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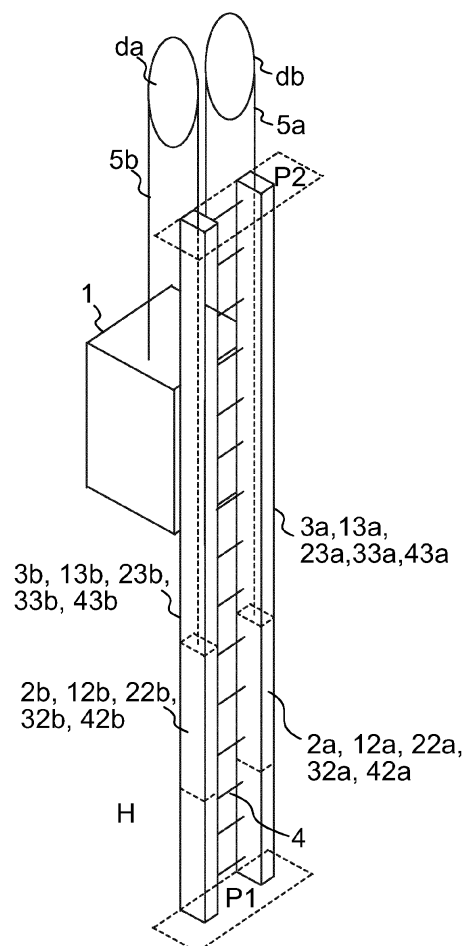
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(54) **An elevator for a wind turbine tower**

(57) The invention relates to an elevator comprising a hoistway (H), an elevator car (1), a first counterweight (2a, 12a, 22a, 32a, 42a) and a second counterweight (2b, 12b, 22b, 32b, 42b), which counterweights are each connected to the elevator car (1), a first vertical guide profile (3a, 13a, 23a, 33a, 43a) arranged to guide the first counterweight (2a, 12a, 22a, 32a, 42a), a second vertical guide profile (3b, 13b, 23b, 33b, 43b) arranged to guide the second counterweight (2b, 12b, 22b, 32b, 42b), a lower platform (P1), and an upper platform (P2). The elevator comprises a plurality of vertically spaced apart horizontal bars (4), which connect said guide profiles (3a, 13a, 23a, 33a, 43a, and 3b, 13b, 23b, 33b, 43b) and which are distributed at regular intervals between the upper and lower platform (P1,P2). Said horizontal bars thereby form cross-pieces of a ladder for people to climb up or down. The invention also relates to a wind turbine tower comprising said elevator.

Fig. 1



Description

Field of the invention

[0001] The invention relates to an elevator, in particular to an elevator meant for transporting passengers and/or goods. The invention also relates to a wind turbine tower comprising said elevator.

Background of the invention

[0002] An elevator is sometimes the only means for traveling between two landings. This is often the case when the elevator is installed as a service elevator inside tower-like structure, such as a wind turbine tower, tall smoke pipe, radio mast or an oil pumping tower. This kind of installation needs to be provided with an auxiliary arrangement for traveling between the landings. Usually, this problem is solved by installing an emergency ladder in the hoistway. This enables the user to climb between the landings, for example if the elevator cannot be used for returning from the top end of the tower structure back to the entrance landing. The towers are usually narrow in cross-direction so the elevator structure needs to be compact. The ladder should also be safe to use. A problem with known solutions is that the ladder structure has been difficult to position inside the hoistway such that the space-efficiency of the elevator is not weakened. Also, in many cases it has been difficult to arrange the elevator layout such the ladder can be climbed without being dangerously on the path of the car or the counterweight of the elevator.

Brief description of the invention

[0003] The object of the invention is, inter alia, to solve previously described drawbacks of known solutions and problems discussed later in the description of the invention. An object of the invention is to introduce a elevator where a ladder is provided in a hoistway of an elevator space-efficiently and safely. Embodiments are presented, inter alia, where the counterweights and/or the car can be guided with simple structures. Embodiments are presented, inter alia, where at least some of the moving components move in a space which is separated with a wall from the path of the person climbing the ladder. This facilitates safe climbing along the ladder.

[0004] It is brought forward a new elevator comprising a hoistway, an elevator car vertically movable in the hoistway, a first counterweight and a second counterweight, which counterweights are each connected to the elevator car, in particular with a suspension roping. The counterweights are vertically movable in the hoistway. The elevator further comprises a first vertical guide profile arranged to guide the first counterweight, a second vertical guide profile arranged to guide the second counterweight, and a lower platform and an upper platform. The elevator further comprises a plurality of vertically spaced

apart horizontal bars connecting said guide profiles and distributed at regular intervals, in particular over the vertical distance between the upper and lower platform. Said horizontal bars thereby form cross-pieces of a ladder, such as ladder rungs or steps or cleats, for people to climb up or down. Said guide profiles form ladder stiles for this ladder structure. Preferably, each bar has one end fixed to the first vertical guide profile and a second end fixed on the second vertical guide profile. Preferably, said guide profiles are at a horizontal distance from each other on one side of the elevator car. Providing the elevator with two counterweights guided with different guide profiles makes it possible to form a space between the counterweights which is free to be used for the ladder structures and for forming a safe space where a user can climb without being in the path of the counterweight.

[0005] In a preferred embodiment, the first guide profile comprises guide surface(s) for guiding the first counterweight and the second guide profile comprises guide surface(s) for guiding the second counterweight. Preferably, the first counterweight comprises guide element(s) supported against said guide surface(s) of the first guide profile and the second counterweight comprises guide element(s) supported laterally against said guide surface(s) of the second guide profile.

[0006] In a preferred embodiment, said guide profiles are also arranged to guide the car. This makes the overall structure more simple and compact. Accordingly, the elevator can be installed in a narrow space. Combining the guidance of the counterweights and the elevator car also makes the profile structure more rigid with same amount of material when compared to a solution where the car and counterweights are separately guided.

[0007] In a preferred embodiment, the first guide profile comprises guide surface(s) for guiding the car and the second guide profile comprises guide surface(s) for guiding the car. Preferably, the car comprises guide element(s) supported against said guide surface(s) of the first guide profile and guide element(s) supported laterally against said guide surface(s) of the second guide profile.

[0008] In a preferred embodiment, the first guide profile comprises an inside space continuous in the length-direction of the guide profile inside which said guide element(s) of the first counterweight is/are arranged to travel supported laterally against guide surface(s) formed by inside surface(s) of the inside space and the second guide profile comprises an inside space continuous in the length-direction of the guide profile inside which said guide element(s) of the second counterweight is/are arranged to travel supported laterally against guide surface(s) formed by inside surface(s) of the inside space. Thereby, those moving components move in a space which is separated with a profile wall from the path of the person climbing the ladder. This facilitates safe climbing along the ladder. The box-like structure also facilitates the rigidity of the profile structure.

[0009] In a preferred embodiment, the first guide profile

comprises an inside space continuous in the length-direction of the guide profile inside which said guide element(s) of the car is/are arranged to travel supported laterally against guide surface(s) formed by inside surface(s) of the inside space and the second guide profile comprises an inside space continuous in the length-direction of the guide profile inside which said guide element(s) of the car is/are arranged to travel supported laterally against guide surface(s) formed by inside surface(s) of the inside space. Thereby, those moving components move in a space which is separated with a profile wall from the path of the person climbing the ladder. This facilitates safe climbing along the ladder. The box-like structure also facilitates the rigidity of the profile structure.

[0010] In a preferred embodiment, the first guide profile comprises an inside space continuous in the length-direction of the guide profile accommodating the first counterweight (including the weight element(s) and guide element(s) thereof) inside which space the first counterweight is arranged to travel supported laterally against guide surface(s) formed by inside surface(s) of the inside space. The second guide profile correspondingly comprises an inside space continuous in the length-direction of the guide profile accommodating the first counterweight (including the weight element(s) and guide element(s) thereof) inside which space the second counterweight is/are arranged to travel supported laterally against guide surface(s) formed by inside surface(s) of the inside space. Thereby, each of the counterweights moves in a space which is separated with a profile wall from the path of the person climbing the ladder. This facilitates safe climbing along the ladder. The large box-like structure also facilitates the rigidity of the profile structure, thus forming a rigid base for mounting the horizontal bars.

[0011] In a preferred embodiment, the first counterweight is suspended with a roping connecting the car and the first counterweight and passing over a diverting wheel at the upper end of the hoistway, and in that the roping passes from the diverting wheel to the first counterweight inside the inside space of the first guide profile and the second counterweight is suspended with a roping connecting the car and the second counterweight and passing over a diverting wheel at the upper end of the hoistway, and in that the roping passes from the diverting wheel to the second counterweight inside the inside space of the second guide profile. Thereby, each of the ropes moves in a space which is separated with a profile wall from the path of the person climbing the ladder. This facilitates safe climbing along the ladder.

[0012] In a preferred embodiment, each of the guide profiles is a tube profile comprising a tubular inside space wholly or at least essentially closed in lateral directions, inside which tubular inside spaces the counterweights, including the weight element(s) and guide element(s) thereof, are arranged to travel vertically.

[0013] It is also brought forward a wind turbine tower comprising an elevator, which elevator is as defined an-

ywhere above or as defined elsewhere in the application. Preferably, the wind turbine tower comprises a tower body on top of which there is a wind turbine rotatable by wind for generating electricity. The wind turbine tower body is tubular and inside it there is installed an elevator. The elevator car is arranged travel between the lower and upper platforms in a hoistway, which is located inside the tubular tower body. The machinery of the elevator is preferably at the lower end of the tower. Thus, the machinery can be accessed and serviced easily without using the elevator.

[0014] The elevator is preferably of the type where the car is arranged to serve two landings. Then, the car preferably responds to calls from landing and/or destination commands from inside the car so as to serve persons on the landing(s) and/or inside the elevator car. Preferably, the car has an interior space suitable for receiving a passenger or passengers. The car may be provided with a floor, a ceiling, walls and at least one door these all forming together a closable and openable interior space. In this way, it is well suitable for safely serving passengers.

Brief description of the drawings

[0015] In the following, the present invention will be described in more detail by way of example and with reference to the attached drawings, in which

Figure 1 illustrates a first embodiment of an elevator according to the invention.

Figure 2 illustrates a second embodiment of an elevator according to the invention.

Figures 3a-3e illustrate alternative structures for implementing the elevator of Figure 1.

Figures 4a-4c illustrate alternative structures for implementing the elevator of Figure 2.

Figure 5 illustrates a tower comprising an elevator according to Figure 1 or 2.

Detailed description

[0016] Figure 1 illustrates an embodiment of an elevator according to the invention. The elevator comprises a hoistway H, an elevator car 1, a first counterweight 2a, 12a, 22a, 32a, 42a and a second counterweight 2b, 12b, 22b, 32b, 42b vertically movable in the hoistway H. The elevator further comprises a lower platform P1 and an upper platform P2. These platforms are in this case platforms which serve as an elevator landing. For the purpose of providing machine-powered driving of the car 1, the elevator preferably comprises a drive machine which drives the elevator car 1 under control of an elevator control system (not shown).

[0017] Each of the counterweights 2a, 12a, 22a, 32a, 42a and 2b, 12b, 22b, 32b, 42b is connected to the elevator car 1 with a suspension roping 5a, 5b. The movement of the counterweights is guided with guide profiles 3a, 13a, 23a, 33a, 43a and 3b, 13b, 23b, 33b, 43b posi-

tioned at a horizontal distance from each other. A first vertical guide profile 3a, 13a, 23a, 33a, 43a is arranged to guide the first counterweight 2a, 12a, 22a, 32a, 42a and a second vertical guide profile 3b, 13b, 23b, 33b, 43b is arranged to guide the second counterweight 2b, 12b, 22b, 32b, 42b. Providing the elevator with two counterweights guided with different guide profiles makes it possible to form a space between the counterweights which is free to be used for the ladder structures and for forming a safe space where a user can climb without being in the path of the counterweight. For the purpose of traveling between the lower and upper landing P1, P2, the elevator is provided with a ladder structure. This is implemented such that the elevator comprises a plurality of vertically spaced apart horizontal bars 4 connecting said guide profiles 3a, 13a, 23a, 33a, 43a, 3b, 13b, 23b, 33b, 43b and distributed at regular intervals over substantially the whole vertical distance between the upper and lower platform P1, P2. Thereby, said horizontal bars 4 form cross-pieces and the guide profiles 3a, 3b form the side rails of a ladder for people to climb up or down. The cross pieces 4 are preferably in the form of ladder rungs or steps or cleats.

[0018] Figures 3a-3e illustrate alternative ways to implement elevator of Figure 1. In each of these, for enabling guidance, the first guide profile 3a, 13a, 23a, 33a, 43a comprises guide surfaces 6a, 16a, 26a, 36a, 46a for guiding the first counterweight 2a, 12a, 22a, 32a, 42a and the second guide profile 3b, 13b, 23b, 33b, 43b comprises guide surfaces 6b, 16b, 26b, 36b, 46b for guiding the second counterweight 2b, 12b, 22b, 32b, 42b. The first counterweight 2a, 12a, 22a, 32a, 42a comprises guide elements 7a, 17a, 27a, 37a, 47a supported against said guide surfaces 6a, 16a, 26a, 36a, 46a of the first guide profile 3a, 13a, 23a, 33a, 43a and the second counterweight 2b, 12b, 22b, 32b, 42b comprises guide elements 7b, 17b, 27a, 37a, 47b supported laterally against said guide surfaces 6b, 16b, 26b, 36b, 46b of the second guide profile 3b, 13b, 23b, 33b, 43b. So as to provide lateral support in all lateral directions each guide profile comprises plurality of said guide surfaces facing towards different lateral directions against which one of said guide elements is supported.

[0019] In the preferred embodiment, said guide profiles 3a, 13a, 23a, 33a, 43a, 3b, 13b, 23b, 33b, 43b are also arranged to guide the car 1. This is however not necessary as the car could be guided alternatively in some other way, for example with its own separate guide profiles. In the preferred embodiment, the first guide profile 3a, 13a, 23a, 33a, 43a comprises guide surfaces 8a, 18a, 28a, 38a, 48a for guiding the car 1 and the second guide profile 3b, 13b, 23b, 33b, 43b comprises guide surfaces 8b, 18b, 28b, 38b, 48b for guiding the car 1. The car 1 comprises guide element(s) 9a, 19a, 29a, 39a, 49a supported laterally against said guide surface(s) 8a, 18a, 28a, 38a, 48a of the first guide profile 3a, 13a, 23a, 33a, 43a and the guide element(s) 9b, 19b, 29b, 39b, 49b supported laterally against said guide surface(s) 8b, 18b,

28b, 38b, 48b of the second guide profile 3b, 13b, 23b, 33b, 43b.

[0020] The first guide profile 3a, 13a, 23a, 33a, 43a comprises an inside space 10a, 110a, 210a, 310a, 410a continuous in the length-direction of the guide profile inside which said guide elements 7a, 17a, 27a, 37a, 47a of the first counterweight 2a, 12a, 22a, 32a, 42a are arranged to travel supported laterally against guide surfaces 6a, 16a, 26a, 36a, 46a formed by inside surfaces of the inside space 10a, 110a, 210a, 310a, 410a and the second guide profile 3b, 13b, 23b, 33b, 43b comprises an inside space 10b, 110b, 210b, 310b, 410b continuous in the length-direction of the guide profile inside which said guide element(s) 7b, 17b, 27a, 37a, 47b of the second counterweight 2b, 12b, 22b, 32b, 42b are arranged to travel supported laterally against guide surfaces 6b, 16b, 26b, 36b, 46b formed by inside surface(s) of the inside space 10b, 210b, 310b, 410b. The inside space 10a, 210a, 310a, 410a of the first guide profile 3a, 13a, 23a, 33a, 43a accommodates the first counterweight 2a, 12a, 22a, 32a, 42a and the inside space 10b, 210b, 310b, 410b of the guide profile 3b, 13b, 23b, 33b, 43b accommodates the second counterweight 2b, 12b, 22b, 32b, 42b.

[0021] In particular, each of the guide profiles 3a, 13a, 23a, 33a, 43a, 3b, 13b, 23b, 33b, 43b is a tube profile comprising said inside space 10a, 210a, 310a, 410a, 10b, 210b, 310b, 410b which is tubular and essentially closed in lateral direction. The counterweights are arranged to travel inside the inside spaces 10a, 210a, 310a, 410a, 10b, 210b, 310b, 410b of the guide profiles supported laterally against the guide surfaces formed by inside surfaces of said inside spaces 10a, 210a, 310a, 410a, 10b, 210b, 310b, 410b. Said inside spaces 10a, 110a, 210a, 310a, 410a, 10b, 210b, 310b, 410b are in the embodiment of Figures 3a-3c and 3e rectangular in cross section and in Figure 3d round.

[0022] In the alternative as illustrated in Figure 3b the first guide profile 13a comprises an inside space 11a, continuous in the length-direction of the guide profile inside which said guide element 9a of the car 1 are arranged to travel supported laterally against guide surfaces 18a formed by inside surfaces of the inside space 11a and the second guide profile 3b comprises an inside space 11b continuous in the length-direction of the guide profile inside which said guide element 19b of the car 1 is arranged to travel supported laterally against guide surfaces 18b formed by inside surfaces of the inside space 11b. The inside space is open in one lateral direction so as to allow free vertical traveling of the parts connecting the guide elements 19a, 19b to the car 1. As an alternative to the illustrated structure the single guide elements 19a and 19b could be replaced with several guide elements. In the alternatives as illustrated in Figures 3a and 3c-3e there are guide elements 9a and 9b ; 29a and 29b ; 39a and 39b; 49a and 49b are supported against at least one guide surface which is not an inside surface of an inside space of the guide profile in question.

[0023] The first counterweight 2a, 12a, 22a, 32a, 42a is suspended with a roping 5a connecting the car 1 and the first counterweight 2a, 12a, 22a, 32a, 42a such that the roping passes over a diverting wheel which is located at the upper end of the hoistway or its proximity. The roping 5a passes from the diverting wheel to the first counterweight 2a, 12a, 22a, 32a, 42a inside the inside space 10a, 110a, 210a, 310a, 410a of the first guide profile 3a, 13a, 23a, 33a, 43a. The second counterweight 2b, 12b, 22b, 32b, 42b is suspended with a roping 5b connecting the car 1 and the second counterweight 2b, 12b, 22b, 32b, 42b. The roping 5b passes over a diverting wheel located at the upper end of the hoistway or its proximity. The roping 5b passes from the diverting wheel to the second counterweight 2b, 12b, 22b, 32b, 42b inside the inside space 10b, 110b, 210b, 310b, 410b of the second guide profile 3b, 13b, 23b, 33b, 43b.

[0024] Figure 2 illustrates a second embodiment of an elevator according to the invention. The elevator comprises a hoistway H, an elevator car 1, a first counterweight 2a and a second counterweight 2b vertically movable in the hoistway H. The elevator further comprises a lower platform P1 and an upper platform P2. These platforms P1, P2 are in this case platforms which serve as an elevator landings. For the purpose of providing machine-powered driving of the car 1, the elevator preferably comprises a drive machine which drives the elevator car 1 under control of an elevator control system (not shown).

[0025] Each of the counterweights 52a, 62a, 72a and 52b, 62b is connected to the elevator car 1 with a suspension roping 5a, 5b. The movement of the counterweights is guided with guide profiles 53a, 63a, 73a, 53b, 63b, 73b positioned at a horizontal distance from each other. A first vertical guide profile 53a, 63a, 73a is arranged to guide the first counterweight 52a, 62a, 72a and a second vertical guide profile 73a, 53b, 63b, 73b is arranged to guide the second counterweight 52b, 62b, 72b. Providing the elevator with two counterweights guided with different guide profiles makes it possible to form a space between the counterweights which is free to be used for the ladder structures and for forming a safe space where a user can climb without being in the path of the counterweight. For the purpose of traveling between the lower and upper platform P1, P2, the elevator is provided with a ladder structure. This is implemented such that the elevator comprises a plurality of vertically spaced apart horizontal bars 4 connecting said guide profiles 53a, 63a, 73a and 53b, 63b, 73b, which are distributed at regular intervals over substantially the whole vertical distance between the upper and lower platform P1, P2. Thereby, said horizontal bars 4 form cross-pieces and the guide profiles 53a, 63a, 73a, 53b, 63b, 73b form the side rails of a ladder for people to climb up or down. The cross pieces 4 are preferably in the form of ladder rungs or steps or cleats.

[0026] Figures 4a-4c illustrate alternative ways to implement elevator of Figure 1. In each of these, for ena-

bling guidance, the first guide profile 53a, 63a, 73a comprises guide surfaces 56a, 66a, 76a for guiding the first counterweight 52a, 62a, 72a and the second guide profile 53b, 63b, 73b comprises guide surfaces 56b, 66b, 76b for guiding the second counterweight 52b, 62b, 72b. The first counterweight 52a, 62a, 72a comprises guide elements 57a, 67a, 77a supported against said guide surfaces 56a, 66a, 76a of the first guide profile 53a, 63a, 73a and the second counterweight 52b, 62b, 72b comprises guide elements 57b, 67b, 77b supported laterally against said guide surfaces 56b, 66b, 76b of the second guide profile 53b, 63b, 73b. So as to provide lateral support in all lateral directions each guide profile comprises plurality of said guide surfaces facing towards different lateral directions against which one of said guide elements is supported.

[0027] In the preferred embodiment, said guide profiles 53a, 63a, 73a and 53b, 63b, 73b are also arranged to guide the car 1. This is however not necessary as the car could be guided alternatively in some other way, for example with its own separate guide profiles. In the preferred embodiment, the first guide profile 53a, 63a, 73a comprises guide surfaces 58a, 68a, 78a for guiding the car 1 and the second guide profile 53b, 63b, 73b comprises guide surfaces 58b, 68b, 78b for guiding the car 1. The car 1 comprises guide element(s) 59a, 69a, 79a supported laterally against said guide surfaces 58a, 68a, 78a of the first guide profile 53a, 63a, 73a and the guide element(s) 59b, 69b, 79b supported laterally against said guide surfaces 58b, 68b, 78b of the second guide profile 53b, 63b, 73b.

[0028] The first guide profile 53a, 63a, 73a comprises an inside space 510a, 610a, 710a continuous in the length-direction of the guide profile inside which said guide elements 57a, 67a, 77a of the first counterweight 52a, 62a, 72a are arranged to travel supported laterally against guide surfaces 56a, 66a, 76a formed by inside surfaces of the inside space 510a, 610a, 710a, and the second guide profile 53b, 63b, 73b comprises an inside space 510b, 610b, 710b continuous in the length-direction of the guide profile inside which said guide elements 57b, 67b, 77a of the second counterweight 52b, 62b, 72b are arranged to travel supported laterally against guide surfaces 56b, 66b, 76b formed by inside surfaces of the inside space 510b, 610b, 710b. The weight elements W of the counterweights 52a, 62a, 72a and 52b, 62b, 72b, i.e. the elements forming majority of the counterweight in question, are arranged to travel outside said inside spaces 510a, 610a, 710a of the guide profiles 53a, 63a, 73a and 53b, 63b, 73b. In the embodiment as illustrated each inside space 510a, 610a, 710a and 510b, 610b, 710b is open in one lateral direction so as to allow free vertical traveling of the parts connecting the guide elements 59a, 69a, 79a and 59b, 69b, 79b to a counterweight. Said inside spaces 510a, 610a, 710a and 510b, 610b, 710b are in the embodiment of Figures 4a-4c rectangular in cross section.

[0029] In the alternative as illustrated in Figure 4b the

first guide profile 63a comprises an inside space 611a, continuous in the length-direction of the guide profile inside which said guide element 69a of the car 1 is arranged to travel supported laterally against guide surfaces 68a formed by inside surfaces of the inside space 611a. Respectively, the second guide profile 63b comprises an inside space 611b continuous in the length-direction of the guide profile inside which said guide element 69b of the car 1 is arranged to travel supported laterally against guide surfaces 68b formed by inside surfaces of the inside space 611b. The inside space is open in one lateral direction so as to allow free vertical traveling of the parts connecting the guide elements 69a, 69b to the car 1. As an alternative to the illustrated structure the single guide elements 69a and 69b could be replaced with several guide elements. In the alternatives as illustrated in Figures 4a and 4c there are guide elements 59a and 59b ; 79a and 79b supported against at least one guide surface which is not an inside surface of an inside space of the guide profile in question.

[0030] The first counterweight 52a, 62a, 72a is suspended with a roping 5a connecting the car 1 and the first counterweight 52a, 62a, 72a such that the roping 5a passes over a diverting wheel which is located at the upper end of the hoistway or its proximity. The second counterweight 52b, 62b, 72b is suspended with a roping 5b connecting the car 1 and the first counterweight 52b, 62b, 72b such that the roping 5b passes over a diverting wheel which is located at the upper end of the hoistway or its proximity.

[0031] Figure 5 illustrates an embodiment of a wind turbine tower 80. The wind turbine tower comprises a tower body on top of which there is a wind turbine rotatable by wind for generating electricity. The wind turbine tower body is tubular and has an elevator installed inside it. The elevator is as specified in Figures 1 or 2 and the related description. The elevator is preferably more specifically implemented as specified in Figures 3a-4c and the related description. In Figure 5, only part of the elevator structures are illustrated for the sake of clarity. The elevator car 1 is arranged travel in a hoistway H between the lower and upper platforms P1, P2, which hoistway H is located inside the tubular tower 80. The lower platform is at the lower end of the tower 80 and the upper platform P2 is at the upper end of the tower. The machinery of the elevator is preferably at the lower end of the tower 80. Thus, the machinery M can be accessed and serviced easily without using the elevator, which would not even be safe if the elevator is in need of servicing. For this purpose, it is preferable that between each counterweight 2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a and 2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b and the car 1 there is a roping 81a, 81b connecting the counterweight in question and the car 1. The roping 81a and 81b preferably pass between the car 1 and its counterweight in similar manner as illustrated in Figures 1 or 2, but with a vertically inverted structure. Each of these ropings 81a, 81b then pass from the car 1 to the counterweight 2a, 12a, 22a, 32a, 42a,

52a, 62a, 72a ; 2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b around a diverting wheel 82a, 82b mounted at the lower end of the tower 80 and rotated by a machinery M. The diverting wheels preferably are rotated by a common machinery. The machinery M may alternatively be positioned in the upper end of the tower, for example to rotate the diverting wheels (illustrated in Figures 1 and 2) around which the ropings 5a, 5b pass.

[0032] The bars 4 and the guide profiles are preferably metallic so as to ensure adequate strength and rigidity. The bars 4 are preferably elongated members as illustrated in the Figures. The bars 4 preferably connect the guide profiles 3a, 13a, 23a, 33a, 43a and 3b, 13b, 23b, 33b, 43b ; 53a, 63a, 73a and 53b, 63b, 73b to each other rigidly thus facilitating rigidity of the overall structure. Preferably, each bar 4 has one end fixed to the first guide profile 3a, 13a, 23a, 33a, 43a ; 53a, 63a, 73a and a second end fixed on the second guide profile 3b, 13b, 23b, 33b, 43b ; 53b, 63b, 73b. As an alternative to this kind of direct fixing, the bars 4 can be fixed to the guide profiles to the first guide profile 3a, 13a, 23a, 33a, 43a ; 53a, 63a, 73a and a second end fixed on the second guide profile 3b, 13b, 23b, 33b, 43b ; 53b, 63b, 73b via additional fixing parts (not necessary parts, illustrated in broken line in Figures).

[0033] The bars 4 are close to each other such that a person can climb along them. For this end, it is preferable that the bars 4 have more than 20 cm and less than 70 cm free vertical distance between them. Preferably, the bars are distributed such that there are at least 2 bars per meter. The bars 4 are preferably distributed equidistantly. Further for facilitating safe climbing, the elevator comprises a free space between the paths of the counterweights 2a, 12a, 22a, 32a, 42a and 2b, 12b, 22b, 32b, 42b ; 52a, 62a, 72a and 52b, 62b, 72b in which space a user can climb up or down along the horizontal bars 4. The first guide profile 3a, 13a, 23a, 33a, 43a ; 53a, 63a, 73a and the second guide profile 3b, 13b, 23b, 33b, 43b ; 53b, 63b, 73b are at a horizontal distance from each other, preferably on one side of the elevator car 1 as illustrated. This facilitates the space-efficiency of the elevator. For the same purpose, it is preferable that the first guide profile 3a, 13a, 23a, 33a, 43a ; 53a, 63a, 73a and the second guide profile 3b, 13b, 23b, 33b, 43b ; 53b, 63b, 73b are placed on a vertical plane which is parallel to the wall of the elevator car 1.

[0034] The invention could be implemented with different amount of guide elements than what is shown in the Figures. The guide elements may be in the form of guide rollers or sliders, which components are well known in the field. The ropings can each comprise one rope or a plurality of ropes. Said ropes may be in any form, such as in the the form of a belt or a conventional rope with round cross section.

[0035] It is to be understood that the above description and the accompanying Figures are only intended to illustrate the present invention. It will be apparent to a person skilled in the art that the inventive concept can be imple-

mented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

Claims

1. An elevator comprising

- a hoistway (H),
- an elevator car (1),
- a first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) and a second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b), which counterweights are each connected to the elevator car (1),
- a first vertical guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) arranged to guide the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a),
- a second vertical guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) arranged to guide the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b),
- a lower platform (P1),
- an upper platform (P2),

characterized in that the elevator comprises a plurality of vertically spaced apart horizontal bars (4) connecting said guide profiles (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a and 3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) and distributed at regular intervals between the upper and lower platform (P1,P2).

2. An elevator according to claim 1, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) comprises guide surface(s) (6a, 16a, 26a, 36a, 46a, 56a, 66a, 76a) for guiding the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) and the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) comprises guide surface(s) (6b, 16b, 26b, 36b, 46b, 56b, 66b, 76b) for guiding the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b).

3. An elevator according to claim 2, **characterized in that** the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) comprises guide element(s) (7a, 17a, 27a, 37a, 47a, 57a, 67a, 77a) supported against said guide surface(s) (6a, 16a, 26a, 36a, 46a, 56a, 66a, 76a) of the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a), and the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b) comprises guide element(s) (7b, 17b, 27b, 37b, 47b, 57b, 67b, 77b) supported against said guide surface(s) (6b, 16b, 26b, 36b, 46b, 56b, 66b, 76b) of the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b).

4. An elevator according to any one of the preceding claims, **characterized in that** said guide profiles (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a, 3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) are also arranged to guide the car (1).

5. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) comprises guide surface(s) (8a, 18a, 28a, 38a, 48a, 58a, 68a, 78a) for guiding the car (1) and the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) comprises guide surface(s) (8b, 18b, 28b, 38b, 48b, 58b, 68b, 78b) for guiding the car (1).

6. An elevator according to claim 5, **characterized in that** the car (1) comprises guide element(s) (9a, 19a, 29a, 39a, 49a, 59a, 69a, 79a) supported against said guide surface(s) (8a, 18a, 28a, 38a, 48a, 58a, 68a, 78a) of the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) and guide element(s) (9b, 19b, 29b, 39b, 49b, 59b, 69a, 79b) supported against said guide surface(s) (8b, 18b, 28b, 38b, 48b, 58b, 68b, 78b) of the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b).

7. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) comprises an inside space (10a, 210a, 310a, 410a, 510a, 610a, 710a) inside which said guide element(s) (7a, 17a, 27a, 37a, 47a, 57a, 67a, 77a) of the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) is/are arranged to travel supported against guide surface(s) (6a, 16a, 26a, 36a, 46a, 56a, 66a, 76a) formed by inside surface(s) of the inside space (10a, 210a, 310a, 410a, 510a, 610a, 710a) and the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) comprises an inside space (10b, 210b, 310b, 410b, 510b, 610b, 710b) inside which said guide element(s) (7b, 17b, 27b, 37b, 47b, 57b, 67b, 77b) of the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b) is/are arranged to travel supported against guide surface(s) (6b, 16b, 26b, 36b, 46b, 56b, 66b, 76b) formed by inside surface(s) of the inside space (10b, 210b, 310b, 410b, 510b, 610b, 710b).

8. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (13a, 63a) comprises an inside space (11a, 611a) inside which said guide element(s) (19a, 69a) of the car (1) is/are arranged to travel supported against guide surface(s) (18a, 68a) formed by inside surface(s) of the inside space (11a, 611a) and the second guide profile (13b, 63b) comprises an inside space (11b, 611b) inside which said guide element(s) (19b, 69b) of the car (1) is/are arranged to

travel supported against guide surface(s) (18b, 68b) formed by inside surface(s) of the inside space (11b, 611b).

9. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a) comprises an inside space (10a, 110a, 210a, 310a, 410a) accommodating the first counterweight (2a, 12a, 22a, 32a, 42a) and inside which the first counterweight (2a, 12a, 22a, 32a, 42a) is arranged to travel, and **in that** the second guide profile (3b, 13b, 23b, 33b, 43b) comprises an inside space (10b, 110b, 210b, 310b, 410b) accommodating the second counterweight (2b, 12b, 22b, 32b, 42b) and inside which the second counterweight (2b, 12b, 22b, 32b, 42b) is arranged to travel.
10. An elevator according to any one of the preceding claims, **characterized in that** the first counterweight (2a, 12a, 22a, 32a, 42a) is suspended with a roping (5a) connecting the car (1) and the first counterweight (2a, 12a, 22a, 32a, 42a) and passing over a diverting wheel (d_a) at the upper end of the hoistway (H), and **in that** the roping (5a) passes from the diverting wheel (d_a) to the first counterweight (2a, 12a, 22a, 32a, 42a) inside the inside space (10a, 110a, 210a, 310a, 410a) of the first guide profile (3a, 13a, 23a, 33a, 43a) and the second counterweight (2b, 12b, 22b, 32b, 42b) is suspended with a roping (5b) connecting the car (1) and the second counterweight (2b, 12b, 22b, 32b, 42b) and passing over a diverting wheel (d_b) at the upper end of the hoistway (H), and **in that** the roping (5b) passes from the diverting wheel (d_b) to the second counterweight (2b, 12b, 22b, 32b, 42b) inside the inside space (10b, 110b, 210b, 310b, 410b) of the second guide profile (3b, 13b, 23b, 33b, 43b).
11. An elevator according to any one of the preceding claims, **characterized in that** each of the guide profiles (3a, 13a, 23a, 33a, 43a and 3b, 13b, 23b, 33b, 43b) is a tube profile comprising a tubular inside space (10a, 210a, 310a, 410a and 10b, 210b, 310b, 410b), inside which tubular inside space (10a, 210a, 310a, 410a and 10b, 210b, 310b, 410b) the counterweights (2a, 12a, 22a, 32a, 42a and 2b, 12b, 22b, 32b, 42b), including the weight element(s) and guide element(s) thereof, are arranged to travel vertically.
12. An elevator according to any one of the preceding claims, **characterized in that** each bar (4) has one end fixed to the first vertical guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) and a second end fixed on the second vertical guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b).
13. A wind turbine tower (80) comprising an elevator, **characterized in that** the elevator is as defined in

any one of the preceding claims.

Amended claims in accordance with Rule 137(2) EPC.

1. An elevator comprising

- a hoistway (H),
- an elevator car (1),
- a first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) and a second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b), which counterweights are each connected to the elevator car (1),
- a first vertical guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) arranged to guide the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a),
- a second vertical guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) arranged to guide the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b),
- a lower platform (P1),
- an upper platform (P2),

characterized in that the elevator comprises a plurality of vertically spaced apart horizontal bars (4) connecting said guide profiles (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a and 3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) and distributed at regular intervals between the upper and lower platform (P1, P2), said horizontal bars (4) forming the crosspieces of a ladder for people to climb up or down.

2. An elevator according to claim 1, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) comprises guide surface(s) (6a, 16a, 26a, 36a, 46a, 56a, 66a, 76a) for guiding the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) and the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) comprises guide surface(s) (6b, 16b, 26b, 36b, 46b, 56b, 66b, 76b) for guiding the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b).

3. An elevator according to claim 2, **characterized in that** the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) comprises guide element(s) (7a, 17a, 27a, 37a, 47a, 57a, 67a, 77a) supported against said guide surface(s) (6a, 16a, 26a, 36a, 46a, 56a, 66a, 76a) of the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a), and the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b) comprises guide element(s) (7b, 17b, 27b, 37b, 47b, 57b, 67b, 77b) supported against said guide surface(s) (6b, 16b, 26b, 36b, 46b, 56b, 66b, 76b) of the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b).

4. An elevator according to any one of the preceding claims, **characterized in that** said guide profiles (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a, 3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) are also arranged to guide the car (1).

5. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) comprises guide surface(s) (8a, 18a, 28a, 38a, 48a, 58a, 68a, 78a) for guiding the car (1) and the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) comprises guide surface(s) (8b, 18b, 28b, 38b, 48b, 58b, 68b, 78b) for guiding the car (1).

6. An elevator according to claim 5, **characterized in that** the car (1) comprises guide element(s) (9a, 19a, 29a, 39a, 49a, 59a, 69a, 79a) supported against said guide surface(s) (8a, 18a, 28a, 38a, 48a, 58a, 68a, 78a) of the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) and guide element(s) (9b, 19b, 29b, 39b, 49b, 59b, 69a, 79b) supported against said guide surface(s) (8b, 18b, 28b, 38b, 48b, 58b, 68b, 78b) of the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b).

7. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) comprises an inside space (10a, 210a, 310a, 410a, 510a, 610a, 710a) inside which said guide element(s) (7a, 17a, 27a, 37a, 47a, 57a, 67a, 77a) of the first counterweight (2a, 12a, 22a, 32a, 42a, 52a, 62a, 72a) is/are arranged to travel supported against guide surface(s) (6a, 16a, 26a, 36a, 46a, 56a, 66a, 76a) formed by inside surface(s) of the inside space (10a, 210a, 310a, 410a, 510a, 610a, 710a) and the second guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b) comprises an inside space (10b, 210b, 310b, 410b, 510b, 610b, 710b) inside which said guide element(s) (7b, 17b, 27b, 37b, 47b, 57b, 67b, 77b) of the second counterweight (2b, 12b, 22b, 32b, 42b, 52b, 62b, 72b) is/are arranged to travel supported against guide surface(s) (6b, 16b, 26b, 36b, 46b, 56b, 66b, 76b) formed by inside surface(s) of the inside space (10b, 210b, 310b, 410b, 510b, 610b, 710b).

8. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (13a, 63a) comprises an inside space (11a, 611a) inside which said guide element(s) (19a, 69a) of the car (1) is/are arranged to travel supported against guide surface(s) (18a, 68a) formed by inside surface(s) of the inside space (11a, 611a) and the second guide profile (13b, 63b) comprises an inside space (11b, 611b) inside which said guide element(s) (19b, 69b) of the car (1) is/are arranged to

travel supported against guide surface(s) (18b, 68b) formed by inside surface(s) of the inside space (11b, 611b).

9. An elevator according to any one of the preceding claims, **characterized in that** the first guide profile (3a, 13a, 23a, 33a, 43a) comprises an inside space (10a, 110a, 210a, 310a, 410a) accommodating the first counterweight (2a, 12a, 22a, 32a, 42a) and inside which the first counterweight (2a, 12a, 22a, 32a, 42a) is arranged to travel, and **in that** the second guide profile (3b, 13b, 23b, 33b, 43b) comprises an inside space (10b, 110b, 210b, 310b, 410b) accommodating the second counterweight (2b, 12b, 22b, 32b, 42b) and inside which the second counterweight (2b, 12b, 22b, 32b, 42b) is arranged to travel.

10. An elevator according to any one of the preceding claims,

characterized in that the first counterweight (2a, 12a, 22a, 32a, 42a) is suspended with a roping (5a) connecting the car (1) and the first counterweight (2a, 12a, 22a, 32a, 42a) and passing over a diverting wheel (d_a) at the upper end of the hoistway (H), and **in that** the roping (5a) passes from the diverting wheel (d_a) to the first counterweight (2a, 12a, 22a, 32a, 42a) inside the inside space (10a, 110a, 210a, 310a, 410a) of the first guide profile (3a, 13a, 23a, 33a, 43a) and the second counterweight (2b, 12b, 22b, 32b, 42b) is suspended with a roping (5b) connecting the car (1) and the second counterweight (2b, 12b, 22b, 32b, 42b) and passing over a diverting wheel (d_b) at the upper end of the hoistway (H), and **in that** the roping (5b) passes from the diverting wheel (d_b) to the second counterweight (2b, 12b, 22b, 32b, 42b) inside the inside space (10b, 110b, 210b, 310b, 410b) of the second guide profile (3b, 13b, 23b, 33b, 43b).

11. An elevator according to any one of the preceding claims,

characterized in that each of the guide profiles (3a, 13a, 23a, 33a, 43a and 3b, 13b, 23b, 33b, 43b) is a tube profile comprising a tubular inside space (10a, 210a, 310a, 410a and 10b, 210b, 310b, 410b), inside which tubular inside space (10a, 210a, 310a, 410a and 10b, 210b, 310b, 410b) the counterweights (2a, 12a, 22a, 32a, 42a and 2b, 12b, 22b, 32b, 42b), including the weight element(s) and guide element(s) thereof, are arranged to travel vertically.

12. An elevator according to any one of the preceding claims,

characterized in that each bar (4) has one end fixed to the first vertical guide profile (3a, 13a, 23a, 33a, 43a, 53a, 63a, 73a) and a second end fixed on the second vertical guide profile (3b, 13b, 23b, 33b, 43b, 53b, 63b, 73b).

13. A wind turbine tower (80) comprising an elevator,
characterized in that the elevator is as defined in
any one of the preceding claims.

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Fig. 1

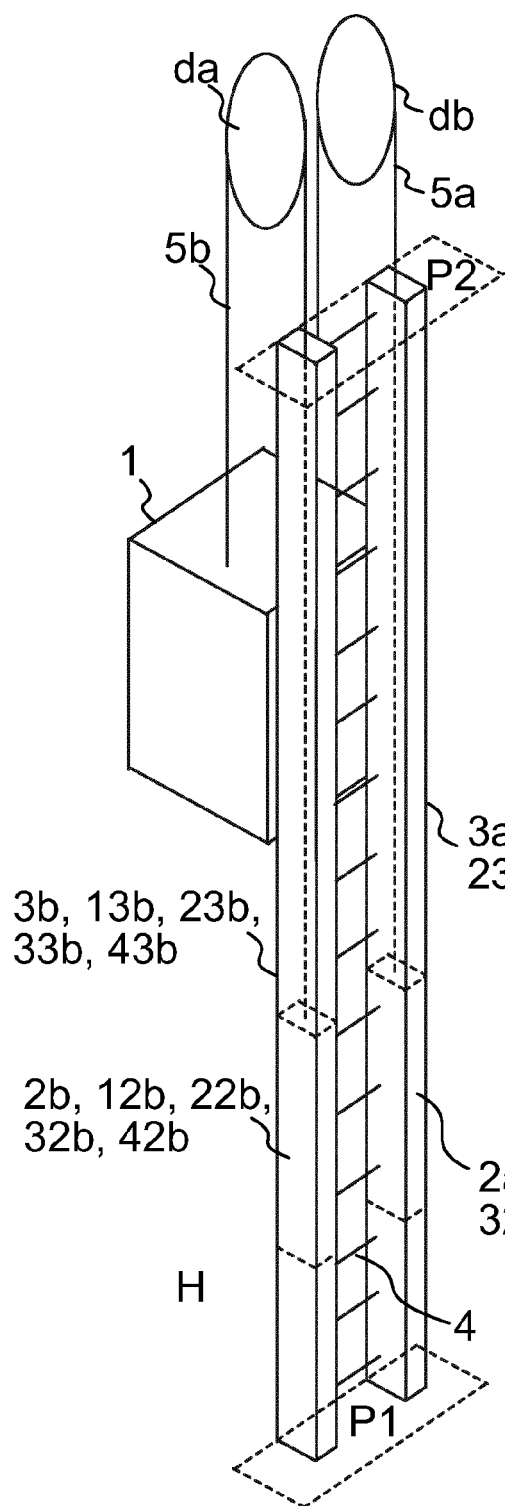


Fig. 2

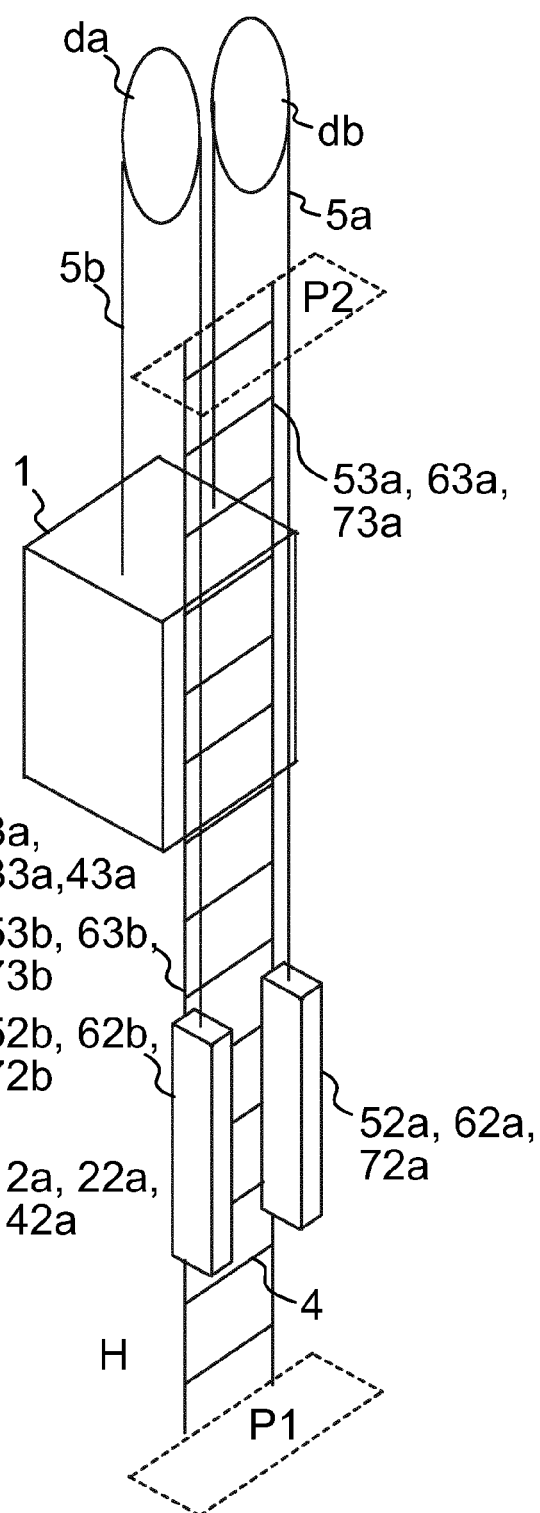
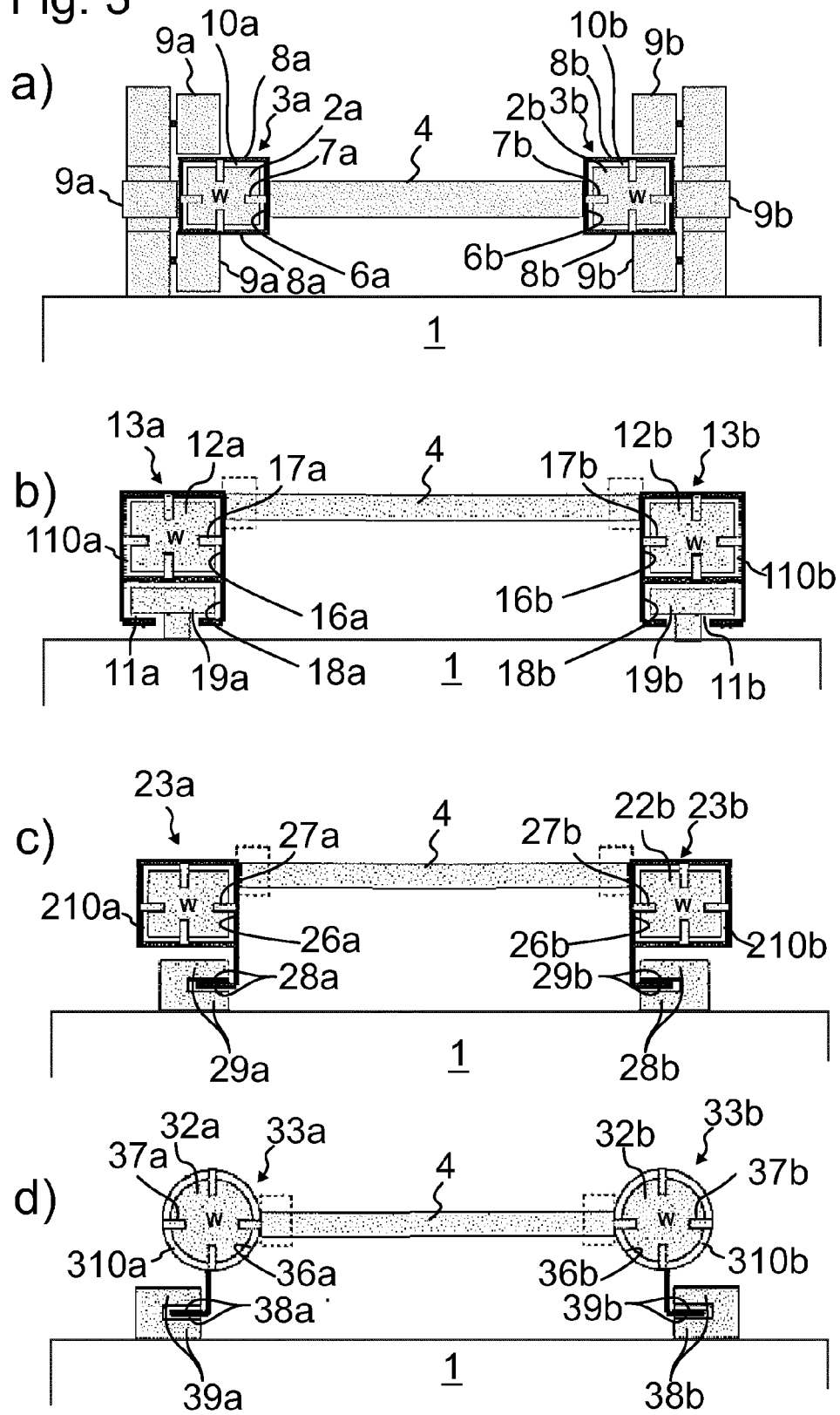


Fig. 3



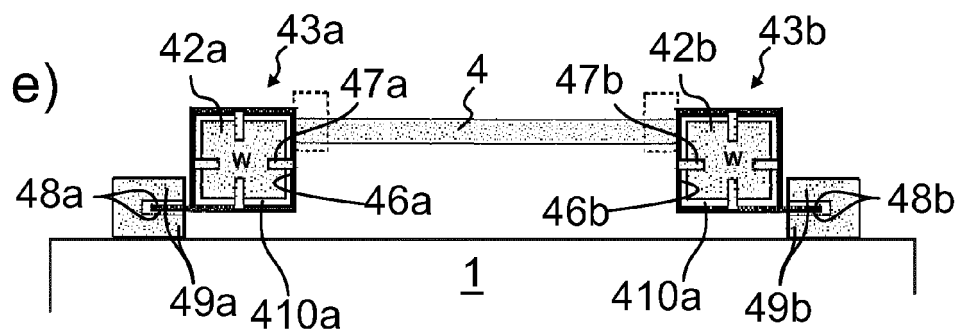


Fig. 4

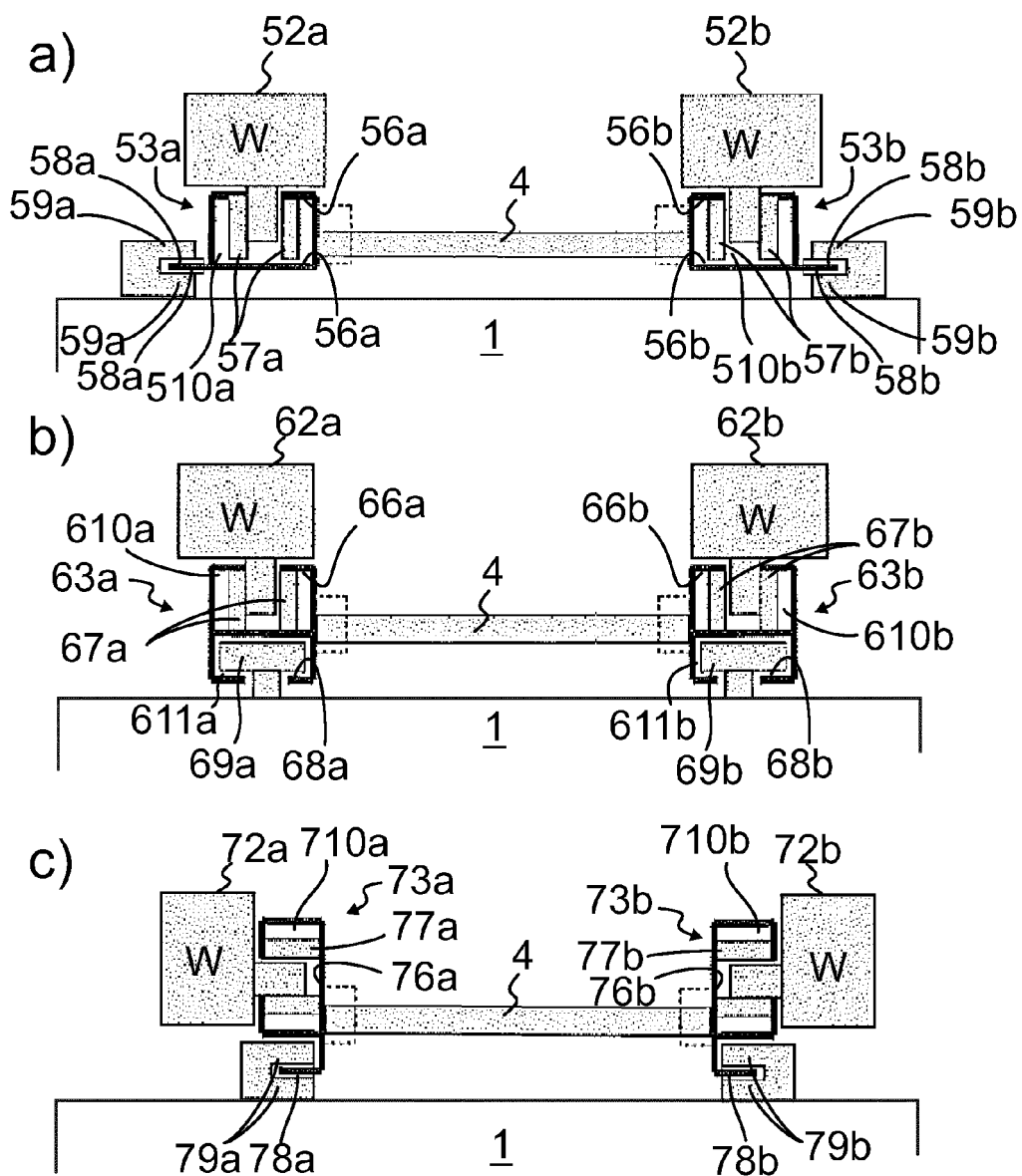
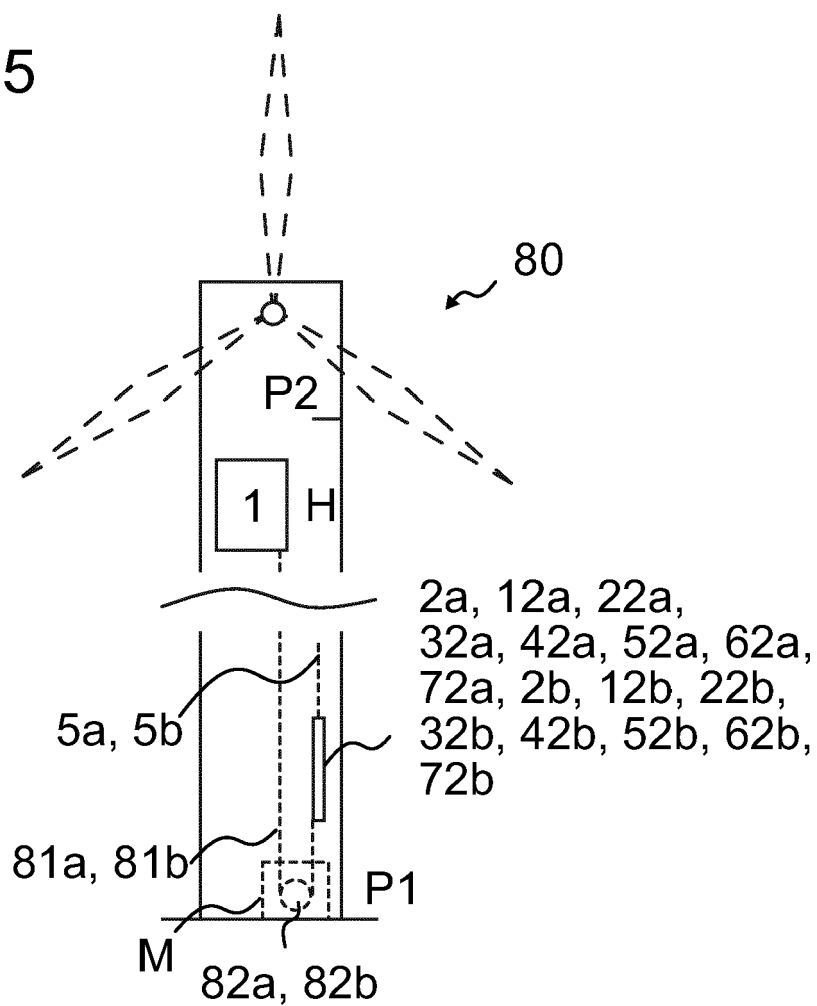


Fig. 5





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Application Number
EP 13 16 1520

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