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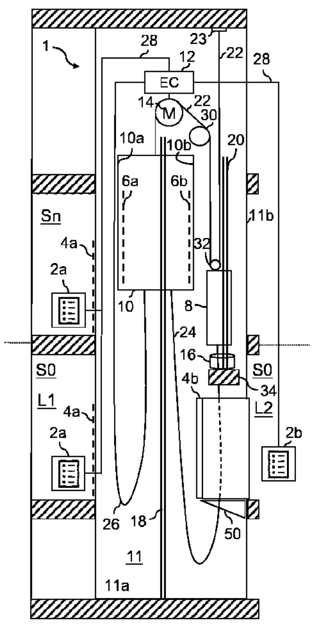

Fig. 10

(57) **Abstract:** In a building having an elevator system (1), an additional shaft door (4b) is installed on a lobby floor (S0) in addition to an existing shaft door (4a) on the lobby floor (S0). The existing shaft door (4a) faces an existing elevator lobby (L1), and the additional shaft door (4b) faces a newly created elevator lobby (L2). The elevator system (1) has a car (10) having two car doors (6a, 6b), each one serving one of the two elevator lobbies (L1, L2) on the lobby floor (S0). The elevator system (1) is configured so that a travel path of a counterweight (8) does not overlap with a zone of the additional shaft door (4b). The second shaft door (4b) includes a passage insert (47, 48) that bridges a gap between the second shaft wall (11b) and the second car door (6b), wherein the gap is larger than a thickness of the counterweight (8).

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Converted elevator system for mixed-use building

Description

The technology described herein generally relates to an elevator system. More particularly, exemplary embodiments of the technology relate to a converted elevator system and a method for converting an existing elevator system.

Buildings are usually designed and constructed for a single use or for a mixed use. A residential building is an example of a single-use building, as is an office building. A mixed type of use is when a building contains, for example, apartments and commercially used rooms and areas. An elevator system is planned (e. g., regarding transport capacity) and installed for the intended use of the building. Depending on the building, the elevator system can have a single elevator, e. g., moveable in an elevator shaft, a group of elevators (an elevator group), or several elevator groups; in addition, one or more special-purpose elevators (e. g. goods or freight elevators) can be provided. An elevator car can have a single entrance on one of its side walls, or two entrances, e. g., on opposite side walls of an elevator car, as disclosed, e. g., in GB 2 315 567 B which refers to such a car as "through car". On floors of the building, shaft doors close off the elevator shaft when no elevator car is present for boarding or deboarding.

Over time, the originally planned use of the building may change for a variety of reasons. The need for office space, or commercial space in general, can decrease, for example, due to changing living and working conditions. In an office building, for example, office space that has become vacant can be converted into apartments on one or more floors. In the event of such a changed use, the elevator system installed in the building essentially remains as it was designed for the originally planned type of use of the building.

Although the installed elevator system is still available for the transport of people and goods after the building's use has changed, such a change in use can result in changed requirements for the elevator system. There is therefore a need for a technology that fully or at least partially meets these requirements.

One aspect of the technology described here is an elevator system of a building having an elevator shaft, a plurality of floors and a first main elevator hall at one of the plurality of floors. The elevator system includes an elevator car having a first sidewall and a second sidewall. The elevator car has a first car door at the first sidewall and a second car door at the second sidewall. The elevator car is suspended by a suspension system using a 1:1 roping arrangement. The elevator system's car guide rails are mounted to a first shaft wall of the elevator shaft along which car guide rails the elevator car is movable by a drive machine controlled by an elevator controller. The elevator system includes first shaft doors provided on floors served by the elevator system, wherein each first shaft door is engageable with the first car door, and wherein at a first floor the first shaft door faces the first main elevator hall. Further, the elevator system includes a counterweight movable along counterweight guide rails mounted to a second shaft wall, wherein the counterweight is suspended by the suspension system using a 2:1 roping arrangement. The second shaft wall faces the second sidewall containing the second car door. A second shaft door is provided at the second shaft wall, wherein the second shaft door is provided at the first floor and faces a second main elevator hall. The second shaft door includes a passage insert that bridges a gap between the second shaft wall and the second car door, wherein the gap is larger than a thickness of the counterweight. The 1:1 roping arrangement of the elevator car and the 2:1 roping arrangement of the counterweight restrict a movement of the counterweight to a zone above the second shaft door.

Another aspect of the technology described here is a shaft door of such an elevator system. The shaft door includes a passage insert that bridges a gap between the second shaft wall and the second car door, wherein the gap is larger than a thickness of the counterweight. The passage insert has a shape of a frame, an elevator hall-facing side and a car-facing side, wherein the frame is formed by a floor plate, lateral and upper panels. Further, the passage insert includes a shaft-door support at the car-facing side, wherein the second shaft door is mounted to the shaft-door support.

The technology described here provides that an existing elevator system can be converted to adapt to the new or changed use of the building. Rather than demolishing the existing building and constructing a new building with a new elevator system suitable for the new or changed use, the building and the elevator system are modified to adapt to the new or changed use of the building. The modification strives to maintain as much of the original elevator system as possible, for example, the drive machine, the shaft doors, the car guide rails, and any related electrical system, and to keep any structural changes of the building at a minimum.

The existing building has an existing main elevator hall (also known as a lobby), usually at a floor on which passengers enter and exit the building using its main entrance. The lobby connects to the elevator system of which passengers may see, e. g., a closed shaft door or an elevator car with its car door being open. On other building floors, minor elevator halls provide access to the elevator system. The main entrance may be on a street level; it is contemplated that another entrance, e. g., for vehicles, may exist at another floor from which passengers can travel to their destination floors or to the main elevator hall. Referring to the main entrance at street-level, upon entering the building and the main elevator hall, passengers may place elevator calls to be transported from the main elevator hall to their destination floors. Elevator trips initiated by passengers that want to walk out of the building usually end at the main elevator lobby.

According to the technology described herein, during the modification, the building is provided with an additional main elevator hall that is separate from the original main elevator hall and intended for a user group that is to be kept separate from a user group using the original main elevator hall. Members (passengers) of the different user groups, hence, use different main elevator halls and may not notice each other or even become aware that there is another main elevator hall or another use of the building. For example, passengers having their residences in the building, or their visitors, use "their" main elevator hall from which they can travel to residential floors, while passengers other than such residential passengers, e. g., commercial tenants or their clients (such as hotel guests), use the other main elevator hall; in one embodiment, "commercial" passengers can travel only to commercial floors, but not to the residential floors. It is contemplated that the separation of the user groups is maintained during their use of the elevator system; elevator calls are assigned to an elevator car so that the user groups are not mixed.

The two main elevator halls can be on the same floor of the building. Access to the additional main elevator hall may be through the building's main entrance, which allows access to the existing main elevator hall, as well, or through a separate building entrance. The separate building entrance may be a newly installed entrance or an existing separate entrance, e. g. on the same or a different floor. It is contemplated that, depending on the building, the existing main elevator hall may be modified so that access is through the existing separate entrance instead of the building's main entrance; access to the additional main elevator hall may then be through the building's main entrance.

The modification of the elevator system includes providing an elevator car that has two car doors that are separate from each other, e. g., on opposite car walls. In one embodiment, one of these car doors, a first car door, can be controlled to open towards both the existing main elevator hall and (some of) the minor elevator halls, whereas the other car door, a second car door, can be controlled to open only towards the additional main elevator hall. For example, in case a residential passenger boards the elevator car through the second car door to travel from the additional main elevator hall to its residential floor, the passenger exits the elevator car using the first car door. Similarly, in case a hotel guest boards the elevator car through the first car door to travel from the main elevator hall (hotel lobby) to a hotel floor on which the hotel guest's room is located, the hotel guest exits the elevator car using the first car door.

Furthermore, the modification of the elevator system includes changing the suspension of the counterweight so that it no longer passes through the region of the shaft wall where access to the additional elevator hall is to be provided. For that purpose, the elevator car is suspended by the suspension system using a 1:1 roping arrangement, and the counterweight is suspended by the suspension system using a 2:1 roping arrangement. The 1:1 roping arrangement of the elevator car and the 2:1 roping arrangement of the counterweight restrict a movement of the counterweight to a zone above the second shaft door. If, in the existing elevator system, the elevator car is suspended using a 1:1 roping arrangement, that roping arrangement is maintained. The travel path of the counterweight is reduced by about a half. Depending on the elevator system, the weight of the counterweight is adjusted, e. g., doubled.

The passage insert bridges the gap between the second shaft wall and the second car door. Since the existing elevator installation is configured to that the counterweight can pass through that gap, the gap is wider than a thickness of the counterweight. The passage insert has a depth (as considered from the second main elevator hall) that bridges the gap so that passengers can board and deboard the elevator car. The thickness of the counterweight and, hence, the width of the gap depend on the general specification of the elevator system (e. g., its load capacity of the elevator car). The passage insert can be configured for the actual gap of a certain building. Further, the passage insert can be configured to conform to its surrounding building area, e. g., regarding design, material, and any required or helpful illumination.

In one embodiment, the passage insert has a shape of a frame, an elevator hall-facing side and a car-facing side, wherein the frame is formed by a floor plate, lateral (e. g., two side wall panels) and upper panels. Further, the passage insert includes in one embodiment a shaft-door support at the car-facing side, wherein the second shaft door is mounted to the shaft-door support. Considered from the second main elevator hall, the shaft door is positioned at the passage insert's distal end to be opened and closed by the (second) elevator car door when the elevator car serves the second main elevator hall. The passage insert separates the passengers from the shaft interior.

Due to the mentioned roping arrangements, the counterweight no longer passes through and below the mentioned shaft region and the concerned counterweight guide rails are no longer needed for the counterweight. The counterweight guide rails include first vertically extending guide rails and second vertically extending guide rails. The first and second vertically extending guiderails are arranged in parallel and spaced apart from each other at a distance. In one embodiment, those counterweight guide rails that are no longer needed can be removed. In this case, the counterweight guide rails end above the second shaft door. With the counterweight guide rails being removed, any restrictions (due to the locations and the spacing between two parallel extending counterweight guide rails) as to the size of an opening (in particular its width) in the shaft wall for the additional shaft door and the additional shaft door itself are reduced. In such an embodiment, the second shaft door has a width that is larger than the distance (spacing).

In another embodiment, the counterweight guide rails are left in place. This simplifies converting the existing elevator system, and these left-in-place guide rails may be used to attach components of the second shaft door. In such an embodiment, the second shaft door has a width that is smaller than the distance (spacing); it then fits between the vertically extending guide rails. While these guide rails may limit the width of the second car door, in certain elevator systems (e. g., for high-rise buildings where the spacing is relatively large) the width may be sufficient to fit in a shaft door that complies with elevator code requirements, e. g., the width of the door opening.

In one embodiment, the elevator system includes a counterweight buffer structure that is arranged at, or close to, the second shaft wall; it may be supported by the elevator shaft or the left-in-place counterweight guide rails. In case of the removed counterweight guide rails, the remaining counterweight guide rails end above the second shaft door and, for example, are supported by the counterweight buffer structure. In case of the left-in-place counterweight guide rails, the counterweight buffer structure is supported by the counterweight guide rails. In either case, the counterweight buffer structure supports at least one buffer which is also arranged above the additional shaft door.

In addition to the at least one buffer, the counterweight buffer structure includes in one exemplary configuration a horizontal beam that extends above and parallel to the second shaft door. The at least one buffer and the horizontal beam are configured to support the counterweight.

The counterweight buffer structure can further include a vertical support structure extending from a pit of the elevator shaft to the horizontal beam. In that configuration, the horizontal beam is supported by the vertical support structure. The vertical support structure includes two vertical beams, each vertically extending at or in proximity of a shaft corner at the second shaft wall.

In one embodiment, the elevator system includes a safety brake system mounted to the counterweight to act upon the counterweight guide rails. The safety brake system is coupled to an overspeed governor to be triggered by the overspeed governor. This allows directly braking and halting of the counterweight in case of a malfunctioning of the elevator system.

The elevator system's compensation cable may be subject to modification, as well. The compensation cable usually extends between an about centered fixation at the bottom of the counterweight and an about centered fixation at the bottom of the elevator car. By the modification, a deflection system is provided according to one embodiment that deflects the compensation cable out of the mentioned shaft region so that it does not pass through the area occupied by the additional shaft door. In one embodiment, the deflection system has a set of pulleys arranged in the shaft above the additional shaft door that deflect the compensation cable from its about centered fixation at the bottom of the counterweight to a side to bypass the additional shaft door. A set of pulleys arranged in the shaft below the additional shaft door deflect the compensation cable back to its about centered fixation at the bottom of the elevator car. In one embodiment, two separate compensation cables are provided totaling the weight of a "normal" single compensation cable, each being deflected above and below the additional shaft door by sets of pulleys, respectively.

It is contemplated that any of the above-mentioned embodiments may be combined with any of the embodiments disclosed herein.

In the following, various aspects of the improved technology are explained in more detail by means of exemplary embodiments in connection with the figures. All figures are merely schematic illustrations of methods and devices or their components according to exemplary embodiments of the improved technology. In particular, distances and size relations are not reproduced to scale in the figures. In the figures, identical elements have identical reference signs. In the figures:

Fig. 1 shows a schematic illustration of an exemplary elevator system in a building, wherein the elevator system is to be converted to adapt to a changed use of the building;

Fig. 2 shows a schematic illustration of one embodiment of the elevator system converted to adapt to the changed use of the building;

Fig. 3 is a first schematic cross-sectional top view of the elevator system shown in Fig. 2;

Fig. 4 is a second schematic cross-sectional bottom view of the elevator system shown in Fig. 2;

Fig. 5 shows a schematic side view of the elevator system according to Fig. 2, wherein a roping arrangement of a counterweight and a deflection system for a compensation cable are shown;

Fig. 6 shows a schematic cross-sectional top view of the elevator system according to Fig. 5 at a level above a drive unit;

Fig. 7 shows a schematic cross-sectional bottom view of the elevator system according to Fig. 5;

Fig. 8 shows a schematic illustration of a situation in which an elevator car is at a newly installed shaft door;

Fig. 9 shows a schematic partial top view of the situation shown in Fig. 8;

Fig. 10 shows a schematic illustration of a variation of the elevator system shown in Fig. 2;

Fig. 11 shows a schematic illustration of a further variation of the elevator system shown in Fig. 2 with left-in-place counterweight guiderails; and

Fig. 12 shows a schematic side view of the elevator system according to Fig. 11 together with a relative narrow additional shaft door.

Fig. 1 shows a schematic illustration of an exemplary embodiment of an elevator system 1 in a building. Based on this elevator system 1, various embodiments of the technology disclosed herein are described with reference to the following exemplary scenario: The elevator system 1 may have been installed at, or around, the time the building was constructed. It is, therefore, configured to meet the building's requirements existing at the time of construction. The building may have been constructed for a specified commercial use, e. g., as an office building with or without retail space. Over time, the building's use may change, e. g., due to employment and societal changes, which leads to changing requirements for the elevator system 1. The elevator system 1 shown in **Fig. 1** is, therefore, considered to be the existing elevator system 1 that is to be converted to adapt to the changed use/requirements of the building. In that scenario, certain components of the elevator system 1 may be maintained in amended form, while others may be removed without being replaced; the building may undergo certain remodeling, as well. These measures concerning the elevator system 1 and/or the building may be generally referred to as modernization.

In the following, components and functions of the elevator system 1 are explained as far as they are believed to be helpful for an understanding of the technology described herein. Distances and size relations of the components and their relative positioning are not reproduced to scale. The building shown in **Fig. 1** has a plurality of floors of which only two floors S0, Sn are shown; that the building has a plurality of floors is indicated through a horizontal dotted line between the floors S0, Sn, whereas the floor Sn is herein the uppermost floor of the building served by the elevator system 1. The plurality of floors is served by the elevator system 1, e. g., a passenger can be transported from a boarding floor to a destination floor by an elevator car 10 of the elevator system 1 after inputting an elevator call ("call") at a call input terminal 2a. Alternatively, or in addition, elevator calls may be entered using, e. g., a mobile phone equipped with a suitable software application for communicating with the elevator system 1. For example, the passenger may enter the building at a street level and enter the call after arriving in a main elevator hall L1 (also referred to as elevator lobby L1) at that level of the building, as illustrated in **Fig. 1**. Below that level, the building may have additional floors which, in one embodiment, may be served by the elevator system 1, as well.

In the exemplary embodiment shown, the elevator car 10 is coupled to a suspension system 22 and movable along vertical car guide rails 18 installed in an elevator shaft 11, e. g., mounted on opposite shaft walls. The elevator car 10 has an elevator door at a side where the shaft wall does not have guide rails 18. The suspension system 22 includes, for example, a set of steel ropes. The various embodiments of the technology are described herein with reference to such a set of steel ropes; it is, however, contemplated that in another embodiment, the suspension system 22 can include a set of flat belts, wherein each belt can have a width that is larger than its thickness. The suspension system 22 may include one or more pulleys 30 to guide the set of steel ropes. The set of steel ropes of the suspension system 22 support on one side the elevator car 10 and on another side a counterweight 8 that is movable along counterweight guide rails 20 installed in the elevator shaft 11. In the illustrated embodiment, the set of steel ropes are attached to the elevator car 10 and the counterweight 8, respectively, and partially wrap around the one or more pulleys 30 and a traction sheave of a drive machine (M) 14; however, other roping and/or suspension arrangements are possible and known to the skilled person, in particular in connection with a traction elevator system shown in **Fig. 1**.

The use of the counterweight 8 in the illustrated traction elevator system 1 is generally known to the skilled person. Briefly, the counterweight 8 gives balance to the elevator system 1 and makes it simpler to raise and lower the elevator car 10; it travels in opposite direction from the elevator car 10. As a general rule, the weight of the elevator car 10 plus part of a passenger load (about 40 to 50% of its rated load) determines the weight of the counterweight 8. The counterweight guide rails 20 can be a pair of spaced apart guide rails arranged in parallel.

The elevator system 1 has an elevator controller (EC) 12 coupled to and controlling the drive machine 14 to move the elevator car 10 in the elevator shaft 11 to serve a passenger's call entered at the call input terminal 2a. In addition, and as described below in more detail, the elevator controller 12 is – for illustrative purposes – representative of a call control system that processes elevator calls according a call control technology implemented in the elevator system 1. A communications system 28 couples each call input terminal 2a to the elevator controller 12. The elevator car 10 has a (first) car door 6a at a first sidewall 10a to allow the passenger to board the elevator car 10 at the boarding floor and to deboard it at the destination floor. At each floor S0, Sn served by the elevator system 1, (first) shaft doors 4a are installed. In one embodiment, the shaft doors 4a are operable by the car door 6a; e. g., at a destination or boarding floor, the elevator controller 12 activates the car door 6a which engages with the shaft door 4a to open and close the shaft door 4a. The person skilled in the art will recognize that the elevator system 1 can have a plurality of elevator cars 10 or multi-deck cars in one or more elevator shafts 11, or can comprise one or more groups of elevators (each having, e. g., one elevator car) controlled by a group controller.

Various structures and arrangements of an elevator shaft are known to the skilled person depending on the building and/or the elevator system. Generally, an elevator shaft is the building structure in which one or more elevator cars 10 can move, wherein, for example, several elevator cars 10 can move independent of each other side-by-side, or two elevator cars 10 can move vertically above each other. For example, the elevator shaft 11 can be a concrete structure with four walls provided at or near a central vertical building space surrounded by other building areas. In the embodiments described herein, the elevator shaft 11 has a rectangular cross-section with four shaft walls (11a, 11b). The drive machine 14, the elevator controller 12 and other elevator-related equipment may be arranged at the top of the elevator shaft 11, e. g., in a machine room. An elevator pit is at the bottom of the elevator shaft 11 and, for example, provides room for parts of the bottom of the elevator car 10, or components extending therefrom, e. g., a hanging cable 26, which is further coupled to the elevator controller 12, and a compensation cable 24, when the elevator car 10 is at its lowest position (e. g., serving the lowest floor). As shown in **Fig. 1**, the elevator pit provides room for a counterweight buffer 16 (one or more) mounted to the pit floor and supports the counterweight guide rails 20. To illustrate the support function, the counterweight guide rails 20 are depicted as resting on the pit floor. Therefore, the elevator pit is usually a relatively massive concrete structure configured to support the elevator system 1 during normal and exceptional (e. g., emergency) situations.

Fig. 2 shows a schematic illustration of one embodiment of the elevator system 1 which (based on the situation shown in **Fig. 1**) has been converted to adapt to the changed use of the building. Generally, a second main elevator hall L2 is provided in the building on one of the building's floors S0, Sn; the second main elevator hall L2 is separate from the first main elevator hall L1 to allow access to the elevator system 1 independent and separate from the first main elevator hall L1. In the illustrated embodiment, the second main elevator hall L2 is provided on the same floor S0 as the first main elevator hall L1, e. g., on the street level. A building may have an additional building entrance. In such a building, in one embodiment, passengers entering the building using the additional building entrance may get to the second main elevator hall L2 without noticing the first main elevator hall L1 or becoming aware of passengers using the first main elevator hall L1. The additional building entrance may be newly created in a building wall or be separated or walled off from the existing building entrance. As described elsewhere in this description in more detail, on the floor S0 on which the second main elevator hall L2 is to be provided, an opening sized for a second shaft door 4b is made in the shaft wall 11b. The second shaft door 4b installed in the opening is schematically shown in **Fig. 2** using dashed lines.

It is contemplated that a passenger may enter an elevator call when using the main elevator hall L2. In one embodiment, and similar to the call input terminal 2a arranged in the main elevator hall L1, a call input terminal 2b can be arranged in the main elevator hall L2, as shown in the embodiment of **Fig. 2**. The call input terminal 2b can be coupled to the communications system 28, as well. Alternatively, or in addition, elevator calls may be entered using, e. g., mobile phones, as mentioned above.

Comparing **Fig. 1** and **Fig. 2**, the second shaft door 4b in **Fig. 2** occupies an area and a space in which in **Fig. 1** lower ones of the existing counterweight guide rails 20 are located and the counterweight 8 and the compensation cable 24 move. In the modified elevator system 1 of **Fig. 2**, the suspension of the counterweight 8 is changed so that the counterweight 8 no longer passes through the region of the shaft wall 11b where access to the additional elevator hall L2 is provided. For that purpose, the elevator car 10 is suspended by the suspension system 22 using a 1:1 roping arrangement, and the counterweight 8 is suspended by the suspension system 22 using a 2:1 roping arrangement. The 1:1 roping arrangement of the elevator car 10 and the 2:1 roping arrangement of the counterweight 8 restrict the counterweight's movement to a zone above the second shaft door 4b. If, in the existing elevator system 1, the elevator car is suspended using a 1:1 roping arrangement, that roping arrangement is maintained. The travel path of the counterweight 8 is reduced by about a half. Depending on the elevator system, the weight of the counterweight 8 is adjusted, e. g., doubled.

Due to these roping arrangements, the counterweight 8 no longer passes through and below the mentioned shaft region and the concerned lower counterweight guide rails 20 are no longer needed for guiding the counterweight 8. In one embodiment, the counterweight guide rails 20 can be removed, as shown in **Fig. 2**; in this case, these lower counterweight guide rails 20 are removed so that the remaining counterweight guide rails 20 end above the second shaft door 4b at a newly installed counterweight buffer structure (16, 34, 36). With the counterweight guide rails being removed, any restrictions (due to the locations and the spacing between two parallel extending counterweight guide rails) as to the size of an opening (in particular its width) in the shaft wall 11b for the additional shaft door 4b and the additional shaft door 4b itself are reduced. In another embodiment shown in **Fig. 11** and **Fig. 12**, the counterweight guide rails 20 are left in place, and the counterweight buffer structure (16, 34) is installed above the second shaft door 4b. This simplifies converting the existing elevator system 1, and the left-in-place counterweight guide rails 20 may be used to attach components of the second shaft door 4b. While these counterweight guide rails may restrict the width of the second car door, in certain elevator systems (e. g., for high-rise buildings with large elevator cars and correspondingly large counterweights requiring relatively widely spaced counterweight guide rails) the width may be sufficient to fit in a shaft door that complies with code requirements.

The counterweight buffer structure includes a buffer 16 (one or more), which may be similar to the one shown in **Fig. 1**, and a horizontal beam 34 extending above and essentially parallel to the second shaft door 4b. The buffer 16 and the horizontal beam 34 are configured to support the weight of the counterweight 8 during normal operation of the elevator system 1, wherein the counterweight guide rails 20 may be supported by the horizontal beam 34, e. g., to prevent the counterweight guide rails 20 from sliding downwards. The weight of the counterweight 8 is determined according to the above-mentioned general rule. Due to the roping arrangement shown in **Fig. 2**, the counterweight 8 is heavier, and depicted larger, than the counterweight 8 shown in **Fig. 1**.

The buffer 16 and the horizontal beam 34 are configured in consideration of the weight of the counterweight 8; for example, they can support the counterweight 8 at its lowest position during normal operation. Another consideration may be configuring the buffer 16 and the horizontal beam 34 for a predefined maximum kinetic energy of the counterweight 8. As shown in **Fig. 2**, the buffer 16 is mounted on top of the horizontal beam 34. The horizontal beam 34 may be attached to at least one shaft wall 11a, 11b. In an exemplary embodiment, opposite ends of the horizontal beam 34 may be set in concrete at the opposite shaft walls 11a and/or bolted to these walls. It is contemplated that the horizontal beam 34 may be comprised of a set of individual beams.

Depending on the building and at what height or floor level the horizontal beam 34 is installed, in one embodiment, the counterweight buffer structure may include a vertical support structure 36 that extends from the pit of the elevator shaft 11 to the horizontal beam 34 and is configured to support the horizontal beam 34, for example, in addition to the horizontal beam 34 being mounted to one or more of the shaft walls 11a, 11b. In the illustrated embodiment, the vertical support structure 36 rests on the pit floor and may be attached to at least one shaft wall 11a, 11b. In one embodiment, the vertical support structure 36 includes two vertical beams 36a, 36b, as shown in **Fig. 5**, each vertically extending at, or in proximity of, a shaft corner at, or in proximity of, the second shaft wall 11b. The horizontal beam 34 may be attached to the vertical support structure 36.

The vertical support structure 36 is optional. **Fig. 10** shows a schematic illustration of a first variation of the elevator system 1 shown in **Fig. 2** that does not have the vertical support structure 36. In that case, the horizontal beam 34 can be mounted, as described above.

A pulley 32 is mounted to the counterweight 8 for suspending the counterweight 8. As shown in **Fig. 2**, the pulley 32 can be mounted to an upper part of the counterweight 8. The pulley 32 may include several individual pulleys depending on the number of steel ropes contained in the set of steel ropes, or a corresponding number of guide grooves on a single pulley body. The pulley 32 is arranged to engage with the set of steel ropes of the suspension system 22 within a predetermined rope length between a rope attachment point 23 in the elevator shaft 11 and the drive unit 14 when the counterweight 8 travels up and down between an upper position and a lower position. The counterweight's travel distance between these two positions is set so that the counterweight 8 does not pass the zone of the second shaft door 4b, but the elevator car 10 can still serve the lowest floor and the highest floor of the building.

According to the illustrated embodiment of the (converted) elevator system 1 shown in **Fig. 2**, the elevator car 10 has a second car door 6b at a second sidewall 10b which are, for example, opposite to the first car door 6a and the first sidewall 10a of the elevator car 10. In one embodiment, the existing one-door elevator car 10 may have been removed and a new two-door elevator car 10 may have been installed. In another embodiment, the second car door 6b may have been inserted into the existing one-door elevator car 10. It is contemplated that in either case, any car-related electrical wiring is configured to allow the elevator controller 12 to operate the car doors 4a, 4b, for example. As is known to the skilled person, communications between the elevator car 10 and the elevator controller 12 may take place via the hanging cable 26; alternatively, communications may take place using a radio communications system.

Fig. 3 is a schematic cross-sectional top view of the elevator system 1 shown in **Fig. 2**, looking down towards the pit from underneath the counterweight 8; the counterweight 8 is, therefore, not shown. The shaft 11 has a rectangular cross-section with four shaft walls 11a, 11b, wherein at the opposite shaft walls 11b the shaft doors 4a, 4b are installed. At the above-mentioned height and in a vertical space between the travel path of the elevator car 10 and the shaft wall 11b that includes the shaft door 4b, the horizontal beam 34 is installed and extends between the opposite shaft walls 11a. In a vertical extension of this space above the buffer 16, the counterweight 8 can travel, as shown in **Fig. 4**, which is also a schematic cross-sectional bottom view of the elevator system shown in **Fig. 2** looking down towards the pit, however, from above the counterweight 8.

Fig. 5 shows a schematic side view of the elevator system 1 according to **Fig. 2**, wherein the roping arrangement of the counterweight 8 and a deflection system 42 for the compensation cable 24 are shown. As mentioned above, the compensation cable 24 interconnects the counterweight 8 and the elevator car 10, wherein the compensation cable 24 is about centrally attached to the bottom of the elevator car 10. For example, when the counterweight 8 is at its uppermost position, the compensation cable 24 may extend along (or close to) a vertical center line of the shaft wall 11b along which the counterweight 8 travels.

The deflection system 42 is arranged to deflect the compensation cable 24 at least out of the space required for the newly installed shaft door 4b. That space must be unobstructed to fit in, e. g., a passage insert shown in **Fig. 8**. The deflection system 42 acts on the compensation cable 24 using a set of pulleys 42a, 42b; for example, a first set of pulleys 42a is installed at a level above the shaft door 4b, and a second set of pulleys 42b is installed at a level below the shaft door 4b. In the exemplary embodiment shown in **Fig. 5**, two pulleys 42a of the first set deflect the compensation cable 24 from the center line towards a corner space formed by the shaft walls 11a, 11b, and two pulleys 42b of the second set deflect the compensation cable 24 back towards the center line so that the compensation cable 24 reaches the bottom of the elevator car 10 where it is attached to the elevator car's underside at about the underside's center.

Instead of a single compensation cable 24, its function can be implemented, for example, by two separate compensation cables 24. As illustrated in the example show in **Fig. 5** (as seen from the elevator hall L2), the separate compensation cables 24 are guided symmetrically with respect to the elevator car 10 and the counterweight 8. Each one of the separate compensation cables 24 is attached to the support structure and extends upwards (essentially vertically) to a pulley 43 at a bottom part of the counterweight 8, where it is partially wrapped around the pulley 43 to then extend downwards (essentially vertically) to the first set of pulleys 42a that deflect the separate compensation cable 24 to the corner space. Within the zone of the elevator hall L2, each separate compensation cable 24 extends along the corner space down to the second set of pulleys 42b which deflect it back towards the elevator car 10.

In the embodiment of **Fig. 5**, two buffers 16 are shown that are mounted on a base 35. The base 35 is mounted on the horizontal beam 34, wherein the base 35 in a side view may have a shape of a lying U or C, as shown in **Fig. 5**, so that the buffers 16 are positioned higher than the horizontal beam's upper surface. The separate compensation cables 24 are attached to the base 35. It is contemplated, however, that the C-shaped base 35 is optional and that selecting an appropriate number of buffers 16 is within the skill of the skilled person.

Further, as shown in the embodiment of **Fig. 5**, the elevator system 1 includes an overspeed governor 38 coupled to an overspeed rope 40, which is further coupled to the elevator car 10. As known to the skilled person, the overspeed governor 38 restricts movement of the elevator car 10 when a predetermined speed is exceeded; it can include a switch (not shown) that opens when the elevator car 10 reaches a predetermined velocity, e. g., 110% of a rated speed. When the switch opens, electrical power is removed from the drive machine 14 and, e. g., an electrical holding magnet of a car brake. Actuated in response to the movement of the elevator car 10, the car brake then impedes the motion of the elevator car 10. The switch remains open, and the elevator system 1 remains inoperable until the switch is manually reset. Further details regarding structure and function of the overspeed governor 38, and its electrical interconnections within the elevator system 1 are known to the skilled person.

In addition to the above-mentioned car brake, the elevator system 1 includes in the illustrated embodiment a safety brake system 44 mounted to the counterweight 8. The safety brake system 44 is configured to act upon the counterweight guide rails 20 and may have a structure that is in general similar to the car brake. As such, the safety brake system 44 may be triggered by the overspeed governor 38, as well, e. g., due to the removal of the electrical power. During regular operation, the counterweight 8 accelerates and decelerates corresponding to the movement of the set of ropes of the suspension system 22. If in the elevator system 1 an irregular event occurs, e. g., an overspeed of the elevator car 10 or the counterweight 8, the safety brake system 44 is configured to act upon the counterweight guide rails 20 to reduce the speed of the counterweight 8 before it stops at, or is stopped by, the buffers 16. The safety brake system 44 may be configured to hold the counterweight 8 and/or to bring it to a halt before it reaches the buffers 16.

It is contemplated that additional measures may be implemented to ensure that there is no risk of the counterweight 8 reaching the zone of the second shaft door 4b. For example, one or more brake elements may be installed in the shaft 11 so that at least a part of a brake element extends into a travel path of the counterweight 8. The brake element may include a damper whose dampening effect increases with the speed it is acted upon. In a brake application contemplated here, the damper shows a relative low resistance, hence no or a low brake force, when it is compressed by a relatively slow-moving counterweight 8; however, the resistance is high when being hit/compressed by a relatively fast-moving counterweight 8. A fast-moving counterweight 8, e. g., as a result of a failure in the elevator system 1, experiences a high brake force that significantly slows down or stops the counterweight 8. Various technologies for such a damper are known, e. g., using a hydraulic fluid, a gas fluid, or a mechanical spring. The number of brake elements may be selected, for example, based on the damper technology and/or the weight of the counterweight 8. In the embodiment of **Fig. 5**, the one or more brake elements may be installed above the horizontal beam 34, e. g., at or above the level of the buffers 16.

Furthermore, it is contemplated the drive machine 14 itself has a brake function, either its internal electrical motor can be operated as a brake, or a separate machine brake is provided in or at the drive machine 14. The drive machine 14 provides, therefore, a safety feature, also with respect to the counterweight 8.

Fig. 6 shows a schematic cross-sectional top view of the elevator system 1 according to **Fig. 5** at a level above the drive unit 14 to illustrate the arrangement of the drive unit 14 within the shaft 11. Besides other components of the elevator system 1, the elevator car doors 6a, 6b and the shaft doors 4a, 4b are illustrated. The set of ropes of the suspension system 22 is indicated by a representative rope that partially wraps around a drive sheave of the drive unit 14. It is contemplated that the drive sheave can be configured for the set of ropes, e. g., by having several grooves. The drive sheave has a horizontal axis of rotation that is about parallel to the plane of the shaft wall 11b. The drive unit 14 and the pulley 32 are arranged so that the set of ropes extends vertically down to the counterweight 8 essentially without an angular offset.

Fig. 7 shows a schematic cross-sectional bottom view of the elevator system 1 according to **Fig. 5**, as seen from the pit, to illustrate the run of the separate compensation cables 24. In that view, for example, the set of sheaves 42b for the separate compensation cables 24 and an underside of the shaft door 4b are visible. The shaft door 4b bridges the gap between the shaft wall 11b and the elevator car door 6b. Each compensation cable 24 is guided by the set of sheaves 42b from the corner space to the center area at the bottom of the elevator car 10. As shown in **Fig. 7**, in the region of the pit, the sheave 42b arranged in the corner space changes the direction of the compensation cable 24 from a vertical direction to a horizontal direction, wherein the horizontal direction has an inclined angle with respect to the plane of the shaft wall 11b. The sheave 42b arranged below the elevator car's center area changes the direction of the compensation cable 24 from the horizontal direction to the vertical direction.

Fig. 8 shows a schematic illustration of a situation in which the elevator car 10 is at the newly installed shaft door 4b; e. g., at a time the elevator car 10 serves the (second) main elevator hall L2 on the floor S0 for boarding and/or deboarding. The illustration is a partial view of the elevator system 1 shown, e. g., in **Fig. 2**, and is simplified to show the car guide rails 18 and the elevator car 10 opposite the shaft door 4b. A schematic partial top view of the situation shown in **Fig. 8** is shown in **Fig. 9**.

As illustrated in **Fig. 8** and **Fig. 9**, a vertical gap between the elevator car's sidewall 10b and the shaft wall 11b has a depth D. The depth D can be measured between an outer surface of the sidewall 10b of the elevator car 10 and an inner surface of the shaft wall 11b. In the existing elevator system 1, as shown in **Fig. 1**, before converting it to the changed use, the counterweight 8 travels up and down through that gap. To bridge the gap in the converted elevator system 1, the shaft door 4b may be constructed include a frame-shaped passage insert having an elevator hall-facing side and a car-facing side. In one embodiment, the passage insert has a floor plate 48, lateral and upper panels 47 (upper panel not shown), and a shaft-door support 49 at the car-facing side, wherein the actual shaft door 4b may be mounted to the shaft-door support 49. At the hall-facing side, a face plate 46 (or molding) may be provided, e. g., to cover the transition between the shaft wall 11b and the lateral panels 47. As to material(s), color and design, the face plate 46 may be selected according to its surroundings.

In one embodiment, at least some of the elements of the frame-shaped passage insert may be bolted to the shaft wall 11b, either directly or by means of auxiliary support elements, depending on a rated weight or force to which an element may be exposed. For example, the floor plate 48 may be rated for a maximum weight (e. g., also in consideration of goods to be loaded using a cart); accordingly, the floor plate 48 may rest on a support structure 50 (**Fig. 10**) mounted to the shaft wall 11b or resting on the pit floor. The shaft-door support 49 may be supported by the same or a separate support structure.

The floor plate 48 and the lateral and upper panels 47 provide for a passageway for passengers boarding or deboarding the elevator car 10 and separate the passengers from the shaft 11. The shaft door 4b, in **Fig. 9** it is, for example, a pair of door leaves, closes the elevator shaft 11 off and, hence, secures the elevator hall L2 towards the elevator shaft 11 except at time when boarding or deboarding is permitted.

In one embodiment, the car door 6b and the shaft door 4b are configured so that the car door 6b can engage with the shaft door 4b when at the floor S0. This configuration can be similar to the configuration on the other side of the elevator car 10, namely the car door 6a and the shaft door 4a. As indicated in **Fig. 9**, the shaft-door support 49 is arranged to position the shaft door 4b so that the mentioned engagement of the two door systems is possible; for illustrative purposes, the shaft door 4b and the car door 6b are arranged close to and opposite to each other. It is contemplated that the structural details (e. g., components and dimensions) of these door systems are known to the skilled person. It is further contemplated that the mechanical and electrical operations and functions of these door systems, including the activation of the respective car door 6a, 6b at a certain floor S0, Sn by the elevator controller 12 and the monitoring of the doors (4a, 4b, 6a, 6b) using, e. g., light curtains to safely operate the doors, are known to the skilled person.

Fig. 11 shows a schematic illustration of a further variation of the elevator system 1 shown in **Fig. 2**. As mentioned above, that variation concerns the left-in-place counterweight guide rails 20 which are shown to cross the zone of the shaft door 4b and rest on the pit floor. **Fig. 12** shows a schematic side view of the elevator system 1 according to **Fig. 11** wherein the left-in-place counterweight guide rails 20 are shown; the deflection system 42 is shown, as well. As shown, the counterweight guide rails 20 include a pair of vertical rails that are spaced apart from each other. That spacing limits the width of the shaft door 4b, as indicated in **Fig. 12**. However, depending on the elevator system 1 and the dimensions of the counterweight 8, the spacing is sufficient to fit in a code-compliant shaft door 4b.

The elevator system 1, e. g., according to **Fig. 1** or **Fig. 2**, is equipped with a call control system configured for a call control technology to process an elevator call entered by a passenger at one of the call input terminals 2a, 2b. For illustrative purposes, the implemented call control system is represented by the elevator controller 12 shown in **Fig. 1** and **Fig. 2**. The call control technology may be a destination call control technology that allows the passenger to enter a desired destination at a call input terminal 2a, 2b while standing on a floor; such a call is referred to as "destination call". The call input terminal 2a, 2b may have a keypad with a set number of keys assigned to the floors served by the elevator system 1, or a touchscreen that displays fields that represent the floors served by the elevator system 1. Alternatively, the call control technology may be a directional call control technology that requires the passenger to enter a travel direction at a call input terminal 2a, 2b while standing on a floor, and to enter a desired destination floor at a car operating panel arranged inside the elevator car 10. The destination call control technology is considered to provide for a more efficient operation of the elevator system 1. If the existing elevator system 1 of **Fig. 1** is equipped with a directional call control technology, it may be provided with the destination call control technology while the elevator system 1 is converted to adapt to the changed use of the building.

Regardless of the implemented call control technology, the call control system recognizes the call input terminal 2a, 2b the passenger uses to enter an elevator call. With the call input terminal 2a, 2b being recognized, the location of the passenger can be determined, e. g., the floor S0 and the main elevator hall L1, L2, and the elevator car 10 can be controlled to serve the elevator call. Regarding the floor S0, this includes controlling the appropriate car door 6a, 6b, and determining which destination floors Sn may be served based on the passenger being in the main elevator hall L1 or in the main elevator hall L2. For example, as mentioned above, the passenger being a resident in the building, the passenger may only be allowed to travel to a residential floor.

Patent claims

1. An elevator system (1) of a building having an elevator shaft (11), a plurality of floors (S0, Sn) and a first main elevator hall (L1) at one of the plurality of floors (S0, Sn), comprising:

an elevator car (10) having a first sidewall (10a) and a second sidewall (10b), wherein the elevator car (10) comprises a first car door (6a) at the first sidewall (10a) and a second car door (6b) at the second sidewall (10b), and wherein the elevator car (10) is suspended by a suspension system (22) using a 1:1 roping arrangement;

car guide rails (18) mounted to a first shaft wall (11a) of the elevator shaft (11) and along which the elevator car (10) is movable by a drive machine (14) controlled by an elevator controller (12);

first shaft doors (4a) provided on floors (S0, Sn) served by the elevator car (10), wherein each first shaft doors (4a) is engageable with the first car door (6a), wherein at a first floor (S0) the first shaft door (4a) faces the first main elevator hall (L1);

a counterweight (8) movable along counterweight guide rails (20) mounted to a second shaft wall (11b), wherein the counterweight (8) is suspended by the suspension system (22) using a 2:1 roping arrangement, wherein the second shaft wall (11b) faces the second sidewall (10b) containing the second car door (6b); and

a second shaft door (4b) provided at the second shaft wall (11b),

wherein the second shaft door (4b) is provided at the first floor (S0) and faces a second main elevator hall (L2),

wherein the second shaft door (4b) includes a passage insert (47, 48) that bridges a gap between the second shaft wall (11b) and the second car door (6b), wherein the gap is larger than a thickness of the counterweight (8); and

wherein the 1:1 roping arrangement of the elevator car (10) and the 2:1 roping arrangement of the counterweight (8) restrict a movement of the counterweight (8) to a zone above the second shaft door (4b).

2. The elevator system (1) according to claim 1, wherein the passage insert (47, 48) has a shape of a frame, an elevator hall-facing side and a car-facing side, wherein the frame is formed by a floor plate (48), lateral and upper panels (47).

3. The elevator system (1) according to claim 2, wherein the passage insert (47, 48) comprises a shaft-door support (49) at the car-facing side, wherein the second shaft door (4b) is mounted to the shaft-door support (49).

4. The elevator system (1) according to any preceding claim, further comprising a counterweight buffer structure (16, 34, 36) arranged at the second shaft wall (11b) and supported by the elevator shaft (11), wherein the counterweight guide rails (20) end above the second shaft door (4b) and are supported by the counterweight buffer structure (16, 34, 36).

5. The elevator system (1) according to claim 4, wherein the counterweight guide rails (20) include first vertically extending guide rails (20) and second vertically extending guide rails (20), wherein the first and second vertically extending guiderails (20) are arranged in parallel and spaced apart from each other at a distance, and wherein the second shaft door (4b) has a width that is larger than the distance.

6. The elevator system (1) according to claims 1, 2 or 3, further comprising a counterweight buffer structure (16, 34, 36) arranged at the second shaft wall (11b) and supported by the counterweight guide rails (20), wherein the counterweight guide rails (20) extend below the second shaft door (4b).

7. The elevator system (1) according to claim 6, wherein the counterweight guide rails (20) include first vertically extending guide rails (20) and second vertically extending guide rails (20), wherein the first and second vertically extending guiderails (20) are arranged in parallel and spaced apart from each other at a distance, and wherein the second shaft door (4b) has a width that is smaller than the distance.

8. The elevator system (1) according to claim 4, 5, 6 or 7, wherein the counterweight buffer structure (16, 34, 36) includes a buffer (16) and a horizontal beam (34) extending above and parallel to the second shaft door (4b), wherein the buffer (16) and the horizontal beam (34) are configured to support the counterweight (8).

9. The elevator system (1) according to claim 8, wherein the counterweight buffer structure (16, 34, 36) further includes a vertical support structure (36) extending from a

pit of the elevator shaft (11) to the horizontal beam (34), wherein the horizontal beam (34) is supported by the vertical support structure (36).

10. The elevator system (1) according to claim 9, wherein the vertical support structure (36) includes two vertical beams (36a, 36b), each vertically extending at or in proximity of a shaft corner at the second shaft wall (11b).

11. The elevator system (1) according to any preceding claim, further comprising a safety brake system (44) mounted to the counterweight (8) to act upon the counterweight guide rails (20), wherein the safety brake system (44) is coupled to an overspeed governor (38) to be triggered by the overspeed governor (38).

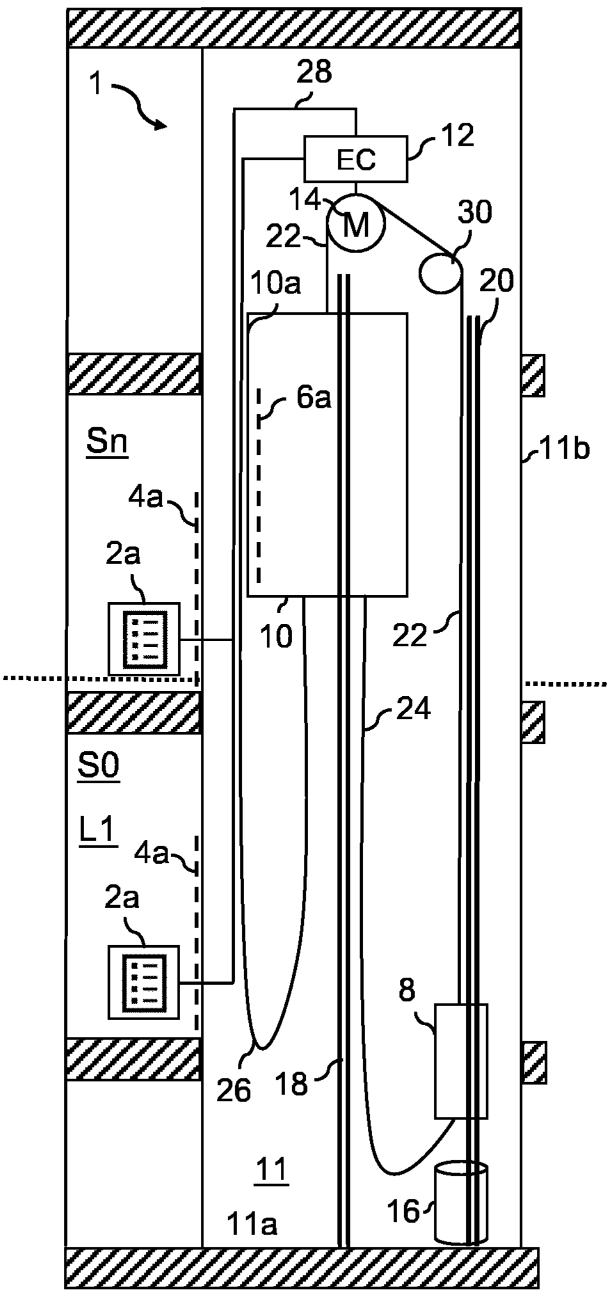
12. The elevator system (1) according to one of the preceding claims, further comprising a compensation cable (24) having a car-side end attached to the elevator car (10) and counterweight end attached to the counterweight (8), wherein the compensation cable (24) extends between the elevator car (10) and the counterweight (8).

13. The elevator system (1) according to claim 10, further comprising a deflection system (42) having at least one deflection pulley system (42a, 42b) arranged to guide the compensation cable (24) out of a space occupied by the second shaft door (4b).

14. The elevator system (1) according to claim 13, wherein the compensation cable (24) is composed of a first compensation cable (24a) and a second compensation cable (24b), which is separate from the first compensation cable (24a), wherein the deflection system (42) has a first set of pulleys (42a) arranged to deflect the first and second compensation cables (24a) above the second shaft door (4b) out of the space occupied by the second shaft door (4b) and a second set of pulleys (42b) arranged to deflect the first and second compensation cables (24b) towards a center area at an underside of the elevator car (10).

15. A shaft door (4b) of an elevator system (1) according to one of the preceding claims, comprising a passage insert (47, 48) that bridges a gap between the second shaft wall (11b) and the second car door (6b), wherein the gap is larger than a thickness of the counterweight (8), wherein the passage insert (47, 48) has a shape of a frame, an elevator

hall-facing side and a car-facing side, wherein the frame is formed by a floor plate (48), lateral and upper panels (47), wherein the passage insert (47, 48) comprises a shaft-door support (49) at the car-facing side, wherein the second shaft door (4b) is mounted to the shaft-door support (49).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6a
Sn
11b
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Fig. 1

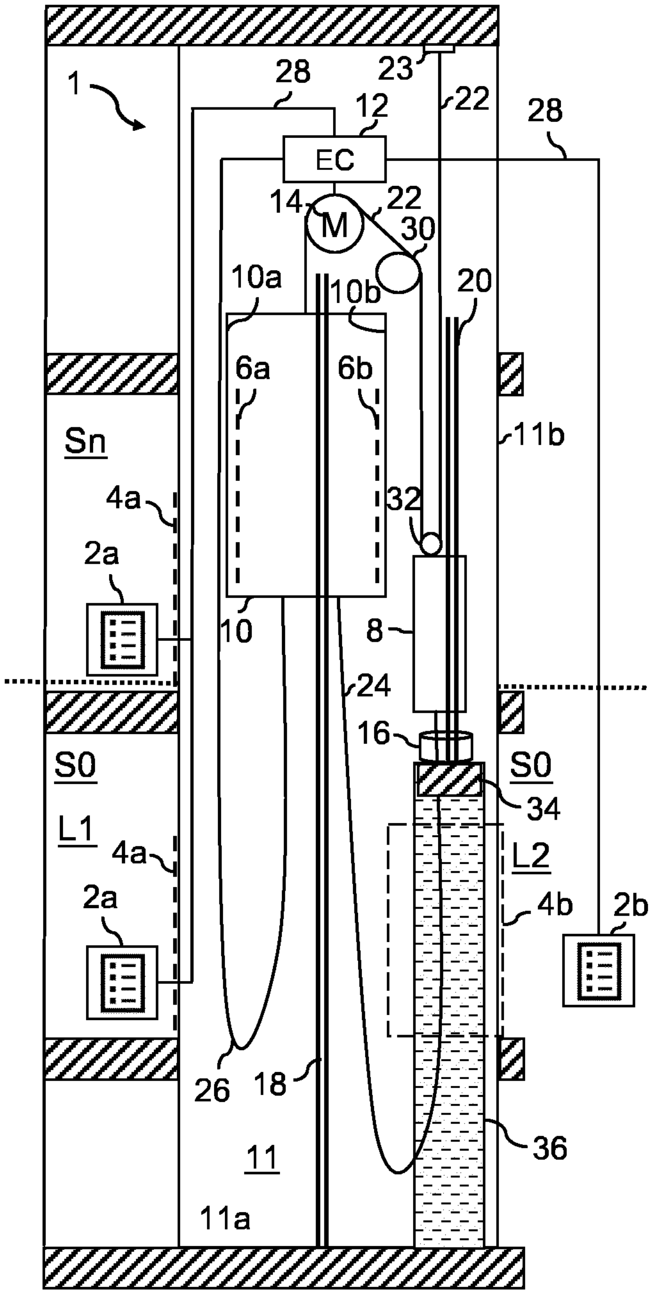
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Fig. 2

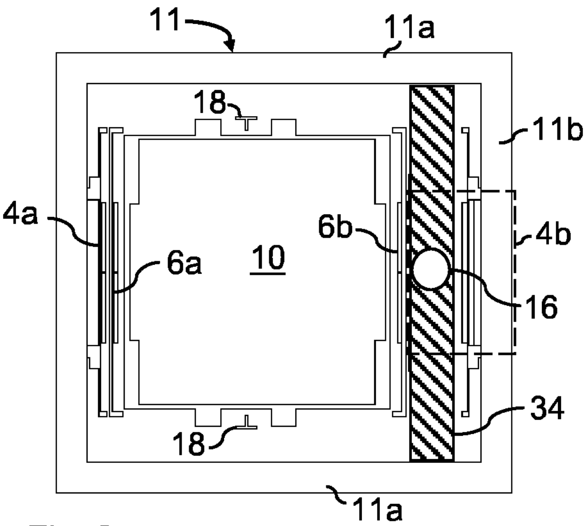


Fig. 3

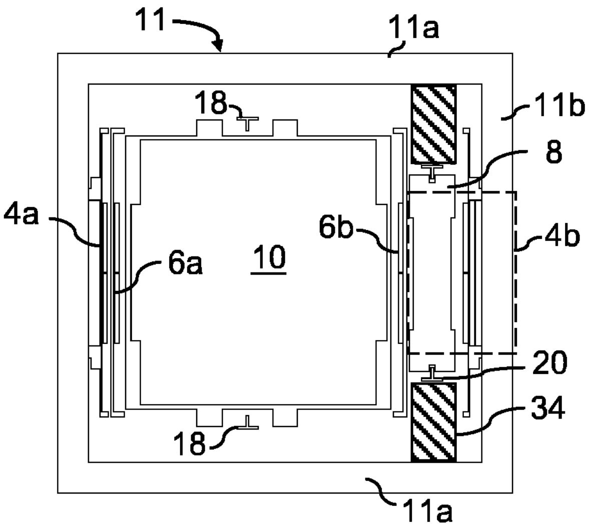


Fig. 4

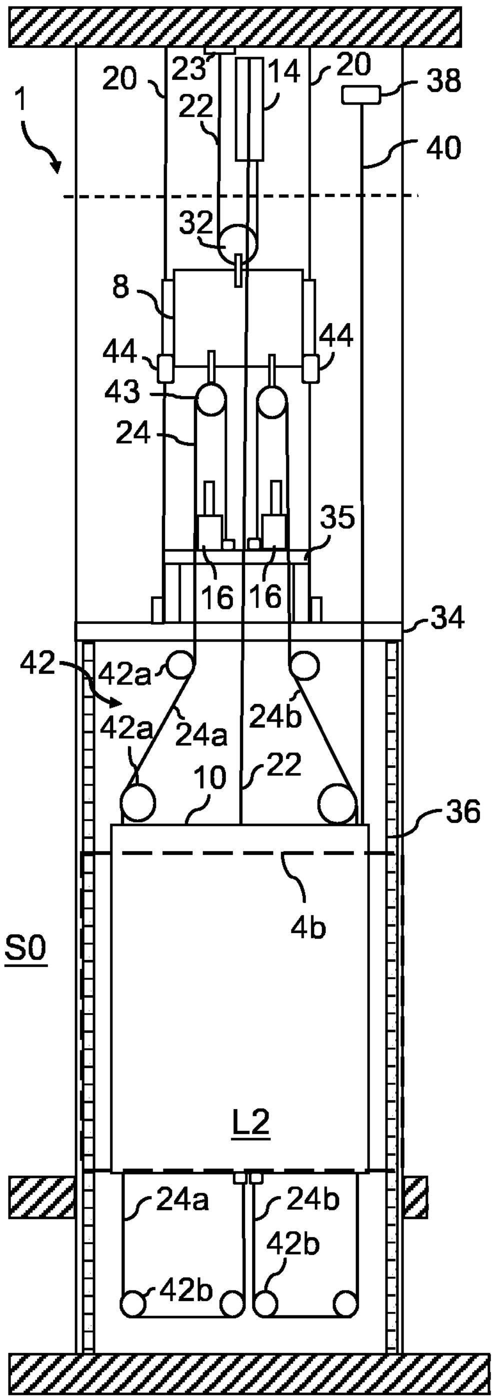
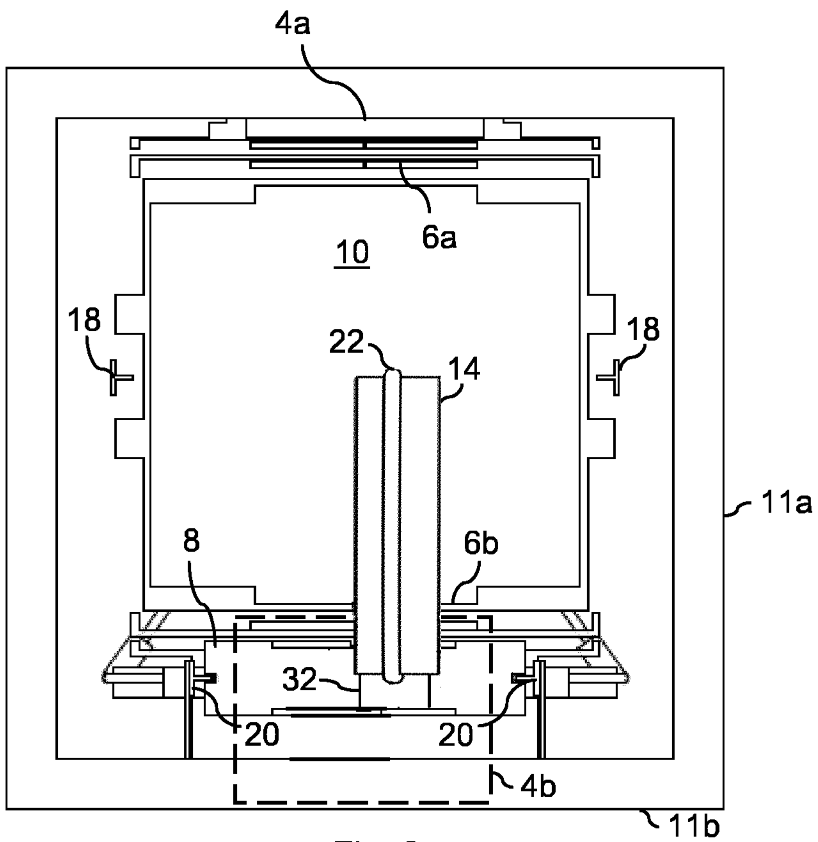


Fig. 5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6b
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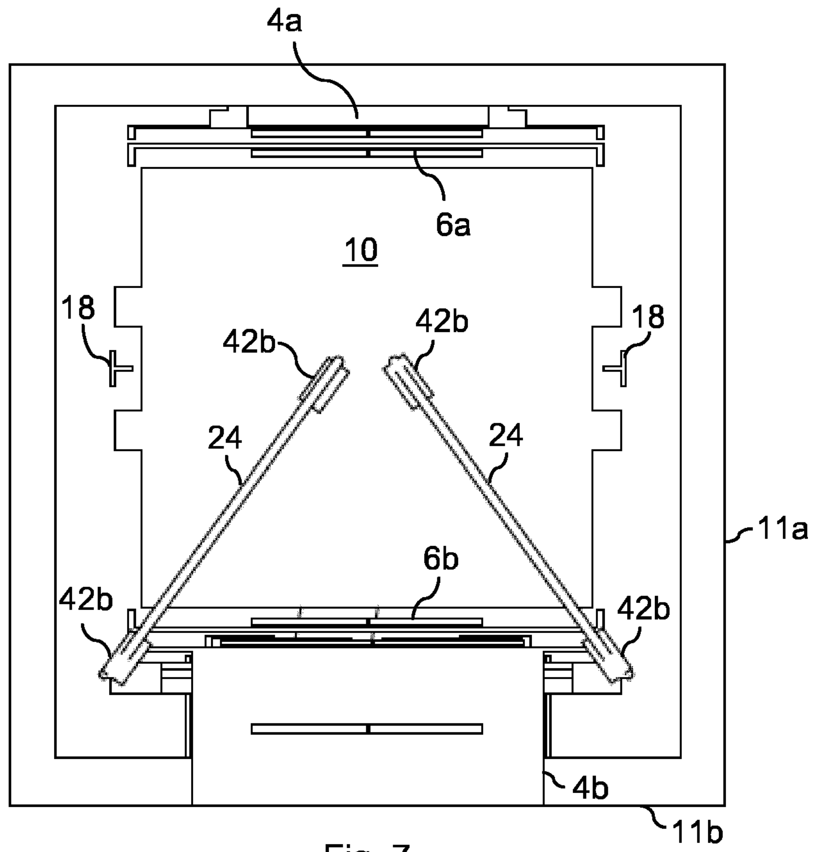
4b
11b

Fig. 6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11b

Fig. 7

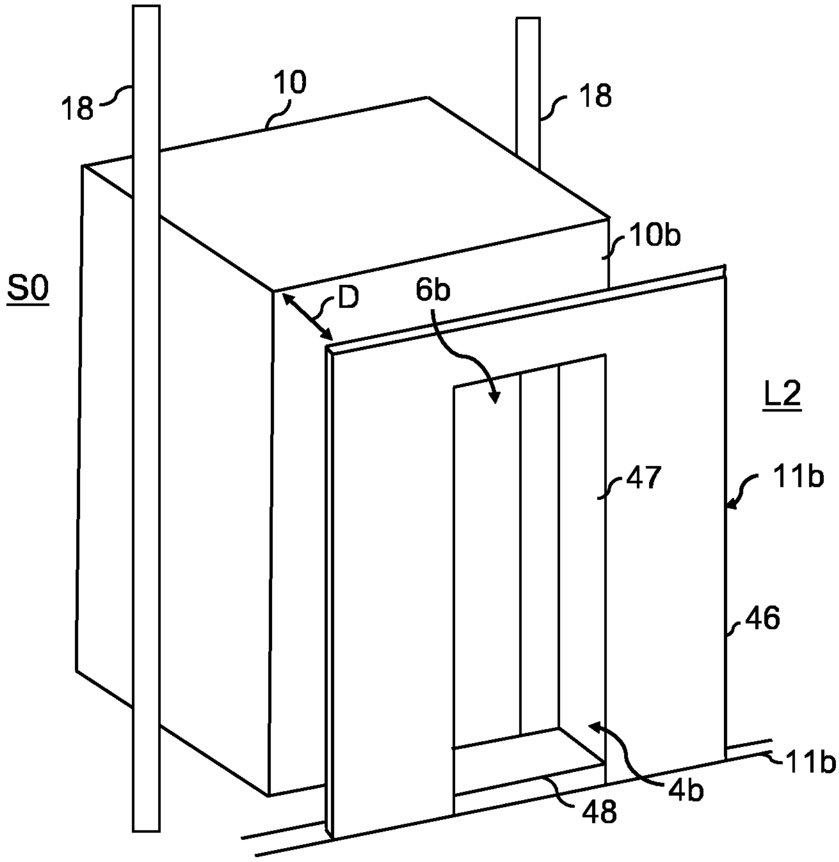
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Fig. 8

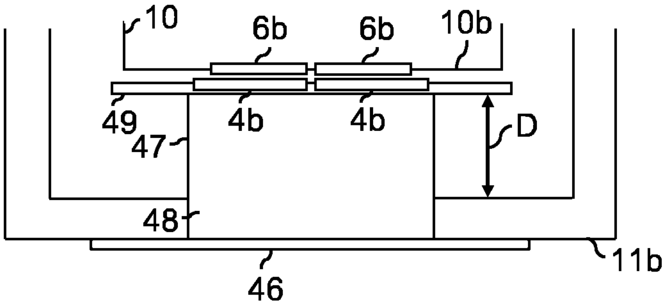
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Fig. 9

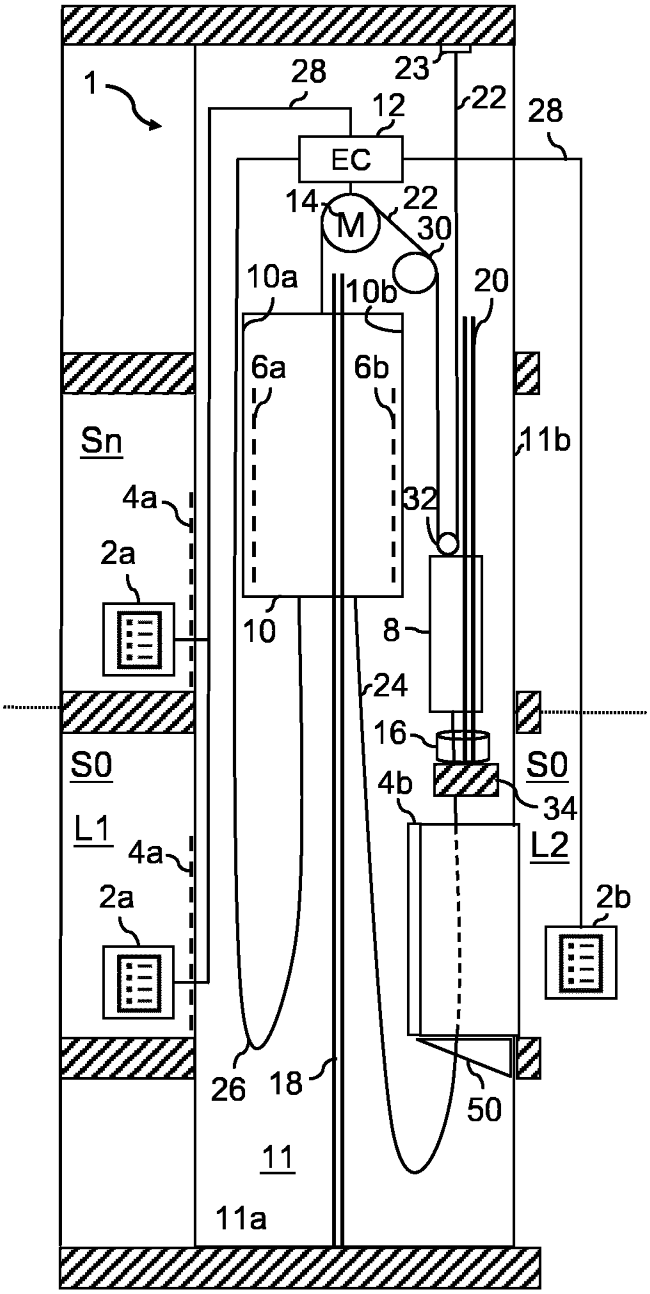
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Fig. 10

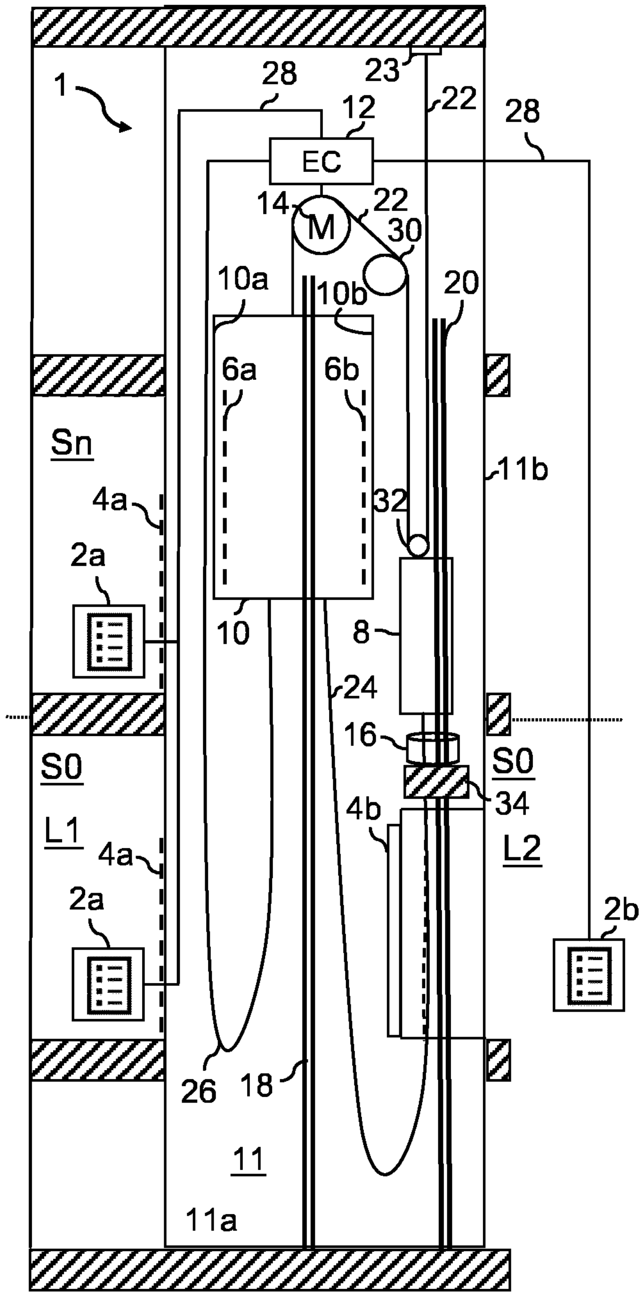
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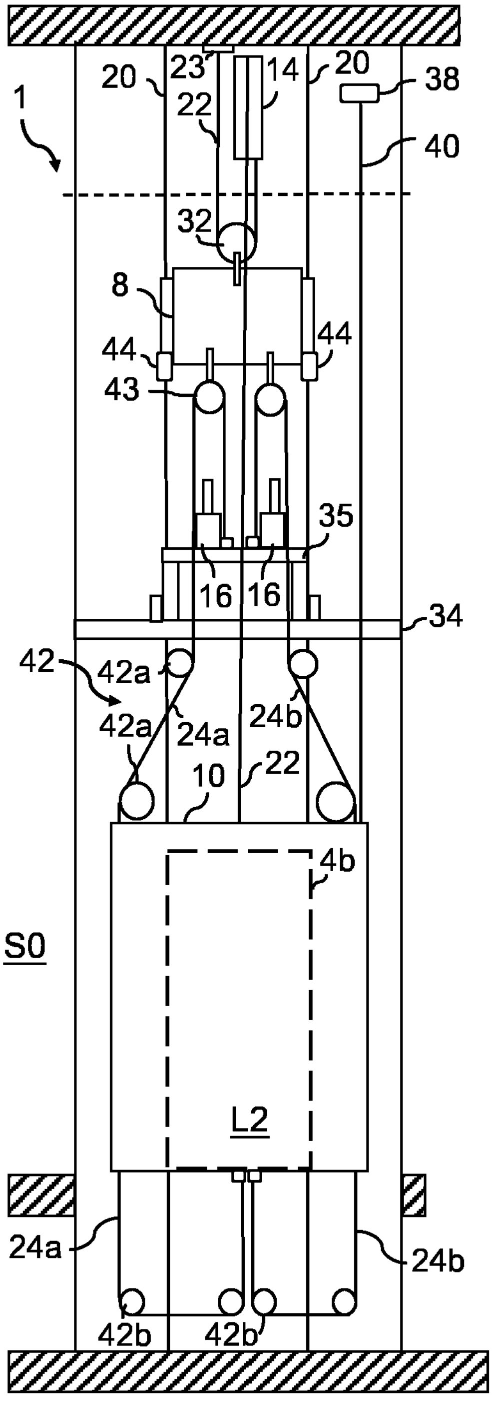
Fig. 11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4b
S0
L2
24a
24b
42b
42b

Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/072186

A. CLASSIFICATION OF SUBJECT MATTER
INV. B66B11/00 B66B11/02
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.
X A	IT UA20 164 672 A1 (RA ASCENSORI S R L) 27 December 2017 (2017-12-27) claim 3; figures 1-3 -----	1-8,11, 12,15 9,10,13, 14
A	WO 2020/190115 A1 (DAE RYOON ELES [KR]) 24 September 2020 (2020-09-24) figures 1,5 -----	1,15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
30 September 2024	10/10/2024

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2024/072186

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
IT UA20164672 A1	27-12-2017	----------------------------------	
WO 2020190115 A1	24-09-2020	CN 111704004 A	25-09-2020
		KR 101994433 B1	18-09-2019
		WO 2020190115 A1	24-09-2020