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## (54) Drive for elevators and goods hoists

(57) A drive (1) for elevators and goods hoists, comprising a shaft in which a car (2) and a counterweight (3) are guided so that they can slide parallel to each other in opposite directions, the car and the counterweight being connected by at least one toothed belt (4), which is functionally associated with a drive unit (6), the drive unit (6) having, interposed between the electric motor (6) and the pinion (9) for meshing with the belt (4), a torque-limiting coupling (8). The drive unit (6) is installed on a portion of the car.

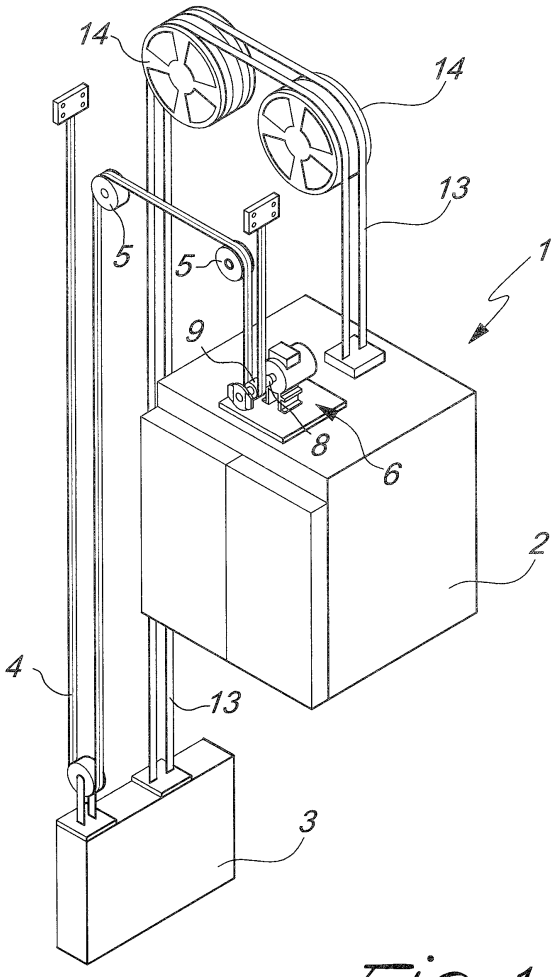


Fig. 1

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## Description

**[0001]** The present invention relates to a drive for elevators and goods hoists.

**[0002]** Elevators and goods hoists are currently provided with a car of variable size depending on the installation environment and on the operating requirements. The car is provided externally with appropriate safety elements, which are suitable to act as a safety brake if the elements that support it are damaged or even broken.

**[0003]** The elements designed to move and support the car can be hydraulic or of the cable (or chain) type.

**[0004]** In embodiments using cables (or chains), the car is moved vertically within an appropriate shaft, which is made of masonry or other structural material, inside or outside the building where it is installed, by means of cables (or chains) by a drive unit.

**[0005]** The weight of the car, and part of the load (usually half), can be balanced by way of the presence of appropriately provided counterweights connected to the car by means of one or more metal cables (the same ones used for traction), which are engaged in appropriately provided pulleys, so that the car and the counterweight slide within the shaft with mutually parallel orientations but with opposite directions.

**[0006]** The advantage achieved by using counterweights is that the drive unit only needs to provide the energy required to move part of the load.

**[0007]** The cables that are used are usually made of metal or other materials having excellent mechanical qualities (composite fibers based on Kevlar, carbon or other synthetic materials). To ensure sufficient tensile strength, it is necessary to resort to relatively large-diameter cables, which due to the compulsory requirements set by standards force the adoption of pulleys having a large diameter; this drawback can be avoided by using chains that mesh directly in a respective pinion that has a substantially smaller diameter. Each movement of the pinion is matched by a respective movement of the chain.

**[0008]** The use of chains is also considered by currently applicable statutory provisions, and known examples of systems that use it have existed for a long time.

**[0009]** The use of toothed belts provides the same advantages as chains, associating with them considerable quietness, and can advantageously replace chains; this entails a high level of comfort for the users of the elevator.

**[0010]** Besides, toothed belts have been used for decades in various industrial fields for the horizontal and vertical translational motion of masses that move in a reciprocating fashion.

**[0011]** The standard related to elevators (UNI EN 81-1) requires, for friction pulleys, pulleys and pinions, the adoption of precautions required to avoid fleeting (i.e., the escape of the cable from the race of the pulley or the skipping of teeth in the meshing of the pinion and the chain or belt) if slackening occurs.

**[0012]** Secondly, the standard requires the presence of an electromechanical brake, which acts automatically if the main electric power supply fails or if the drive circuit power supply fails.

**[0013]** Finally, the standard requires the adoption of measures suitable to ensure the sliding of the cables when the car is stuck in the shaft for any reason.

**[0014]** Many of the problems described above have been solved by the invention disclosed in EPA 04015126.8 in the name of this same Applicant.

**[0015]** Said invention has the disadvantage of requiring a fixed region for installing the motor in the lift shaft; this is not always possible, especially when the system already exists and has to be modified (for example to adapt it to currently applicable standards) and therefore it is not possible to change the building structure of the shaft.

**[0016]** The aim of the present invention is to obviate the above-cited drawbacks and meet the mentioned requirements, by providing a drive for elevators and goods hoists that can adopt commercial toothed belts and in which the motor can be installed even on non-fixed portions of the system.

**[0017]** Positively, an object of the present invention is to provide a drive that is equipped with means suitable to maintain the continuous mutual meshing of the belt and the pinion and has an element that is suitable to ensure mutual sliding of the belts and the car when said car is stuck.

**[0018]** Advantageously, the drive according to the invention can be connected to the car and to the counterweight by arranging the belts in a simple or multiple tackle configuration, in order to reduce the stress to which the motor drive is subjected.

**[0019]** Within this aim and object, another object of the present invention is to provide a structure that is simple, relatively easy to provide in practice, safe in use, effective in operation, and has a relatively low cost.

**[0020]** This aim and these and other objects that will become better apparent hereinafter are achieved by the present drive for elevators and goods hoists, of the type that comprises a shaft in which a car and a counterweight are guided so that they can slide parallel to each other in opposite directions, said car and said counterweight being connected by at least one toothed belt, which is functionally associated with a drive unit, said drive unit having, interposed between the electric motor and the pinion for meshing with said belt, a torque-limiting coupling, characterized in that said drive unit is installed on a portion of said car.

**[0021]** Further characteristics and advantages of the present invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment of a drive for elevators and goods hoists, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a view of a lift provided with a drive according to the invention, designed to move the car and the counterweight, with the drive unit installed

in an upper region in the car and cables for connecting and supporting the car and the counterweight;

Figure 2 is a perspective view of an assembly designed to move the car and the counterweight according to the invention, which can be installed on the top of the car;

Figure 3 is a view of a lift provided with a drive according to the invention, designed to move the car and the counterweight, with the drive unit that is installed in an upper region in the car and twin cables for connecting and supporting the car and the counterweight;

Figure 4 is a view of a lift provided with a unit according to the invention, designed to move the car and the counterweight, with the drive unit installed laterally in the car and cables for connecting and supporting the car and the counterweight;

Figure 5 is a perspective view of an assembly designed to move the car and the counterweight according to the invention, which can be installed on the top of the car.

**[0022]** With reference to the figures, the reference numeral 1 generally designates a drive for elevators and goods hoists.

**[0023]** The elevator is constituted by a car 2 and a counterweight 3, which are respectively connected by toothed belts 4 (rigidly coupled to points that are fixed to the travel shaft, either directly or by way of elastic means such as helical springs), conveniently guided by fixed guiding pulleys 5 on the upper or lateral surfaces of the installation shaft.

**[0024]** The toothed belts 4 are substantially commercial belts that have characteristics of high tensile strength and low deformation when loaded.

**[0025]** It is important that the belts 4 be made of (or covered with) wear-resistant material, in order to ensure maximum safety and require limited maintenance and maximum quietness in operation.

**[0026]** The toothed belts 4, indeed by virtue of the fact that they are of a commercial type and therefore are manufactured to ensure the most compact possible couplings, can be coupled advantageously to driving pinions that have a reduced diameter (the minimum diameter compatible with the type of belt, even approximately 50 mm), in order to transmit the required torque, ensuring low dimensions for the entire drive 1.

**[0027]** In this manner, the acceleration and braking torques also decrease, and the adjustment speed of the motor, for an equal speed of the car 2, is higher and therefore the motor is easier to adjust.

**[0028]** In the figures, the teeth of the belts 4 and of the pinions or rollers that are associated therewith in order to transmit motion are shown by means of thin black lines: this choice has been dictated by the need to make the comprehension of the figures compatible with the scale in which they are drawn.

**[0029]** A drive unit 6 is mounted on the external surface of the car (for example on the top, on the bottom or on one of the lateral surfaces that cannot be opened) and supports a torque-limiting coupling 8, a pinion 9 for the meshing of the teeth of the belts 4, and a brake 10, all of which are keyed to its shaft 7.

**[0030]** The torque-limiting coupling 8 prevents, when the car 2 and the counterweight 3 are already in an extreme configuration (for example, the car 2 is at the top floor or not at floor level toward the top of the shaft, and the counterweight 3 is resting on the bottom of the shaft), the motor 6 from being able to provide torque to the belts 4, possibly damaging them (excessive fiber stretching) and, worse still, causing the car to strike the ceiling of the shaft.

**[0031]** The coupling 8 is adjusted so as to avoid its activation during the acceleration of the loaded car as it rises.

**[0032]** The pinion 9 is provided with a set of teeth that is complementary to the set of teeth of the belts 4 and is surrounded by a closely-fitting housing 9a, the internal surface of which is proximate to the surface of the back of the belts 4, thus keeping them correctly engaged in the pinion 9, preventing their escape, a precaution that is necessary in order to avoid fleeting in case of loosening, as prescribed by the standards. This function might be obtained with any other component that is suitable for the purpose, such as for example a sliding block whose surface rests on the back of the belt 4 proximate to the portion where the belt 4 meshes with the pinion 9, or a series of rollers that are freely mounted in the same position and are designed to keep the belt 4 and the pinion 9 mutually meshed.

**[0033]** Even in case of intense traction on the belts 4 caused for example by sudden jamming of the car as a consequence of a failure, with a consequent rebound of the counterweight, there would be no risk of said belts disengaging from the pinion 9, compromising the operation of the system.

**[0034]** The brake 10 can be of any type and is designed to ensure the stable parking of the car at a given floor (in the examples shown in the figure, it comprises a disc 11, which is rigidly coupled to the shaft 7 and on which respective calipers 12 can be closed).

**[0035]** The brake 10 therefore complies with the requirements listed in the standards in relation to the electromechanical brake: said brake in fact acts automatically in case of failure of the main electric power supply or in case of failure of the power supply of the driving circuit.

**[0036]** It should be noted that in order to meet the requirements of the standards, the brake must be capable of stopping the machine on its own while the car is descending at nominal speed and with its capacity increased by 25%.

**[0037]** The installation of the motor 6 on one of the external surfaces of the car 2 is extremely advantageous, in relation to the fact that it allows to use a drive 1 according to the invention even in systems that do not have technical areas that are suitable to accommodate the mo-

tor 6. The drive 1 according to the invention can therefore be installed in any type of lift, even where space for maintenance (and installation) of the motor is not provided, since all the maintenance work can be performed from the inside of the car 2 through an appropriately provided opening formed in order to access the motor 6.

**[0038]** The motor 6 can be installed on the upper surface of the car 2 (in what is found to be the simplest constructive solution), but can also be installed on one of the lateral surfaces.

**[0039]** In this second case, the belt 4 is preferably stretched between the ceiling and the floor of the installation shaft and the pinion 9 engages in its teeth in a manner similar to the engagement of a pinion with a rack, with the only difference that there can be two guiding pulleys 9b and 9c, which are designed to keep the pinion 9 and the belt 4 firmly meshed with an adequate wrap-around angle.

**[0040]** In other configurations, the belts 4 can be fixed directly onto the ceiling of the installation shaft and can be guided by appropriately provided pulleys 5, which are mounted on the ceiling of the installation shaft so as to constitute a tackle, in practice reducing the stress to which the motor 6 is subjected.

**[0041]** It is also possible to subject the belts 4 only to the stress required for movement, entrusting to other supporting elements the task of supporting the loads, with the advantage of ensuring the support of the car 2 and of the counterweight 3, achieving maximum safety in case of breakage of the belts 4; the other supporting elements allowed to activate the classic safety systems (safety brake).

**[0042]** In this manner, in addition to the advantages described above there is also the advantage of increasing the safety of the system: in this manner, the toothed belts 4 in fact perform exclusively a traction function, while cables 13 (for example) bear the considerable loads of the car 2, of the counterweight 3 and of the load.

**[0043]** The supporting elements can be conventional cables 13, flat belts, toothed belts, or other elements that are highly resistant to traction and generate limited noise.

**[0044]** The cables 13 also can be fixed directly to the ceiling of the installation shaft and can be guided by appropriately provided pulleys, which are fixed to the counterweight and to the car, and by other pulleys mounted on the ceiling of the installation shaft, so as to constitute a tackle.

**[0045]** If supporting cables 13 are used, there is reduced wear of such cables with respect to a conventional system, since the cables work on guiding pulleys 14 having races provided with a semicircular profile without a notch; therefore, since they are not clamped within the races, they are less subj ect to wear.

**[0046]** Obviously, every individual characteristic of the installation configuration related to the position of the motor 6, to the fixing of the belts 4 (direct or by means of a spring), to the fixing of the cables 13 (direct or as a tackle), can be combined with any one of the others in order to provide a drive 1 for elevators and goods hoists according to the invention.

**[0047]** The examples given in the figures are merely an example of some of the possible configurations that can be provided.

**[0048]** The operation of the invention is intuitive; the car 2 and the counterweight 3 are moved by the motor 6 by means of the pinion 9.

**[0049]** The toothed belts 4 in fact constantly have a portion of their toothed surface that is engaged on the pinion 9, thus associating rotations (clockwise or counterclockwise ones) of the motor 6 with respective movements (in an upward or downward direction) of the car 2 (and accordingly of the counterweight 3).

**[0050]** It should be noted that, since these are toothed belts 4 with a constant pitch, for each turn of the shaft 7 the car 2 covers a very specific and exact portion of its travel, and therefore the use of an encoder (or of another similar device that measures precisely the turns made by the shaft) allows to establish precisely the position of the car 2 by means of the control panel, eliminating the position transducers (also known as shaft switches) traditionally arranged in the travel shaft.

**[0051]** In the drive 1 according to the invention, the shaft switches are installed only at the top and bottom floors.

**[0052]** It has thus been shown that the invention achieves the intended aim and objects.

**[0053]** The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

**[0054]** In all cases in which tackles have been described (guiding by means of a pulley 5 of the belts 4 and subsequent fixing thereof to a fixed point, for example of the containment shaft) in order to reduce the stress to which some of the elements involved are subjected, it is evident that it is always possible to combine a plurality of guiding elements, increasing the number of tackles in order to provide an even more favorable transmission ratio.

**[0055]** All the cases with supporting cables 13 and corresponding guiding pulleys 14 can have the working surfaces of the cables 13 rotated through 90° and arranged laterally with respect to the car 2.

**[0056]** The brackets for retaining the cables 13, which are shown on the top of the car 2 and of the counterweight 3, can be arranged in any position of the lateral surface to which they will be fixed.

**[0057]** In this manner, the guiding pulleys 14 are external to the projection of the ceiling of the car 2 in case of overtravel thereof to the top floor.

**[0058]** All the details may further be replaced with other technically equivalent elements.

**[0059]** In the embodiments that have been described, individual characteristics, given in relation to specific examples, may actually be interchanged with other different characteristics that exist in other embodiments.

**[0060]** Moreover, it is noted that anything found to be

already known during the patenting process is understood not to be claimed and to be the subject of a disclaimer.

**[0061]** In practice, the materials used, as well as the shapes and the dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the appended claims.

**[0062]** The disclosures in Italian Patent Application No. BO2004A000396 from which this application claims priority are incorporated herein by reference.

**[0063]** Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

## Claims

1. A drive for elevators and goods hoists, of the type that comprises a shaft in which a car (2) and a counterweight (3) are guided so that they can slide parallel to each other in opposite directions, said car and said counterweight being connected by at least one toothed belt (4), which is functionally associated with a drive unit (6), said drive unit (6) having, interposed between the electric motor (6) and the pinion (9) for meshing with said belt (4), a torque-limiting coupling (8), **characterized in that** said drive unit (6) is installed on a portion of said car (2).

2. The drive according to claim 1, **characterized in that** said pinion (9) is surrounded by a closely-fitting housing (9a), the internal surface of which is proximate to the external surface of the belt (4) that is wound around the pinion (9), said housing being suitable to retain the belt (4) correctly coupled to the pinion (9), preventing its escape if the motion of the belt (4) is affected by events of various kinds.

3. The drive according to claim 1 and as an alternative to claim 2, **characterized in that** said pinion (9) is proximate to a sliding block, in which one surface is in contact with the outer surface of the belt (4) that is wound around the pinion (9), said block being suitable to keep the belt (4) correctly coupled to the pinion (9), preventing its escape if the motion of the belt (4) is affected by events of various kinds.

4. The drive according to claim 1 and as an alternative to claims 2 and 3, **characterized in that** said pinion (9) is proximate to a plurality of rollers (9b and 9c) whose axes are parallel to the axes of the pinion (9) and are mounted so that they can rotate freely with their lateral surfaces in contact with the outer surface of the belt (4), which is wound around the pinion (9), said rollers being suitable to keep the belt (4) correctly coupled to the pinion (9), preventing its escape if the motion of the belt (4) is affected by events of various kinds.

5. The drive according to one or more of the preceding claims, **characterized in that** said toothed belt (4) engages within appropriately provided pulleys (5), which are rigidly coupled to a part that is fixed to the shaft and to the counterweight (3), the ends being anchored to the ceiling of said shaft, constituting a tackle and therefore subj ecting the drive unit (6) to reduced stresses.

6. The drive according to one or more of the preceding claims, **characterized in that** said car (2) and said counterweight (3) are connected to the ends of at least one second cable (13), which is engaged within appropriately provided guiding pulleys (14) anchored to the top of said shaft, said cable (13) being suitable to support statically the car (2) and the counterweight (3).

7. The drive according to claim 6, **characterized in that** said second cable (13) is a belt.

8. The drive according to claim 7, **characterized in that** said second cable (13) is a toothed belt.

9. The drive according to claim 6, **characterized in that** said second cable (13) has a high tensile strength and a reduced noise emission during operation.

10. The drive according to claim 6, **characterized in that** said second cable (13) engages within appropriately provided pulleys, which are mounted so that they can rotate freely on the respective upper surfaces of the car (2) and of the counterweight (3), its ends being anchored to the top of said shaft, constituting a tackle.

11. The drive according to one or more of the preceding claims, **characterized in that** said pinion (9) has a minimum diameter that is compatible with the type of toothed belt that is chosen.

12. The drive according to one or more of the preceding claims, **characterized in that** a brake (10) is fixed to the motor shaft (7).

13. The drive according to one or more of the preceding claims, **characterized in that** said motor drive (6) is mounted rigidly on the top of said car (2) in a position that can be accessed for maintenance.

14. The drive according to one or more of the preceding claims, **characterized in that** said motor drive (6)

is rigidly fixed to the base of said car (2) in a position that can be accessed for maintenance.

**15.** The drive according to one or more of the preceding claims, **characterized in that** said motor drive (6) is rigidly fixed on one of the lateral surfaces of said car (2) that can be accessed for maintenance.

**16.** The drive according to claim 15, **characterized in that** said belt (4) is mounted so that it is stretched between the ceiling and the floor of said shaft, the pinion (9) rigidly coupled to the motor (6) being engaged in said belt (4), in a manner similar to a rack.

**17.** The drive according to claims 13 and 14, **characterized in that** said pinion (9) of said motor (6) is engaged on said belt (4), said belt having an end that is rigidly coupled to the ceiling of said shaft.

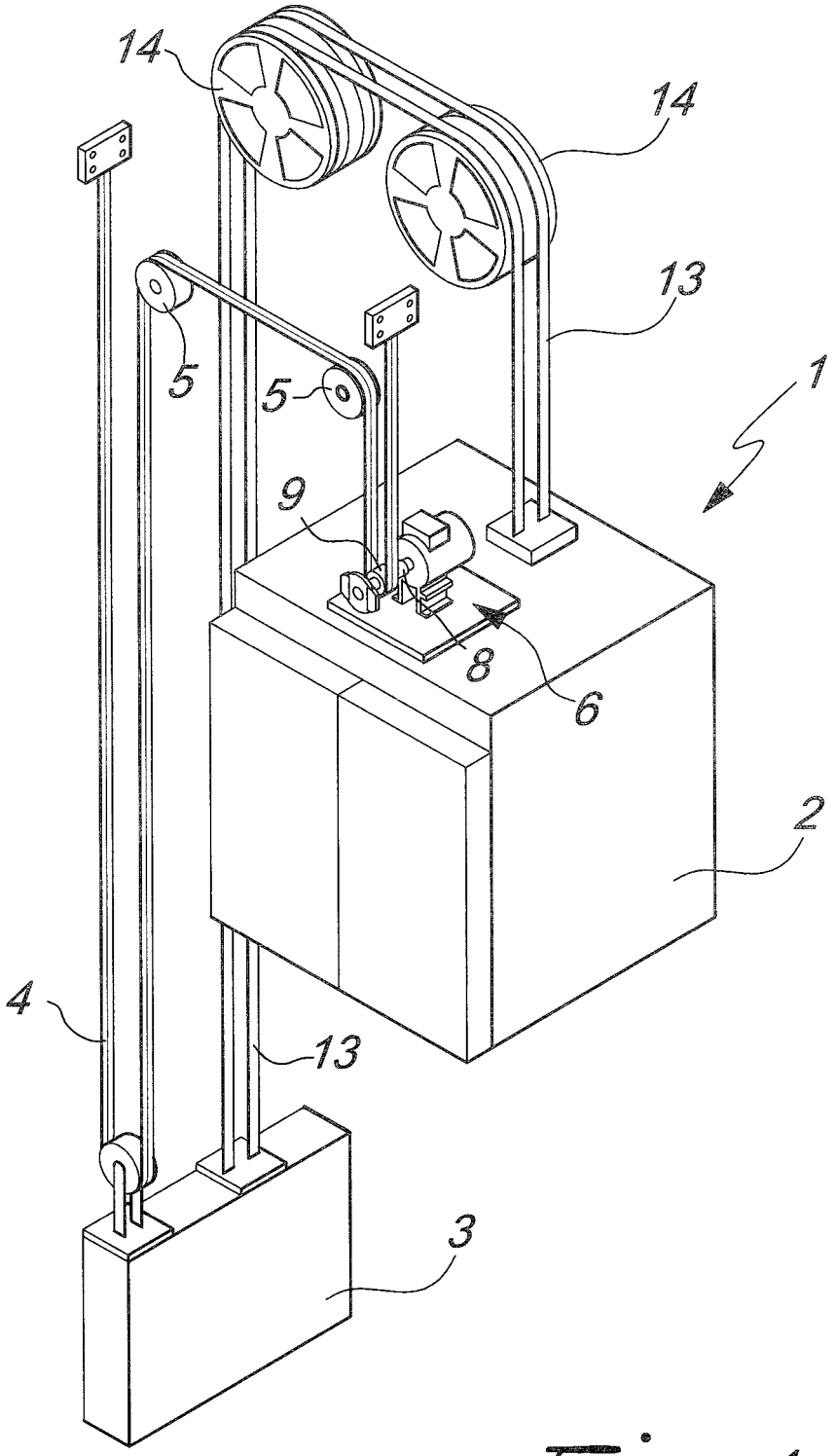


Fig. 1

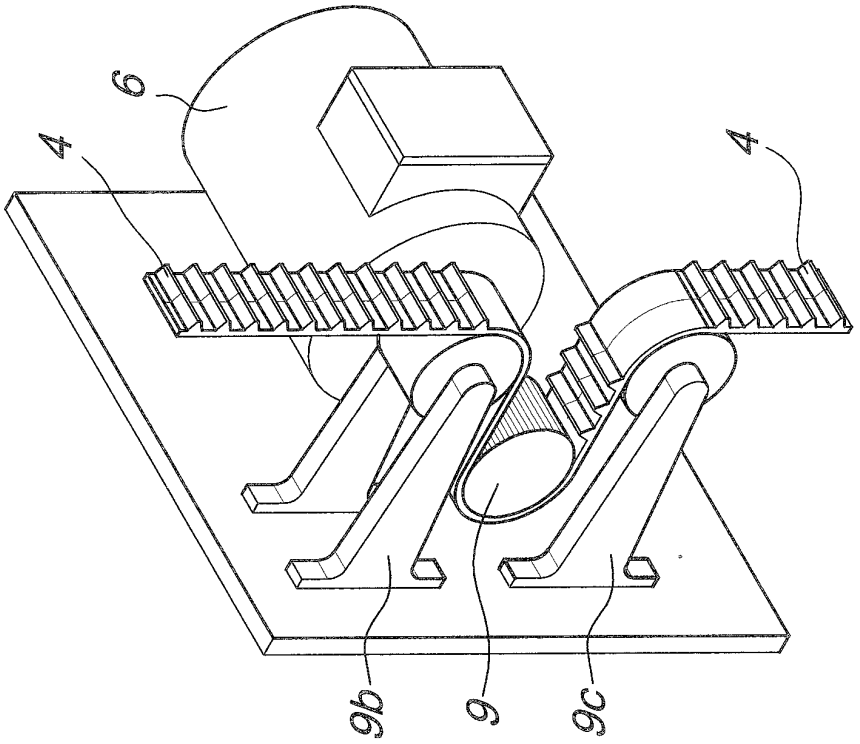


Fig. 5

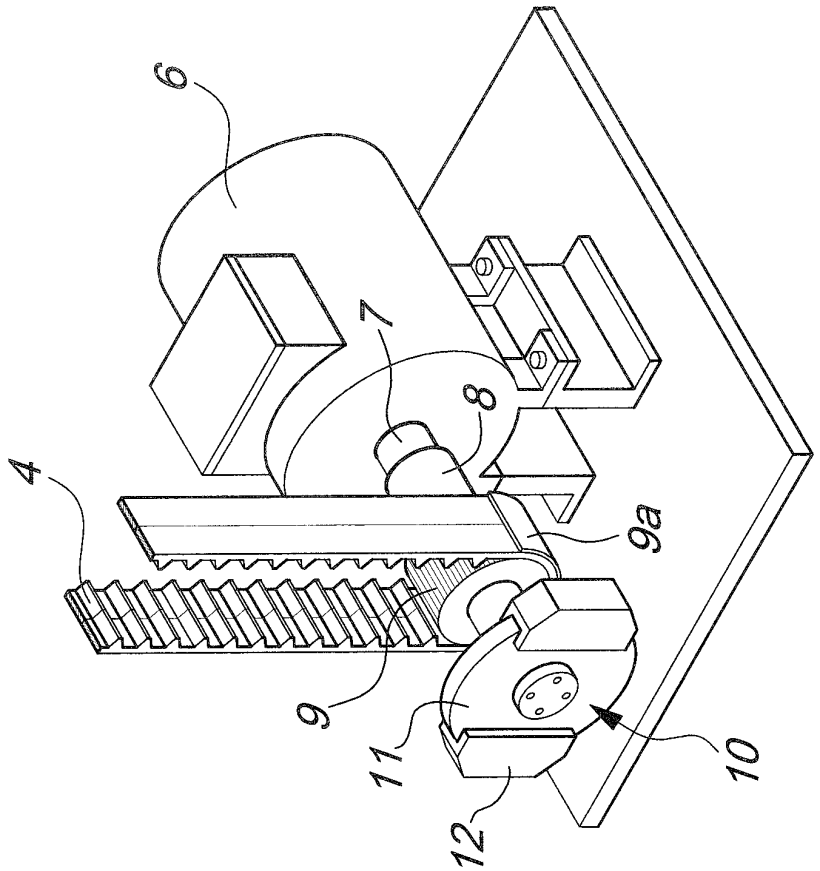


Fig. 2

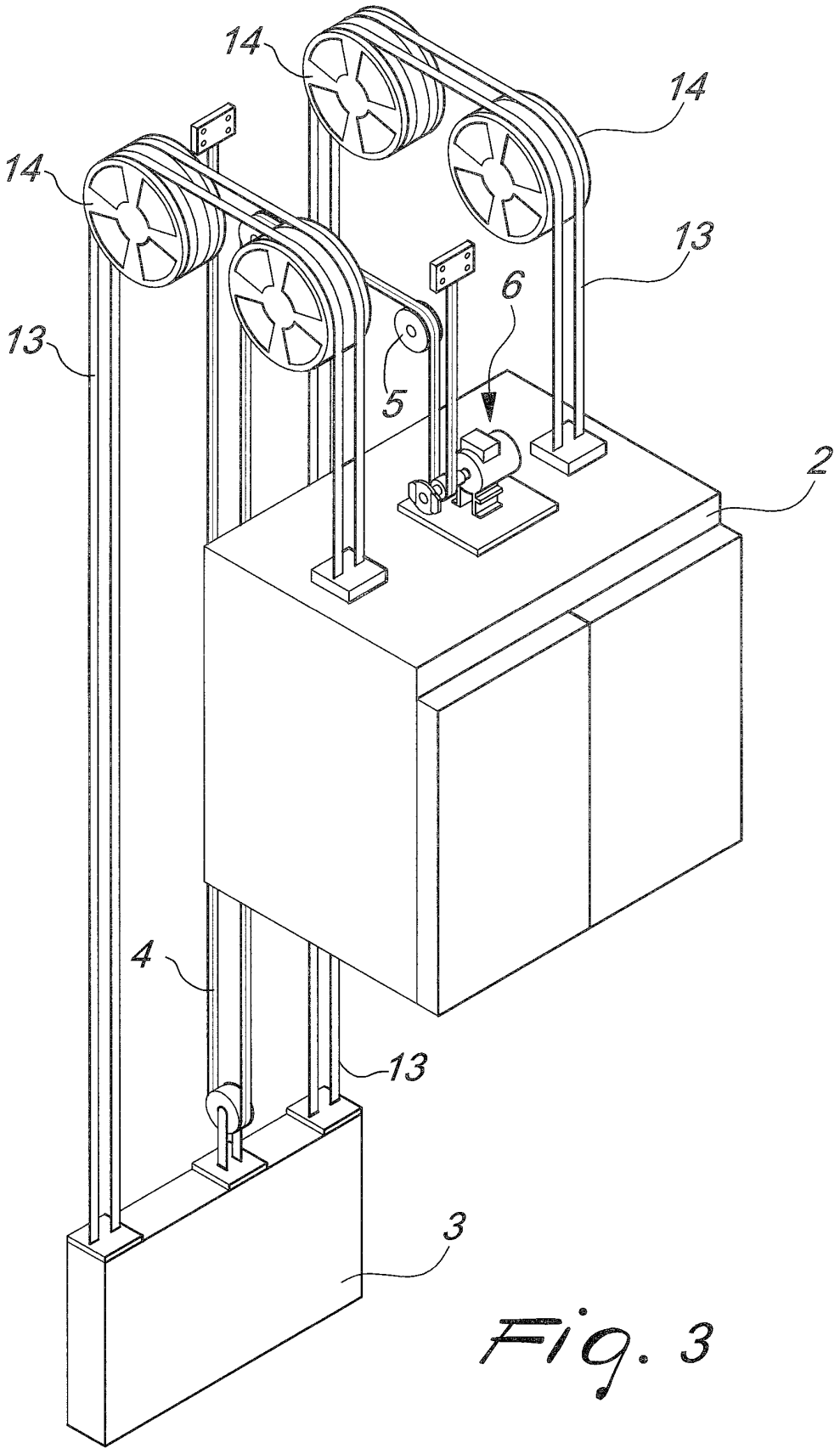


Fig. 3

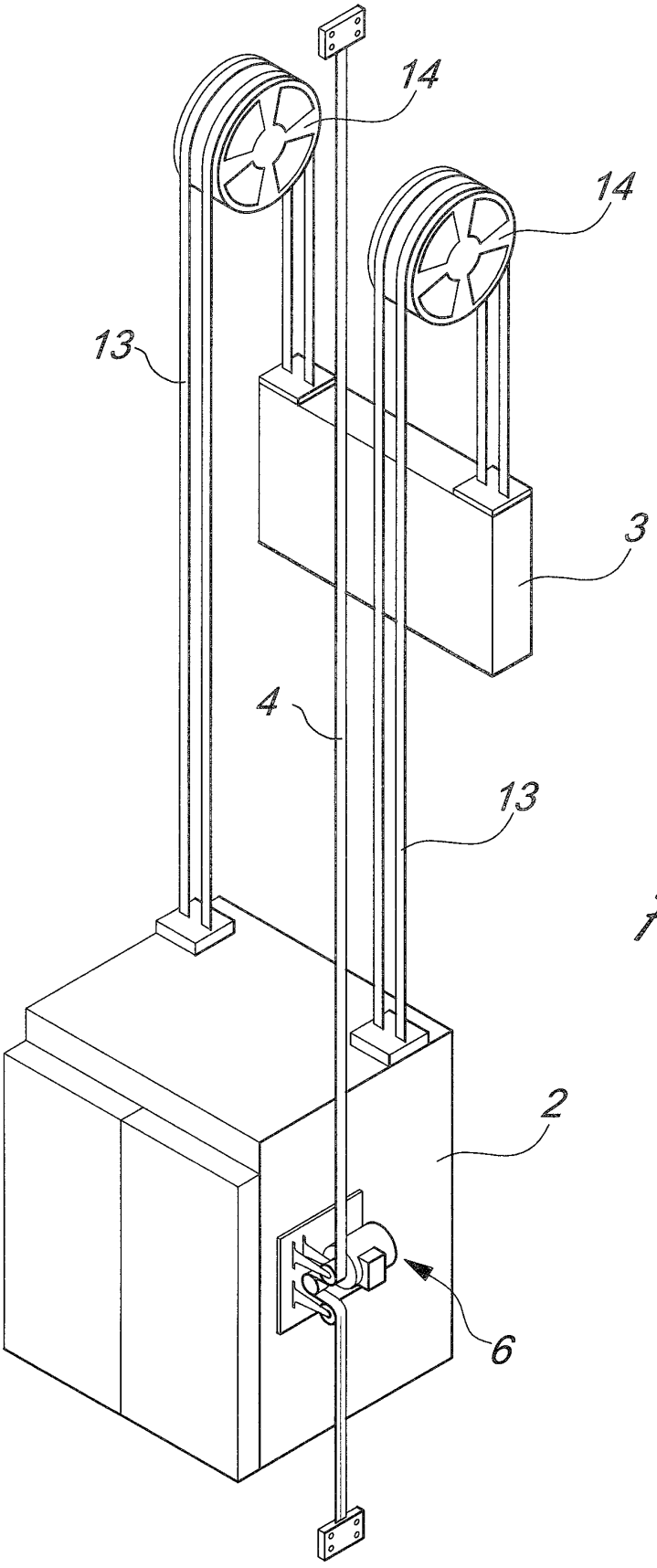


Fig. 4

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B66B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 10 4432

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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