the hoistway **11**, upper and lower transfer stations **30**, **32** (and any intermediate transfer station), and linear motor system, in particular, can have any suitable structure. It should be understood also that the hoistway **11**, lanes **13**, **15**, **17**, upper and lower transfer stations **30**, **32** (and any intermediate transfer station), and linear motor system can have any suitable relationship with each other. It should be understood also that each of the cars **14** can move within the hoistway **11** and in the corresponding lane **13**, **15**, **17** in any suitable manner. It should be understood also that any suitable number of cars **14** can travel in a corresponding lane in any suitable direction. It should be understood also that each of the transfer stations **30**, **32** can impart horizontal motion to the cars **14** in any suitable manner. It should be understood also that the cars **14** can be propelled using any suitable propulsion system—e.g., an on-board propulsion (e.g., on-board rotary magnetic screws) such that structure of each car **14** may be more similar to that of a conventional rope-elevator car including a frame through which propulsion is directed. It should be understood also that, in the case of a ropeless elevator system, the cars **14** thereof can be propelled using any suitable propulsion system as well.

[0020] FIG. 2 depicts operation of a buffering device **34** of the elevator system **10** according to a non-limiting exemplary embodiment. In the figure, an upper or first car **14a** is supported for vertical movement in a corresponding lane **13**, **15**, **17**. A lower or second car **14b** is configured to operate and move vertically in the lane **13**, **15**, **17** below the first car **14a** independently of the first car **14a**. At least one buffering device **34** is supported on at least one of the cars **14a**, **14b** to absorb energy upon contact between each buffering device **34** and the other car **14a**, **14b**. The figure shows the two cars **14a**, **14b** nearly in contact with each other and including respectively four buffering devices **34**. It should be understood that, in the case in which the elevator system **10** includes more than two cars **14** in a particular lane **13**, **15**, **17**, "first and second cars **14a**, **14b**" refer to any pair of adjacent ones of these three or more cars **14**.

[0021] In an aspect, at least one buffering device **34** is positioned on at least a top portion of the second car **14b** and facing toward the first car **14a**, and/or at least one buffering device **34** is positioned on at least a bottom portion of the first car **14a** and facing toward the second car **14b**. In a version of this aspect and as shown in FIG. 2, a pair of buffering devices **34** are supported on a top portion of each of the cars **14a**, **14b** substantially in-line with the secondary portion **18** of the linear motor system, and a pair of buffering devices **34** are supported on a bottom portion of each of the cars **14a**, **14b**. In this example, the pair of

buffering devices **34** supported on the top portion of the second car **14b** and the pair of buffering devices **34** supported on the bottom portion of the first car **14a** are configured to respectively contact each other upon contact between with the cars **14a**, **14b** to, thereby, absorb the contact.

[0022] FIG. 3 depicts one or more buffering devices **34** implemented with a frameless car **14**. In an aspect, the car **14** includes a cabin **50**, and the linear motor system of the car **14** is supported on the cabin **20**. (Again, it should be understood that the linear motor system is only one possible vertical propulsion system for the elevator system **10**.) A buffering device **34** is positioned at least at an upper or a lower part of a portion of the linear motor system. More specifically, permanent-magnet arrays **36** of the secondary portion **18** of the linear motor system are shown mounted to opposite corners of opposed exterior side walls **38** of the car **14**. In a version of this aspect and as shown in the figure, at each corner, a buffering device **34** is positioned at both the upper and lower parts of the secondary portion **18**. In particular, a pair of buffering devices **34** are mounted to opposed upper and lower ends of the secondary portion **18** such that the buffering devices **34** are aligned with the secondary portion **18** and extend beyond respective opposed exterior end walls **40** of the car **14**. In this way, in a two-car scenario, the buffering devices **34** mounted to the upper ends of the secondary portion **18** of the second car **14b** are configured to contact the buffering devices **34** mounted to the lower ends of the secondary portion **18** of the first car **14a** upon contact between with the cars **14a**, **14b** to, thereby, absorb the contact.

[0023] FIG. 4 depicts one or more buffering devices **34** implemented with a framed car **14** (which can be employed in a roped or ropeless multi-car elevator system). The cabin **20** of the car **14** is supported in a known manner on a frame **42** such that members of the frame **42** are operatively mounted to respective exterior side and end walls **38**, **40** of the cabin **20**. (The frame **42** can connect to a roped or ropeless propulsion system that is not shown directly in FIG. 4.) In an aspect, at least one buffering device **34** is positioned at least at an upper or a lower end of the frame **38**. More specifically, the frame **42** includes a crosshead beam **42a** along a top of the frame **42** and a plank beam **42b** along a bottom of the frame **42**. In a version of this aspect and as shown in the figure, a pair of buffering devices **34** are supported at or near each of the beams **42a**, **42b** and arranged substantially perpendicular to the respective beam **42a**, **42b** so that the buffering devices **34** extend upward or downward and beyond the respective beam **42a**, **42b**. Toward that end, a pair of corresponding buffer supports (not shown) can be arranged on each of the crosshead and plank beams **42a**, **42b** for supporting the buffering devices **34**. In this way, in the two-car scenario, the pair of

buffering devices **34** supported at or near the crosshead beam **42a** of the second car **14b** are configured to contact the buffering devices **34** supported at or near the plank beam **42b** of the first car **14a** upon contact between with the cars **14a**, **14b** to, thereby, absorb the contact.

[0024] It should be understood that, although structure of the frame **42** and various members of the frame **14** shown are conventional, they can be of any suitable structure. It should be understood also that the frame **42** can be operatively mounted to the cabin **20** in any suitable manner. It should be understood also that, in the case of a frameless elevator system, each buffering device **34** is positioned at least at a top or bottom structure of the elevator system. In an aspect of this case, the buffering device **34** is arranged substantially perpendicular to the respective top or bottom structure so that the buffering device **34** extends beyond the structure.

[0025] Returning to FIG. 2, in an aspect, the buffering device **34** includes a plurality—in particular, a pair—of members. At least one first buffering member **34a** is positioned on a bottom portion of the first car **14a**, and/or at least one second buffering member **34b** is positioned on a top portion of the second car **14b**. In a version of this aspect, the first buffering member **34a** includes a reaction plate **34a**, and the second buffering member **34b** includes a corresponding buffer **34b**. The reaction plate **34a** is configured to interact with the buffer **34b** in the event that the cars **14a**, **14b** contact each other. As such, the reaction plate **34a** is sufficiently strong to act as a reaction surface for the buffer **34b**. The reaction plate **34a** and buffer **34b** operate to dissipate energy associated with such contact. In the example shown, a pair of reaction plates **34a** are positioned on the bottom portion of the first car **14a**, and a corresponding pair of buffers **34b** are positioned on the top portion of the second car **14b**. Of course, it should be understood that positioning of the reaction plates **34a** and buffers **34b** can be reversed so that the pair of reaction plates **34a** are positioned on the top portion of the second car **14b** and the corresponding pair of buffers **34b** are positioned on the bottom portion of the first car **14a**.

[0026] Each buffering device **34**, as an energy-absorbing device, can be made of any suitable number and kind of materials. For instance, each buffering device **34** can be mechanical, electric, magnetic, or any combination thereof. In an aspect, the buffering device includes a spring, a shock absorber (including fluid or not), an electromechanical device, or a repulsive-magnetic-force-generating component. Also, in an aspect, the buffering device **34** is equipped with a sensor—such as a microswitch—to detect the contact, which detection is readable by, for example, an integrity-management system of the elevator system **10**. The sensor detects further integrity and/or operability (in a non-contacting state) of the buffering

device **34**, and a condition or health of the buffering device **34** is readable by a sub-system of the elevator system **10** as well.

[0027] In operation, each buffering device **34** is configured to contact a car **14** or another buffering device **34** as two cars **14** come together either during normal operation, such as during landing of the cars **14** at respective successive floors of the hoistway **11** (or otherwise in connection with primary motion control of the cars **14**). Upon such contact, the buffering device **34** progressively deforms, thereby effectively dissipating energy associated with the contact. In this way, the buffering device **34** manages potential energy of contact between the cars **14** and can act as a safety back-up to a primary motion controller of the elevator system **10**. The sensor detects the contact, which is readable by the integrity-management system of the elevator system **10**.

[0028] The buffering device **34** can be a multiple-use device or frangible. Also, a simple visual inspection of each buffering device **34** can confirm that the buffering device **34** is intact and operative. The integrity-management system also can be used to verify integrity of the buffering device **34**.

[0029] Each buffering device **34** dissipates or minimizes the energy transmitted from one of the cars **14** to the other car **14** if the cars **14** contact each other in the lane **13**, **15**, **17** during operation of the elevator system **10**. In this way, the buffering device **34** manages the mechanical energy of the contact, allowing for safe operation of the elevator system **10** and travel of the cars **14** to respective successive floors of, for example, a high-rise building. Also, reactive forces between the cars **14** are generated, and resetting of the buffering device(s) **34** is not required.

[0030] In the above embodiments, the buffering devices 34 are on the top and/or bottom of cars 14 to absorb energy in a vertical direction. Similar buffering devices 34 may be employed in the transfer stations 30 and/or 32 to dissipate or minimize the energy transmitted from one of the cars 14 to the other car 14 in a horizontal direction. In such embodiments, the buffers may be positioned on holding carriages within the transfer station that carry and transport the cars 14 horizontally.

[0031] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions, or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various non-limiting embodiments of the invention have been described,

it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

CLAIMS:

1. An elevator system comprising:

a first elevator car supported for vertical movement in a lane of a hoistway;

a second elevator car configured to operate and move vertically in the lane below the first elevator car independently thereof; and

at least one buffering device supported on at least one of the elevator cars to absorb energy upon contact between each buffering device and the other elevator car.

2. The elevator system of claim 1, wherein at least one of at least one buffering device is positioned on at least a top portion of the second elevator car and facing toward the first elevator car and at least one buffering device is positioned on at least a bottom portion of the first elevator car and facing toward the second elevator car.

3. The elevator system of claim 2, wherein at least one buffering device is positioned at least at an upper or a lower part of a linear motor system of at least one of the elevator cars.

4. The elevator system of claim 3, wherein at least one buffering device is positioned at an upper or a lower part of a secondary portion of the linear motor system.

5. The elevator system of claim 4, wherein the linear motor system is mounted to an exterior side wall of the elevator car.

6. The elevator system of claim 5, wherein the buffering device is mounted to an upper or lower end of the secondary portion of the linear motor system such that the buffering device is aligned with the secondary portion and extends beyond a respective exterior end wall of the elevator car.

7. The elevator system of claim 1, wherein the buffering device includes a plurality of buffering members and at least one of at least one first buffering member is positioned on a bottom portion of the first elevator car and at least one second buffering member is positioned on a top portion of the second elevator car.

8. The elevator system of claim 7, wherein at least one first buffering member is positioned on a bottom portion of the first elevator car, at least one second buffering member is positioned on a top portion of the second elevator car, and corresponding ones of the first and second buffering members contact each other upon contact between the first and second elevator cars.

9. The elevator system of claim 8, wherein the first buffering member includes a reaction plate and the second buffering member includes a buffer.

10. The elevator system of claim 1, wherein at least one buffering device is positioned at least at a top or bottom structure of the elevator system.

11. The elevator system of claim 10, wherein the buffering device is arranged substantially perpendicular to the respective top or bottom structure so that the buffering device extends beyond the structure.

12. The elevator system of claim 1, wherein each buffering device is any of mechanical, electric, magnetic, and any combination thereof.

13. The elevator system of claim 12, wherein the buffering device includes any of a spring, a shock absorber, an electromechanical device, and a repulsive-magnetic-force-generating component.

14. The elevator system of claim 1, wherein the buffering device is equipped with a sensor to detect at least one of the contact and integrity and operability of the buffering device and at least one of the detection and a condition of the buffering device is readable by the elevator system.

15. The elevator system of claim 1, wherein the buffering device is frangible.

16. An elevator system comprising:

a first elevator car supported for vertical movement in a lane of a hoistway;

a second elevator car configured to operate and move vertically in the lane below the first elevator car independently thereof;

a transfer station for imparting horizontal movement to the first elevator car and the second elevator car; and

at least one buffering device supported in the transfer station to absorb energy upon contact between each buffering device and the other elevator car.

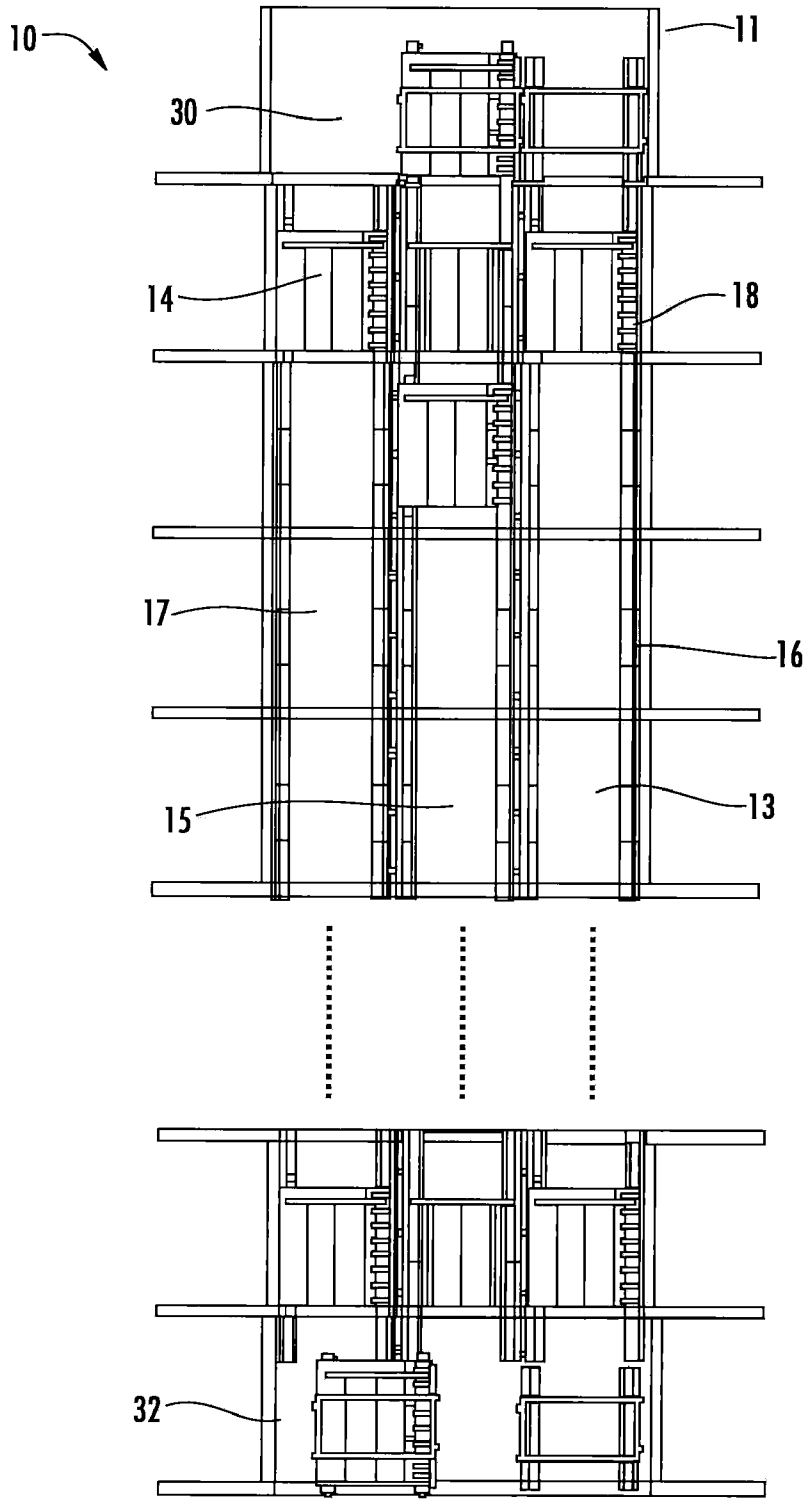

FIG. 1

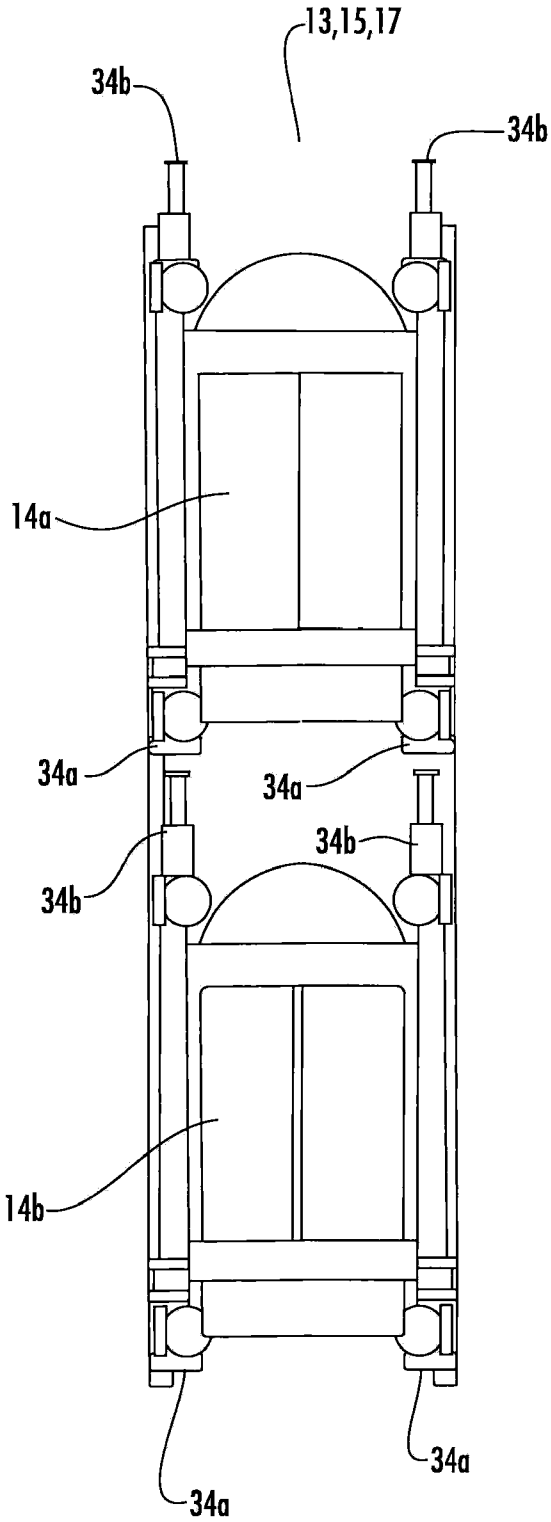

FIG. 2

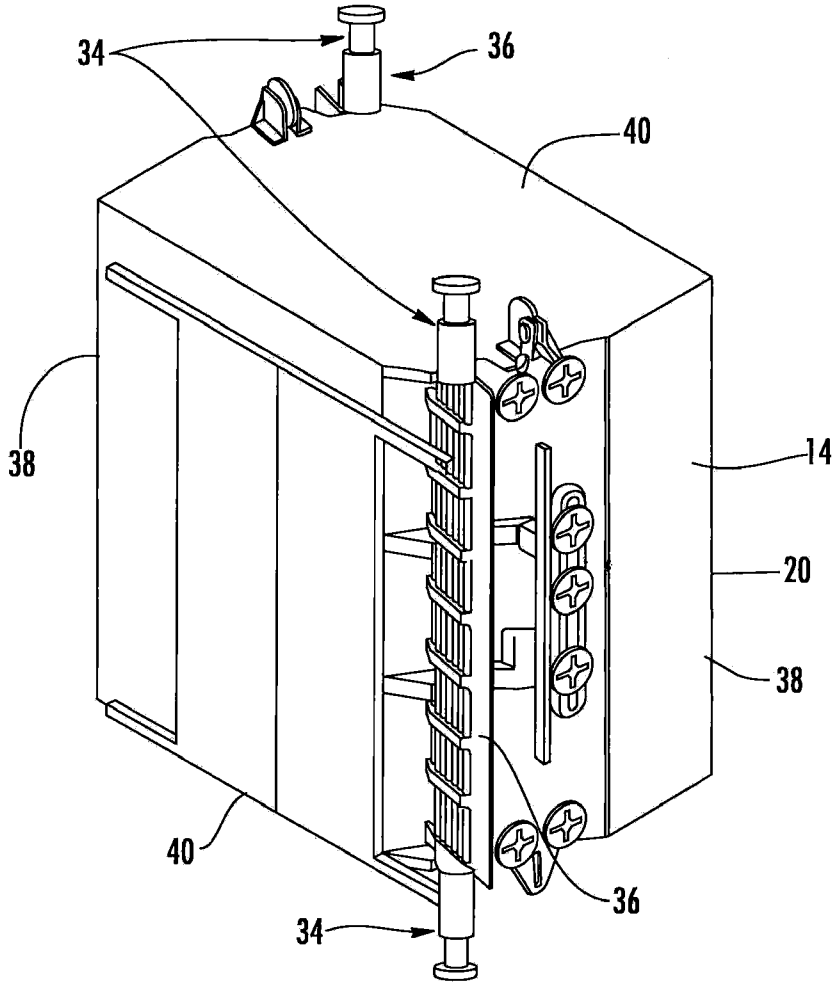

FIG. 3

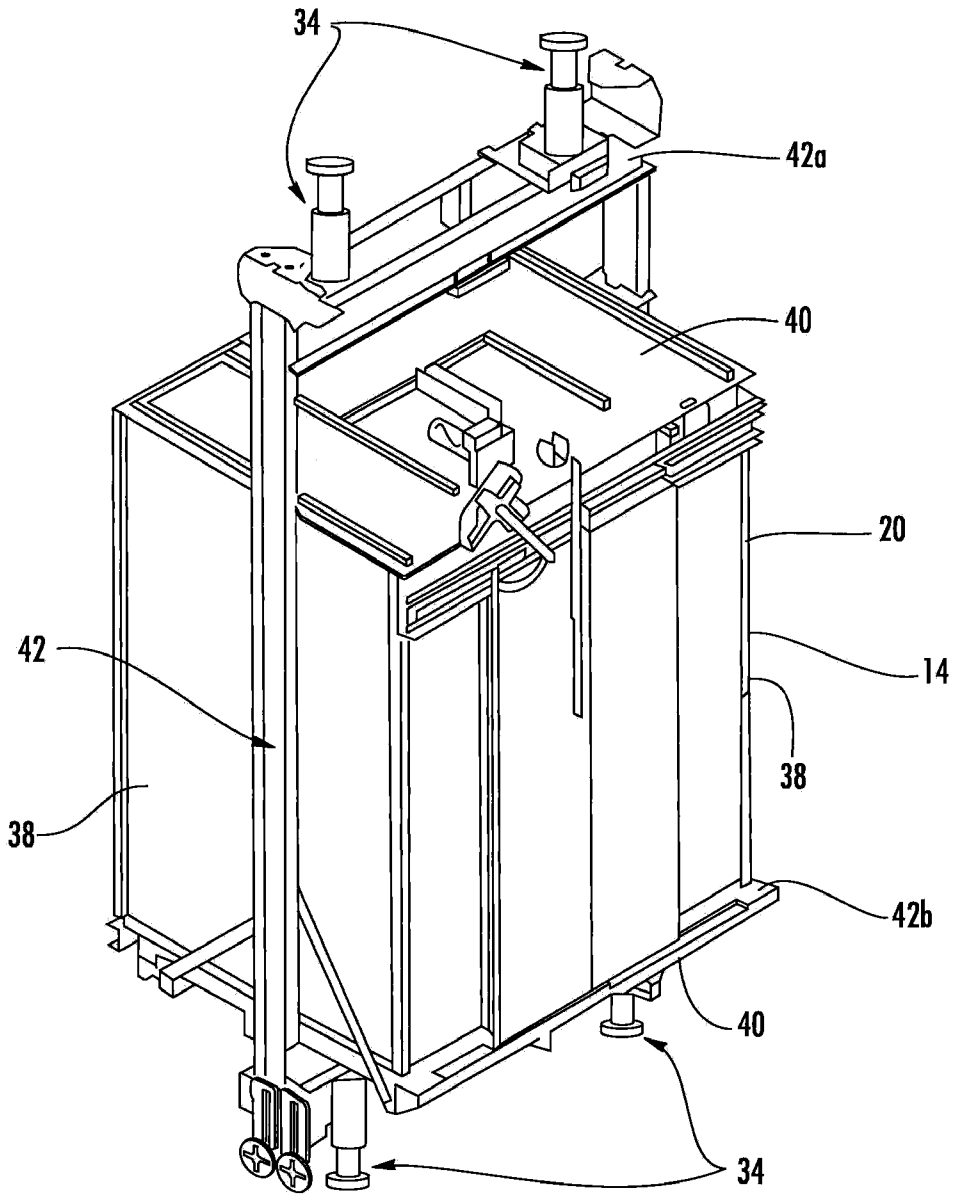

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/013781

A. CLASSIFICATION OF SUBJECT MATTER
INV. B66B5/28
ADD.

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)
B66B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2007/043991 A1 (OTIS ELEVATOR CO [US]; FERRISI JOHN [US]; MCCARTHY RICHARD [US]) 19 April 2007 (2007-04-19) abstract; figures 1-2	1-8, 10-13,15 14
X	EP 0 471 464 A2 (KAJIMA CORP [JP]) 19 February 1992 (1992-02-19) abstract; figures 1,3	16
Y	JP 2000 302353 A (TOSHIBA CORP) 31 October 2000 (2000-10-31) paragraph [0037]; figure 2	14
X	EP 0 499 254 A1 (TOSHIBA KK [JP]) 19 August 1992 (1992-08-19) abstract; figure 2	1-6, 10-13

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[X] Further documents are listed in the continuation of Box C.

[X] 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

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Date of the actual completion of the international search	Date of mailing of the international search report
21 April 2016	10/05/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lenoir, Xavier

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/013781

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP S59 153773 A (TOSHIBA KK) 1 September 1984 (1984-09-01) figures 5,6 -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2016/013781

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