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[Continued on next page]

(54) Title: ASSEMBLY FOR ACTUATING AN ELEVATOR CAR BRAKE

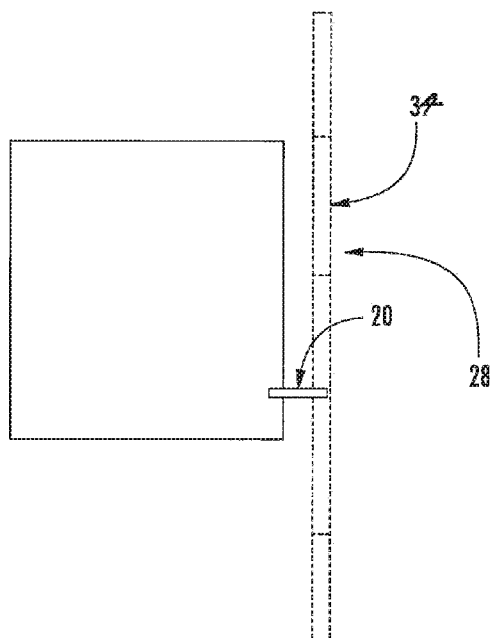


FIG. 3A

(57) Abstract: An assembly 28 for actuating and controlling braking of a car of an elevator system is provided. The assembly includes at least one braking device 20 mounted on the car, supported between the car and a hoistway for movement with the car within the hoistway, and configured to apply a braking force to the car. The assembly also includes at least one corresponding actuator 34 supported by the hoistway and configured to selectively engage the braking device to prevent movement of the car.



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

— *of inventorship (Rule 4.17(iv))*

**Declarations under Rule 4.17:**

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

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

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

## ASSEMBLY FOR ACTUATING AN ELEVATOR CAR BRAKE

### FIELD OF INVENTION

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

[0003] In these elevator systems, batteries or power rails, for example, power brakes to lift and hold the respective cars. Toward this end, the brakes are generally located on the respective movable cars, and control systems and drives are stationary and located in the hoistway. Operation of and communication between the brakes and corresponding drives are configured to be closely coordinated with each other.

### BRIEF DESCRIPTION OF INVENTION

[0004] According to a non-limiting exemplary embodiment of the invention, an assembly for actuating and controlling braking of a car of an elevator system is provided. The assembly includes at least one braking device mounted on the car, supported between the car and a hoistway for movement with the car within the hoistway, and configured to apply a braking force to the car. The assembly also includes at least one corresponding actuator supported by the hoistway and configured to selectively engage the braking device to prevent movement of the car.

### BRIEF DESCRIPTION OF DRAWINGS

[0005] 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:

[0006] FIG. 1 schematically depicts a non-limiting exemplary embodiment of a multiple-car, ropeless elevator system;

[0007] FIG. 2 schematically depicts a car portion of the embodiment of the elevator system illustrated in FIG. 1;

[0008] FIG. 3A schematically depicts a front view of a non-limiting exemplary embodiment of an assembly for actuating and controlling braking of a car of the embodiment of the elevator system illustrated in FIG. 1; and

[0009] FIG. 3B schematically depicts a top view of the embodiment of the brake-actuation-and-control assembly illustrated in FIG. 3A.

## DETAILED DESCRIPTION OF INVENTION

[0010] FIG. 1 depicts a non-limiting exemplary embodiment of a multi-car, ropeless elevator system **10**. 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 readily appreciated 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.

[0011] Above the top floor of the hoistway **11** is an upper transfer station **30** to impart horizontal motion to the cars **14** to move the cars **14** between and among the lanes **13**, **15**, **17**. It should be readily appreciated 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 readily appreciated 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**.

[0012] The cars **14** are propelled using a linear motor system having a primary, fixed portion **16** and a secondary, moving portion **18**. The primary portion **16** includes windings or coils mounted 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.

[0013] As shown in FIG. 1, adjacent lanes **13**, **15**, **17** share a guiderail **12** (or safety rail **12**) 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.

[0014] It should be readily appreciated 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 also be readily appreciated 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 also be readily appreciated 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 also be readily appreciated that any suitable number of cars **14** can travel in a corresponding lane in any suitable direction. It should also be readily appreciated that each of the transfer stations **30**, **32** can impart horizontal motion to the cars **14** in any suitable manner. It should also be readily appreciated that the cars **14** can be propelled using any suitable propulsion system—e.g., an on-board propulsion (e.g., 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.

[0015] FIG. 2 schematically depicts a car portion of the embodiment of the elevator system **10**. Movement of the car **14** along the guiderails **12** is facilitated in a known manner, such as by a plurality of guide-roller devices (not shown). A braking force is applied to prevent undesired movement of each car **14**, such as when the car **14** is in an “over-speed” condition, stopped at a desired position and needs to be held there, or unexpectedly moved.

[0016] However, it should be readily appreciated that movement of the car **14** along the guiderails **12** can be facilitated in any suitable manner. It should also be readily appreciated that a braking force can be applied to prevent any suitable movement of the car **14**.

[0017] Toward that end, at least one safety or braking device **20** is supported between the car **14** and corresponding guiderail **12** for movement with the car **14** along the guiderail **12**. (In the figure, a pair of braking devices **20** are supported between the car **14** and corresponding guiderails **12** for such movement.) The braking device **20** can take the form of

a bar, linkage, or any other suitable structure. In any event, the braking device **20** includes a base portion **22** that is directly or indirectly mounted on an appropriate portion, such as a frame member **24**, of the car **14**. The base portion **22** remains stationary relative to the car **14** and moves vertically with the car **14**. The braking device **20** includes also an opposed portion **26** that is directly or indirectly supported on an appropriate portion of the guiderail **12**. The opposed portion **26** remains stationary relative to the car **14** and moves vertically with the car **14** as well. The opposed portion **26** may include friction components (e.g., wedges) that engage the guiderail **12** to stop the car **14**.

[0018] FIGS. 3A and 3B depict, respectively, front and top views of a non-limiting exemplary embodiment of an assembly **28** for actuating and controlling braking of the car **14**. The assembly **28** includes at least one blade or actuator **34** supported by the building in which the elevator system **10** resides. In an aspect of the embodiment, the actuator **34** is supported by a wall of the hoistway **11**. In a version of this aspect, the actuator **34** is supported by a corresponding guiderail **12**. Each braking device **20** is configured to selectively engage the actuator **34** to activate the braking device **20** to prevent undesired movement of the car **14**. More specifically, the actuator **34** is configured to be retracted to allow, for example, a downward traveling car **14** to move past the location of the actuator **34** in a corresponding “safe zone” of the hoistway **11**. When the actuator **34** is retracted, the braking device **20** is able to avoid contact with the actuator **34** and roll past the actuator **34** during movement of the car **14** to keep the braking device **20** in a position where the braking device **20** does not apply a braking force to the guiderail **12**. The actuator **34** is also configured to be extended to interfere with the corresponding braking device **20** to stop or hold the car **14**. When the actuator **34** is located, say, just below the car **14** and extended, any movement of the car **14** downward causes the braking device **20** to engage the actuator **34** and stop the car **14**.

[0019] In an aspect, a series of actuators **34** is located along the hoistway **11** each of which is capable of engaging a braking device **20**, regardless of location of the corresponding car **14** in the hoistway **11**. In a version of this aspect, to create the “safe zone,” a set of the series of actuators **34** is retracted such that a car **14** can move through the space created by the retracted set of actuators **34**.

[0020] In an aspect and as shown in these figures, each braking device **20** can include, for instance, self-locking wedge-style brake members that are situated for engaging the actuator **34**. In this way, the act of raising wedges of the braking device **20** of a downward traveling car **14** causes the wedges to clamp against the guiderail **12** to stop or hold the car **14**. Toward that end, the actuator **34** in this aspect is a clamp-type actuator **34** and shown in a

retracted state in FIG. 3B. The actuator **34** retracts to allow the car **14** to move past the location of the actuator **34** in the hoistway **11** or extends to interfere with a portion of (e.g., a linkage) the corresponding braking device **20** to trigger the brake device to stop or hold the car **14**. When the actuator **34** is located just below the car **14** and in the extended position, any movement of the car **14** downward causes the braking device **20** to engage the actuator **34**, activating the braking device **20** and stopping the car **14**. Movement of the car **14** upward disengages the wedges.

[0021] It should be readily appreciated that each of the guiderail **12**, braking device **20**, and actuator **34** can have any suitable structure and the guiderail **12**, car **14**, braking device **20**, and actuator **34** can have any suitable relationship with each other. For example, the braking device **20** can include instead rollers that are situated for engaging the actuator **34**. It should also be readily appreciated that one or both of the braking devices **20** can be operating at any given time. It should also be readily appreciated that, although the assembly **28** is described above in connection with only a downward traveling car **14** (i.e., controlling movement of a car **14** in only one direction), the assembly **28** can be suitably implemented with an upward traveling car **14** as well (i.e., controlling movement of the car **14** in both directions).

[0022] Under selected conditions, it is desirable to apply a braking force using the braking device(s) **20**. At least one controller or drive (not shown) is programmed to determine when such a condition exists in which it is desired to control the actuator **34** to apply each braking device **20** (i.e., “unsafe zones”). If such a condition exists, the controller(s) activate(s) the actuator(s) **34** for applying the braking force using the respective braking device(s) **20**. It should be readily appreciated how to configure or program the controller(s) and what type of software, hardware, firmware, or any combination of these best meet the needs of any particular situation. The controller(s) is/are programmed with a variety of conditions for selectively controlling the actuator(s) **34** for controlling the application of braking force(s) using the braking device(s) **20**. In an aspect, each individual controller can be configured to control the primary portion **16** (of the motor system) and actuator(s) **34** in a same general location of the hoistway **11**.

[0023] By way of example only and not by way of limitation, the actuator **34** can include a pair of coils that receive electrical power through a link between the controller and actuator **34**. The link allows the controller to selectively control application of the actuator **34** and includes a hard-wired connection to a source of power or wireless signal transmission between the controller and actuator **34**. A post can be normally biased away from the

actuator **34** and toward the car **14** by a spring. When the coils are energized, the posts can be retracted in a direction toward the actuator **34**. In this retracted position, the braking device **20** avoids contact with the actuator **34**. A control algorithm identifies the “safe zones” into which the cars **14** can move and retracts the respective actuators **34** in such zones. The actuators **34** positioned in the “unsafe zones,” especially space defined by and between adjacent cars **14**, are extended to activate the respective braking devices **20** and prevent any contact between the cars **14**.

[0024] More specifically, in this example, in the event that the controller determines that it is desirable to control movement of a car **14** using the braking device(s) **20**, the controller controls deactivation of the coils to allow the springs to urge the stop members of the actuator(s) **34** into engagement with the braking device(s) **20**. By de-energizing the coils, the stop members are urged into engagement with the braking device(s) **20**. Any downward movement of the car **14** in this condition results in triggering of the braking device(s) **20** to engage the guiderail **12**. This results in applying a braking force that prevents further movement of the car **14**.

[0025] Once the controller determines that it is no longer desired to apply a braking force using the braking device(s) **20**, the controller appropriately controls the respective actuator(s) **34** (e.g., re-energizes the coils), and stop members are retracted away from the braking device(s) **20**. Upward movement of the car **14** releases the braking device(s) **20**.

[0026] Another example of an “unsafe zone” is at a landing during, for example, loading or unloading of a car **14** where the car **14** can move relatively slightly. The car **14** can be controlled by the assembly **28** in a manner that facilitates prevention of such movement. When the car **14** is stopped in a desired position at the landing, the controller controls each actuator **34** to apply the respective braking device **20**. In the event that the load on the car **14** changes significantly such that there would be a perceived bouncing of the car **14** relative to the landing, the braking device **20** operates to prevent such movement of the car **14** relative to the landing outside of a desired range. An acceptable range of movement of the car **14** can be set when the car **14** is otherwise stopped using a brake associated with the elevator system **10** as known.

[0027] It should be readily appreciated that it can be desired to control the actuator **34** in any suitable existing condition. It should also be readily appreciated that the controller can be programmed to determine when the conditions exist in any suitable manner. It should also be readily appreciated that the link can include any suitable type of connection or transmission between the controller and actuator **34**. It should also be readily appreciated that the control

algorithm can identify the “safe zones” and “unsafe zones” in any suitable manner. It should also be readily appreciated that the “safe zones” and “unsafe zones” can be defined in any suitable respective regions of the hoistway **11**.

[0028] The assembly **28** is useful for controlling movement of a car **14** and applying a braking force to prevent the “over-speed” condition or unexpected or undesired movement of the car **14**. The controller obtains information from known devices or techniques for determining when such a condition exists. It should be readily appreciated how to configure or program the controller for that purpose according to particular needs.

[0029] The assembly **28** locates the actuators **34** for the respective braking devices **20** in the hoistway **11** (not on the cars **14**). Also, the system **10** eliminates communication between the cars **14** and respective drives and, thereby, makes the system **10** more robust and simple. Furthermore, the system **10** significantly reduces power requirements of the cars **14** and, thus, saves cost, weight, and life. In addition, the system **10** singularly and safely assures that the cars **14** neither contact each other nor have to take any action on their own for them to be stopped and held.

[0030] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily appreciated 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 readily appreciated 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 assembly for actuating and controlling braking of a car of an elevator system, the assembly comprising:
  - at least one braking device mounted on the car, supported between the car and a hoistway for movement with the car within the hoistway, and configured to apply a braking force to the car; and
  - at least one corresponding actuator supported by the hoistway and configured to selectively engage the braking device to prevent movement of the car.
2. The assembly of claim 1, wherein the braking device is mounted on a frame member of the car.
3. The assembly of claim 1, wherein the actuator is supported by a corresponding guiderail of the hoistway.
4. The assembly of claim 1, wherein the actuator is configured to be retracted to allow the car to move past a location of the actuator in the hoistway and extended to interfere with the corresponding braking device to stop the car.
5. The assembly of claim 4, wherein the actuator includes a spring biasing the actuator in the extended position and a coil to move the actuator into the retracted position.
6. The assembly of claim 1, wherein a controller is programmed to activate and control the actuator to apply the braking force using the braking device.
7. The assembly of claim 1, wherein a series of actuators is supported by the hoistway and each of which is configured to selectively engage the braking device to prevent movement of the car.
8. An elevator system comprising:
  - a hoistway;
  - at least one car supported for vertical movement in a lane of the hoistway; and
  - an assembly for actuating and controlling braking of the car, the assembly including:
    - at least one braking device mounted on the car, supported between the car and the hoistway for movement with the car within the hoistway, and configured to apply a braking force to the car; and
    - at least one corresponding actuator supported by the hoistway and configured to selectively engage the braking device to prevent movement of the car.
9. The elevator system of claim 8, wherein the braking device is mounted on a frame member of the car.

10. The elevator system of claim 8, wherein the actuator is supported by a corresponding guiderail of the hoistway.

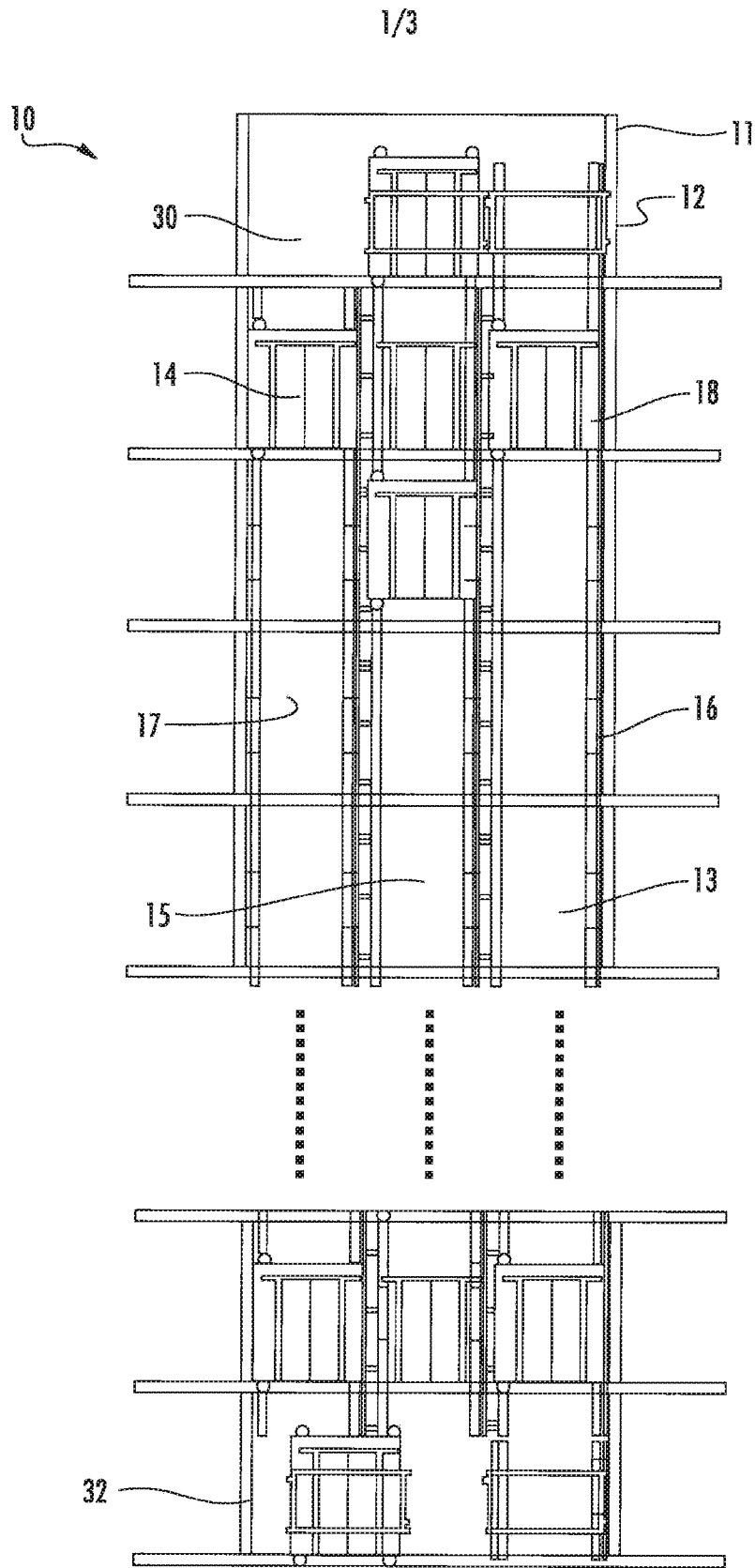
11. The elevator system of claim 8, wherein the actuator is configured to be retracted to allow the car to move past a location of the actuator in the hoistway and extended to interfere with the corresponding braking device to stop the car.

12. The assembly of claim 11, wherein the actuator includes a spring biasing the actuator in the extended position and a coil to move the actuator into the retracted position.

13. The elevator system of claim 7, wherein a controller is programmed to activate and control the actuator to apply the braking force using the braking device.

14. The elevator system of claim 8, wherein a series of actuators is supported by the hoistway and each of which is configured to selectively engage the braking device to prevent movement of the car.

15. The elevator system of claim 14, wherein a set of the series of actuators is retracted to create a safe zone of the hoistway through which the car can move.



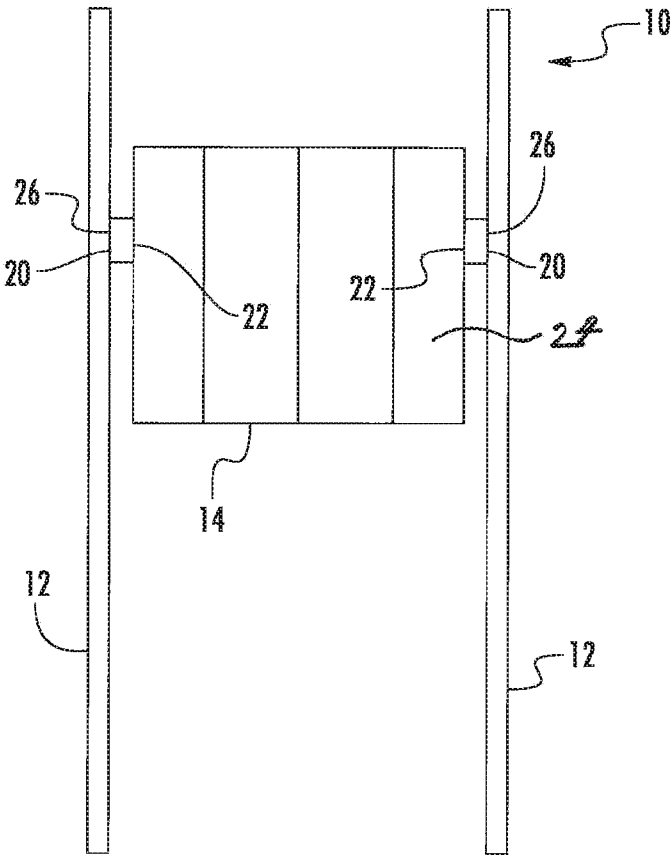


FIG. 2

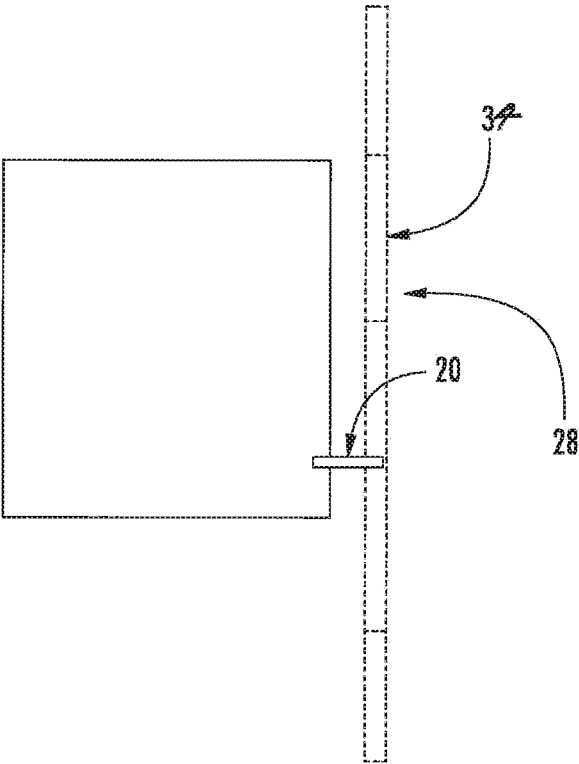


FIG. 3A

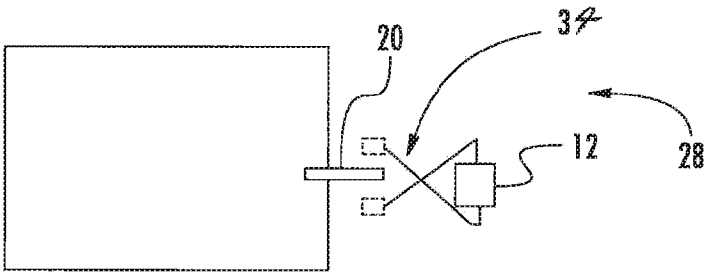


FIG. 3B

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/013889

## A. CLASSIFICATION OF SUBJECT MATTER

INV. B66B5/00

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                              | Relevant to claim No.  |
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| X         | -----<br>EP 1 422 182 A1 (CENTODUCATI S P A [IT])<br>26 May 2004 (2004-05-26)<br>paragraphs [0021], [0022]; figures 9,10                                                        | 1-6,8-13               |
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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

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

26 April 2016

Date of mailing of the international search report

10/05/2016

Name and mailing address of the ISA/

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/013889

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date         |
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