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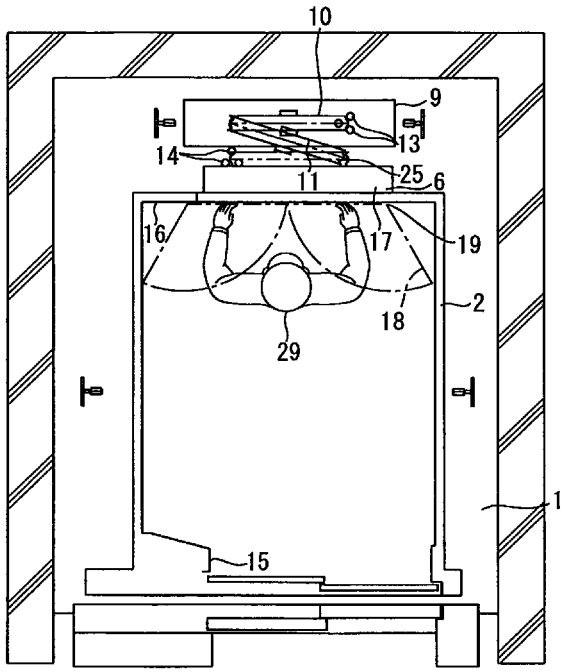
(54) Elevator system

(57) The elevator system includes a car which travels vertically along a predetermined path within a shaft. A counterweight is moved vertically along another predetermined path within the shaft. A hoisting machine is constituted to assume a shallow depth dimension and is provided on the exterior side surface of the car. The hoisting machine includes a sheave having a rotor axis oriented horizontally. A top pulley is rotatively mounted on the upper end of the shaft and whose rotor axis is oriented horizontally. A main cable is connected to the upper end of the shaft at both ends, and is wound around a pulley mounted on the counterweight, the top pulley, and the sheave in the hoisting machine, in this sequence. An access port is provided on the side surface of the car, and is opened to correspond to a portion of the hoisting machine to be subjected to maintenance. Thus, an elevator system is provided which includes a car having a hoisting machine provided thereon and enables a service engineer to readily perform maintenance on the hoisting machine.

Fig. 1



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Description

Background of the Invention

Field of the Invention

[0001] The present invention relates to an elevator system, and more particularly, to an elevator system in which a main cable connecting a car to a counterweight is driven by a hoisting machine disposed on top of the car.

Background Art

[0002] FIGS. 22 and 23 show a conventional elevator system described in; for example, Japanese Patent Application Laid-Open No. Hei-10-114481, wherein FIG. 22 is a conceptual longitudinal cross-sectional view, and FIG. 23 is an enlarged view showing a portion "A" shown in FIG. 22. In the drawings, reference numeral 1 designates a shaft; and 2 designates a car which travels vertically along a predetermined path within the shaft 1. A service recess 3 is formed in a lower portion of the car 2, and an access door 4 is formed in an upper surface of the service recess 3. A seat plate 5 equipped with a cushion is removably provided on the service recess 3 so as to cover the access door 4. Reference numeral 6 designates a hoisting machine disposed on the bottom of the shaft 1 so as to correspond to the position of the service recess 3. The hoisting machine 6 moves the car 2 vertically by way of a cable 7.

[0003] In the conventional elevator system of the above-described configuration, the hoisting machine 6 is energized to move the car 2 vertically along a predetermined path within the shaft 1 by way of the cable 7. The seat plate 5 is removed while the car 2 is situated at its lowermost position, and in the car 2 a service engineer conducts an inspection of and performs maintenance of the hoisting machine 6 by way of the access door 4.

[0004] FIG. 24 is a longitudinal cross-sectional view conceptually showing another conventional elevator system described in, for example, Japanese Utility Model Publication No. Hei-3-48142. In the drawing, reference numeral 1 designates a shaft; 2 designates a car which travels vertically along a predetermined path within the shaft 1; and 6 designates a traction machine. The traction machine 6 is disposed on the lower surface of an upper beam of the car 2, along with a sheave 8 whose rotor axis is oriented in the horizontal direction.

[0005] Reference numeral 9 designates a counterweight which is moved vertically along another predetermined path within the shaft 1; and 10 designates a counterweight pulley provided on the counterweight 9. Reference numeral 11 designates a top pulley which is rotatively fixed to the top of the shaft 1 and whose rotor axis is oriented horizontally; and 12 designates a main cable. One end of the main cable 12 is connected to the upper end of the shaft 1 by means of an anchor 13, and the other end of the main cable 12 is connected to the upper end of the shaft 1 by means of another anchor 14. The main cable 12 is wound around the counterweight pulley 10, the top pulley 11, and the sheave 8, in the sequence given.

[0006] In the conventional elevator system of the foregoing configuration, when the hoisting machine 6 is energized, the sheave 8 is rotated, to thereby move the car 2 and the counterweight 9 in opposite directions by way of the main cable 12. Since the hoisting machine 6 is mounted on the car 2, a machinery room, which would otherwise be independently provided at a position above the shaft 1, is omitted, thus reducing the space occupied by the elevator system within an unillustrated building.

[0007] In the conventional elevator system shown in FIGS. 22 and 23, a service engineer conducts an inspection of and performs maintenance of the hoisting machine 6 in the car 2 while stooping over the hoisting machine 6. Such a stooped posture deteriorates the ability of the service engineer to work. Further, the service engineer must pay careful attention so as to avoid accidentally dropping a tool or a like instrument down into the shaft 1, thus deteriorating the effectiveness of maintenance. In the event of the lower portion of the shaft 1 being flooded, the hoisting machine 6 may be damaged by water.

[0008] Alternatively, in the conventional elevator system shown in FIG. 24, the hoisting machine 6 is disposed at an elevated position with reference to the car 2. The service engineer squeezes into and bends his body within a narrow space formed between the roof of the car 2 and the hoisting machine 6 and conducts an inspection of and performs maintenance of the hoisting machine 6. Such an unnatural posture deteriorates the effectiveness of maintenance. Further, the service engineer must pay careful attention so as to avoid accidentally dropping a tool or a like instrument in the shaft 1, thus deteriorating the effectiveness of maintenance.

Summary of the Invention

[0009] The present invention has been conceived to solve a problem in the conventional elevator systems as described above, and the object of the present invention is to provide an elevator system which includes a car having a hoisting machine provided thereon and enables a service engineer to readily perform maintenance of the hoisting machine.

[0010] According to one aspect of the present invention, an elevator system comprises a car which travels vertically along a predetermined path within a shaft. A counterweight is provided which travels vertically along another predetermined path within the shaft, and the counterweight has a pulley mounted thereon. A hoisting machine including a sheave is provided on the

exterior side surface of the car, and the rotor axis of said sheave is oriented horizontally. A top pulley is rotatively mounted on the upper end of the shaft with the rotor axis thereof oriented horizontally. A main cable is connected to the upper end of the shaft at both ends thereof respectively, and the main cableis wound around said pulley mounted on the counterweight, the top pulley, and the sheave. Further, an access port is provided on the side surface of the car corresponding to the hoisting machine to be subjected to maintenance.

[0011] Other and further objects, features and advantages of the invention will appear more fully from the following description.

Brief Description of the Drawings

[0012]

FIG. 1 is a conceptual transverse plan view showing an elevator system according to a first embodiment of the present invention;
FIG. 2 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 1;
FIG. 3 is a cross-sectional plan view taken along line B-B shown in FIG. 2;
FIG. 4 is a front view showing the hoisting machine when the door of maintenance means is opened at the deep-inside wall of a car shown in FIG. 1;
FIG. 5 is a conceptual transverse plan view showing an elevator system according to a second embodiment of the present invention;
FIG. 6 is a conceptual transverse plan view showing an elevator system according to a third embodiment of the present invention;
FIG. 7 is a longitudinal cross-sectional view conceptually showing the suspended state of the main cable of the elevator system shown in FIG. 6;
FIG. 8 is a conceptual transverse plan view showing an elevator system according to a fourth embodiment of the present invention;
FIG. 9 is a conceptual transverse plan view showing an elevator system according to a fifth embodiment of the present invention;
FIG. 10 is a longitudinal cross-sectional view conceptually showing the suspended state of the main cable of the elevator system shown in FIG. 9;
FIG. 11 is a conceptual transverse plan view showing an elevator system according to a sixth embodiment of the present invention;
FIG. 12 is a conceptual transverse plan view showing an elevator system according to a seventh embodiment of the present invention;
FIG. 13 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 12;
FIG. 14 is a transverse plan view showing a section of the elevator system shown in FIG. 12.
FIG. 15 is a conceptual transverse plan view showing an elevator system according to an eighth embodiment of the present invention;
FIG. 16 is a transverse plan view showing a section of the elevator system shown in FIG. 15;
FIG. 17 is a conceptual transverse plan view showing an elevator system according to a ninth embodiment of the present invention;
FIG. 18 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 17;
FIG. 19 is a conceptual transverse plan view showing an elevator system according to a tenth embodiment of the present invention;
FIG. 20 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 19;
FIG. 21 is a conceptual transverse plan view showing an elevator system according to an eleventh embodiment of the present invention;
FIG. 22 is a conceptual longitudinal cross-sectional view of a conventional elevator system; and
FIG. 23 is an enlarged view showing a portion "A" shown in FIG. 22.
FIG. 24 is a longitudinal cross-sectional view conceptually showing another conventional elevator system.

Detailed Description of the Preferred Embodiments

[0013] Preferred embodiments of the present invention will be described hereinafter with reference to the accompanying drawings, in which same reference numerals indicate same or corresponding portions or elements.

First Embodiment

[0014] FIGS. 1 through 4 show an elevator system according to a first embodiment of the present invention. FIG. 1 is a conceptual transverse plan view showing an elevator system; FIG. 2 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 1; FIG. 3 is a cross-sectional plan view taken along line B-B shown in FIG. 2; and FIG. 4 is a front view showing the hoisting machine when the door of maintenance means is opened at the deep-inside wall of a car shown in FIG. 1.

[0015] In the drawings, reference numeral 1 designates a shaft; 2 designates a car which travels vertically along a predetermined path within the shaft 1; 15 designates an entrance door of the car 2; 16 designates a deep-inside wall or a back wall opposite the entrance door 15 of the car 2; 17 designates an access port which is formed in the deep-inside wall 16 and between reinforcement members 161 provided on the back of the deep-inside wall 16; and 18 designates a door for open-

ing or closing the access port 17. Reference numeral 19 designates maintenance means or maintenance ensemble constituted of the access port 17 and the door 18.

[0016] Reference numeral 6 designates a traction machine having a small depth dimension. The traction machine 6 is disposed on the exterior side surface of the car 2, or in other words, on the exterior side of the deep-inside wall 16. The traction machine 6 is situated at the position of the access port 17. A base body 20 is provided so as to correspond to the access port 17, and is fastened to the reinforcement members 161 disposed on opposite sides of the access port 17. A support plate 21 is disposed vertically at a position close to the access port 17 such that a space is formed between the support plate 21 and the base body 20, and the edge of the support plate 21 is fastened to the base body 20. One end of a support shaft 22 is supported by the base body 20, and the other end of the support shaft 22 is supported by the support plate 21. The axis of the support shaft 22 is oriented horizontally.

[0017] The hoisting machine 6 comprises a stator winding 23, an armature 24, a rotor 26, and an electromagnetic brake 28. The stator winding 23 is provided at a position close to the support plate 21 on the base member 20. The armature 24 is rotatively supported on the support shaft 22 by way of ball bearings and is disposed opposite the stator winding 23, to thereby constitute an electric motor. The rotor 26 is disposed at an inner position in the base member 20, and a sheave 25 is formed on the rotator 26. The electromagnetic brake 28 is disposed on the support plate 21 and comprises brake pads 27. The brake pads 27 are disposed opposite the interior surfaces of the areas of the rotor 26 where the armature 24 is situated, with a clearance "g" shown in FIG. 3 being formed therebetween.

[0018] Reference numeral 9 designates a counterweight which travels vertically along another predetermined path within the shaft 1, and is disposed so as to correspond to the deep-inside wall 16. Reference numeral 10 designates a counterweight pulley provided on the counterweight 9. Reference numeral 11 designates a top pulley which is rotatively attached to the upper end or the roof of the shaft 1, and whose rotor axis is oriented horizontally. Reference numeral 12 designates a main cable. One end of the main cable 12 is connected to the upper end of the shaft 1 by means of an anchor 13, and the other end of the main cable 12 is connected to the upper end of the shaft 1 by means of another anchor 14. The main cable 12 is wound around the counterweight pulley 10, the top pulley 11, and the sheave 25, in the sequence given. Reference numeral 29 designates a service engineer who conducts an inspection of the hoisting machine 6 by way of the maintenance means 19 while in the car 2.

[0019] In the elevator system of the foregoing configuration, when the hoisting machine 6 is energized, the sheave 25 is rotated, to thereby move the car 2 and the counterweight 9 in opposite directions by way of the main cable 12. The hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall of the car 2. Accordingly, as shown in FIGS. 1 and 3, the service engineer 29 opens the door 18 and conducts an inspection of and performs maintenance on the hoisting machine 6 by way of the access port 17 by means of an operation performed in the car 2.

[0020] Thus, the service engineer 29 does not need to stoop to inspect the hoisting machine 6 and can perform operation while in a natural posture. Further, the service engineer 29 is not required to pay special attention so as to avoid accidentally dropping a tool or a like instrument into the shaft 1, thereby improving the efficiency of maintenance. Further, since the hoisting machine 6 is disposed on the exterior side surface of the car 2, there can be prevented damage to the hoisting machine 6 by flood, which would otherwise be caused when the lower portion of the shaft 1 is flooded.

Second Embodiment

[0021] FIG. 5 is a conceptual transverse plan view showing an elevator system according to a second embodiment of the present invention. The remaining portions of the elevator system of the present embodiment other than those illustrated in FIG. 5 are built in the same manner as shown in FIGS. 1 through 4. In FIG. 5, those reference numerals, which are the same as those provided in FIGS. 1 through 4, designate corresponding elements. Reference numeral 30 designates a sidewall continually connected to the entrance door 15 of the car 2. Reference numeral 9 designates a counterweight which is provided within the shaft 1 and is disposed so as to correspond to the sidewall 30. Reference numeral 6 designates a hoisting machine disposed on the car 2, more specifically, on the exterior side surface of the sidewall 30. Reference numeral 19 designates maintenance means disposed on the sidewall 30 so as to correspond to the hoisting machine 6.

[0022] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the second embodiment shown in FIG. 5 yields the same working-effect as that yielded in the first embodiment shown in FIGS. 1 through 4.

Third Embodiment

[0023] FIGS. 6 and 7 show an elevator system according to a third embodiment of the present invention. FIG. 6 is a conceptual transverse plan view showing an elevator system, and FIG. 7 is a longitudinal cross-sectional view conceptually showing the suspended state of the main cable of the elevator system

shown in FIG. 6. The remaining portions of the elevator system of the present embodiment other than that portion illustrated in FIGS. 6 and 7 are constructed in the same manner as shown in FIGS. 1 through 4.

[0024] In the drawings, those reference numerals, which are the same as those provided in FIGS. 1 through 5, designate corresponding elements. Reference numeral 31 designates a deflector wheel rotatively attached to the exterior side surface of the sidewall 30 of the car 2 at a lower portion than the hoisting machine 6. Reference numeral 32 designates a first lower pulley which is rotatively mounted on the lower exterior surface of the car 2 close to its edge at a position under the hoisting machine 6, and is disposed so as to correspond to the sheave 25. Reference numeral 33 designates a second lower pulley which is rotatively mounted on the other side of the lower exterior surface of the car 2 close to the other edge apart from the hoisting machine 6, and is disposed at a position closer to the entrance door 15 than is the first lower pulley 32.

[0025] Reference numeral 34 designates a position (hereinafter referred to as a "rear-end suspension position") where the rear portion of the car 2 is suspended by the main cable 12 extending between the deflector wheel 31 and the top pulley 11. Reference numeral 12 designates a main cable. One end of the main cable 12 is attached to the upper end of the shaft 1 by means of the anchor 13, and the other end of the main cable 12 is attached to the upper end of the shaft 1 at a position corresponding to the location of the second lower pulley 33 by means of another anchor 14. The main cable 12 is wound around the counterweight pulley 10, the top pulley 11, the rear-end suspension position 34 on the deflector wheel 31, the sheave 25, the first lower pulley 32, and the second lower pulley 33, in the sequence given.

[0026] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior surface of the side wall 30 of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the third embodiment shown in FIGS. 6 and 7 yields the same working-effect as that yielded in the embodiment shown in FIGS. 1 through 4.

[0027] In the third embodiment shown in FIGS. 6 and 7, the car 2 is suspended by the main cable 12 by way of the first lower pulley 32 and the second lower pulley 33. The anchor 14 suspends the front side of the car 2, and the rear portion of the car 2 is suspended by the main cable 12 in the rear-end suspension position 34. More specifically, the car 2 is suspended by the main cable 12 at the rear-end suspension position 34 formed on the deflector wheel 31, as well as at the position on the lower surface of the car 2 which is spaced apart from the rear-end suspension position 34 in a diagonal direction. As a result, the portion of the car 2 close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car 2 and an offset load exerted on a rail for guiding the car 2. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be reduced.

Fourth Embodiment

[0028] FIG. 8 is a conceptual transverse plan view showing an elevator system according to a fourth embodiment of the present invention. The remaining portions of the elevator system of the present embodiment other than that portion illustrated in FIG. 8 are constructed in the same manner as shown in FIGS. 1 through 4 and FIGS. 6 and 7. In the drawings, those reference numerals, which are the same as those provided in FIGS. 1 through 7, designate corresponding elements. Reference numeral 9 designates a counterweight which is disposed within the shaft 1, and is positioned so as to correspond to the sidewall 30 neighboring the entrance door 15; and 6 designates a hoisting machine which is provided on the car 2; more specifically, on the exterior side surface of the sidewall 30.

[0029] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the fourth embodiment shown in FIG. 8 yields the same working-effect as that yielded in the embodiment shown in FIGS. 1 through 4.

[0030] In the fourth embodiment shown in FIG. 8, the car 2 is suspended by the main cable 12 by way of the first lower pulley 32 and the second lower pulley 33. The anchor 14 suspends the front side of the car 2, and the rear portion of the car 2 is suspended by the main cable 12 in the rear-end suspension position 34. More specifically, the car 2 is suspended by the main cable 12 at the rear-end suspension position 34 formed on the deflector wheel 31, as well as at the position on the lower surface of the car 2 which is spaced apart from the rear-end suspension position 34 in a diagonal direction. As a result, the portion of the car 2 close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car 2 and an offset load exerted on a rail for guiding the car 2. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be decreased.

Fifth Embodiment

[0031] FIGS. 9 and 10 show an elevator system according to a fifth embodiment of the present invention. FIG. 9 is a conceptual transverse plan view showing an elevator system, and FIG. 10 is a longitudinal cross-sectional view conceptually showing the sus-

pended state of the main cable of the elevator system shown in FIG. 9. The remaining portions of the elevator system of the present embodiment other than that portion illustrated in FIGS. 9 and 10 are constructed in the same manner as shown in FIGS. 1 through 4.

[0032] In the drawings, those reference numerals, which are the same as those provided in FIGS. 1 through 4, FIGS. 6 and 7, designate corresponding elements. Reference numeral 31 designates a deflector wheel which is rotatively disposed on the exterior side surface of the deep-inside wall 16 of the car 2 at a position higher than the hoisting machine 6 mounted on the exterior side surface of the deep-inside wall 16. Reference numeral 35 designates a first side pulley which is rotatively mounted on a sidewall 30 continually connected to the deep-inside wall 16 of the car 2. The first side pulley 35 is disposed in a lower portion of the sidewall 30 so as to correspond to the deflector wheel 31 disposed on the deep-inside wall 16. Reference numeral 36 designates a second side pulley which is rotatively mounted on the sidewall 30 and is disposed at a position closer to the entrance door 15 than is the first side pulley 35.

[0033] Reference numeral 12 designates a main cable. One end of the main cable 12 is attached to the upper end of the shaft 1 by means of the anchor 13, and the other end of the main cable 12 is attached to the upper end of the shaft 1 at a position corresponding to the location of the second side pulley 36, by means of another anchor 14. The main cable 12 is wound around the counterweight pulley 10, the top pulley 11, the rear-end suspension position 34 on the sheave 25, the deflector wheel 31, the first side pulley 35, and the second side pulley 36, in the sequence given.

[0034] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the fifth embodiment shown in FIGS. 9 and 10 yields the same working-effect as that yielded in the embodiment shown in FIGS. 1 through 4.

[0035] In the fifth embodiment shown in FIGS. 9 and 10, the car 2 is suspended by the main cable 12 by way of the first side pulley 35 and the second side pulley 36. The anchor 14 suspends the front side of the car 2, and the rear portion of the car 2 is suspended by the main cable 12 at the rear-end suspension position 34. More specifically, the car 2 is suspended by the main cable 12 at the rear-end suspension position 34 formed on the deflector wheel 31, as well as at the position on the lower surface of the car 2 which is spaced apart from the rear-end suspension position 34 in a diagonal direction. As a result, the portion of the car 2 close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car 2 and an offset load exerted on a rail for guiding the car 2. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be decreased.

[0036] Since the lower ends of the respective first and second side pulleys 35 and 36 are located at a position higher than the lower surface of the car 2, the pit of the shaft 1 can be made shallow. Further, a margin for elevation of the car 2, which is ensured in the upper portion of the shaft 1, can be made small. In other words, an upper margin space originating from the highest stopping position of the car 2 within the shaft 1 or a lower margin space originating from the lowest stopping position of the car 2 can be diminished, thus shortening the overall length of the shaft 1. Accordingly, cost incurred for constructing the shaft 1 and installing the elevator system in the shaft 1 can be reduced. In the fifth embodiment, it is obvious that the same working-effect can be yielded even when the positions of the hoisting machine 6 and the deflector wheel 31 are switched.

Sixth Embodiment

[0037] FIG. 11 is a conceptual transverse plan view showing an elevator system according to a sixth embodiment of the present invention. The remaining portions of the elevator system of the present embodiment other than those portion illustrated in FIG. 11 are constructed in the same manner as shown in FIGS. 1 through 4 and FIGS. 9 and 10. In the drawings, those reference numerals which are the same as those provided in FIGS. 9 and 10 designate corresponding elements. Reference numeral 9 designates a counterweight which is disposed within the shaft 1 and is positioned so as to correspond to the sidewall 30.

[0038] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the sixth embodiment shown in FIG. 11 yields the same working-effect as that yielded in the embodiment shown in FIGS 1 through 4, as well as the same working-effect as that yielded in the embodiment shown in FIGS. 9 and 10.

Seventh Embodiment

[0039] FIGS. 12 through 14 show an elevator system according to a seventh embodiment of the present invention. FIG. 12 is a conceptual transverse plan view showing an elevator system; FIG. 13 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 12; and FIG. 14 is a transverse plan view showing a section of the elevator system shown in FIG. 12. The remaining portions of the elevator system of the present embodiment other than those portions illustrated in FIGS. 12 through 14 are constructed in the

same manner as shown in FIGS. 1 through 4.

[0040] In the drawings, those reference numerals which are the same as those provided in FIGS. 1 through 4 designate corresponding elements. Reference numeral 9 designates a counterweight which is interposed between the deep-inside wall 16 of the car 2 and the interior sidewall of the shaft 1. When viewed in the horizontal plane of projection, an indentation 37 is formed in one side of the counterweight 9 for permitting the hoisting machine 6 provided on the exterior side surface of the deep-inside wall 16 of the car 2 to pass through. Reference numeral 10 designates a first counterweight pulley which is rotatively mounted on one side of the counterweight 9, as viewed in the horizontal plane of projection. Further, reference numeral 101 designates a second counterweight pulley which is rotatively mounted on the other side of the counterweight 9, as viewed in the horizontal plane of projection.

[0041] Reference numeral 11 designates a first top pulley which is rotatively mounted on the roof of or at an upper end of the shaft 1 at a position corresponding to the first counterweight pulley 10 and whose rotor axis is oriented horizontally. Reference numeral 111 designates a second top pulley which is rotatively mounted on the roof of the shaft 1 in parallel with the first top pulley 11 and at a position corresponding to the sheave 25. Further, the rotor axis of the second top pulley 111 is oriented horizontally. Reference numeral 112 designates a third top pulley which is rotatively mounted on the roof of the shaft 1 and whose rotor axis is oriented horizontally. One circumferential edge of the third top pulley 112 is directly opposite one circumferential edge of the second counterweight pulley 101, and the other circumferential edge of the third top pulley 112 is directly opposite one circumferential edge of the sheave 25.

[0042] Reference numeral 12 designates a main cable of first type constituting one of a plurality of main cables. One end of the main cable 12 is connected to the upper end of the shaft 1 by means of the anchor 13, and the other end of the same is connected to the upper end of the shaft 1 by means of the anchor 14. The cable 12 is wound around the first counterweight pulley 10, the first top pulley 11, the second top pulley 111, and the sheave 25, in the sequence given.

[0043] Reference numeral 121 designates a main cable of second type constituting one of the plurality of main cables. One end of the main cable 121 is connected to the upper end of the shaft 1 by means of the anchor 131, and the other end of the same is connected to the upper end of the shaft 1 by means of the anchor 14. The cable 121 is wound around the second counterweight pulley 101, the third top pulley 112, and the sheave 25, in the sequence given.

[0044] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the seventh embodiment shown in FIGS. 12 through 14 yields the same working-effect as that yielded in the embodiment shown in FIGS 1 through 4.

[0045] In the seventh embodiment shown in FIGS. 12 through 14, the indentation 37 is formed in one side of the counterweight 9. When viewed in the horizontal plane of projection, the hoisting machine 6 fits into the indentation 37. The transverse dimension of the shaft 1 can be reduced accordingly, and as a result, cost incurred for constructing the shaft 1 and installing the elevator system within the shaft 1 can be reduced.

Eighth Embodiment

[0046] FIGS. 15 and 16 show an elevator system according to an eighth embodiment of the present invention. FIG. 15 is a conceptual transverse plan view showing an elevator system; and FIG. 16 is a transverse plan view showing a section of the elevator system shown in FIG. 15. The remaining portions of the elevator system of the present embodiment other than those portions illustrated in FIGS. 15 and 16 are constructed in the same manner as shown in FIGS. 1 through 4 and FIGS. 12 through 14.

[0047] In the drawings, those reference numerals which are the same as those provided in FIGS. 1 through 4 and FIGS. 12 through 14 designate corresponding elements. Reference numeral 9 designates a counterweight which is interposed between the sidewall 30 of the car 2 and the interior sidewall of the shaft 1. When viewed in the horizontal plane of projection, an indentation 37 is formed in one side of the counterweight 9 for permitting the hoisting machine 6 provided on the exterior side surface of the sidewall 30 of the car 2 to pass through. The indentation 37 may be called a hollow portion, sunken portion, depression or other way.

[0048] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the eighth embodiment shown in FIGS. 15 and 16 yields the same working-effect as that yielded in the embodiment shown in FIGS 1 through 4.

[0049] In the eighth embodiment shown in FIGS. 15 and 16, the indentation 37 is formed in one side of the counterweight 9. When viewed within the horizontal plane of projection, the hoisting machine 6 fits into the indentation 37. Accordingly, the transverse dimension of the shaft 1 can be reduced, and as a result, cost incurred for constructing the shaft 1 and installing the elevator system within the shaft 1 can be reduced.

Ninth Embodiment

[0050] FIGS. 17 and 18 show an elevator system according to a ninth embodiment of the present invention. FIG. 17 is a conceptual transverse plan view show-

ing an elevator system; and FIG. 18 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 17. The remaining portions of the elevator system of the present embodiment other than those portions illustrated in FIGS. 17 and 18 are constructed in the same manner as shown in FIGS. 1 through 5.

[0051] In the drawings, those reference numerals which are the same as those provided in FIGS. 1 through 5 designate corresponding elements. Reference numeral 38 designates an elevator control panel for controlling the hoisting machine 6 or a like component which is disposed on the exterior side surface of the sidewall 30 of the car 2 so as to protrude outwardly and is placed at a higher position with reference to the hoisting machine 6. Reference numeral 39 designates a console panel for use with the car 2 which is provided on the exterior side surface of the sidewall 30 of the car 2 so as to protrude outwardly and is placed at a lower position with reference to the hoisting machine 6.

[0052] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the eighth embodiment shown in FIGS. 17 and 18 yields the same working-effect as that yielded in the embodiment shown in FIGS 1 through 4.

[0053] In the ninth embodiment shown in FIGS. 17 and 18, the control panel 38 is disposed at a position higher than the hoisting machine 6 provided on the exterior side surface of the sidewall 30 of the car 2 so as to overlap the hoisting machine 6, as viewed within the horizontal plane of projection. Further, the console panel 39 is disposed on the exterior side surface of the sidewall 30 of the car 2 at a position lower than the hoisting machine 6 so as to overlap the hoisting machine 6, as viewed within the horizontal plane of projection. Consequently, the area of the hoisting machine 1 within the horizontal plane with respect to the transverse direction can be effectively used. Accordingly, the transverse dimension of the shaft 1 can be reduced, as a result of which, cost incurred for constructing the shaft 1 and installing the elevator system within the shaft 1 can be reduced.

Tenth Embodiment

[0054] FIGS. 19 and 20 show an elevator system according to a tenth embodiment of the present invention. FIG. 19 is a conceptual transverse plan view showing an elevator system, and FIG. 20 is a longitudinal cross-sectional view conceptually showing a suspended state of the main cable of the elevator system shown in FIG. 19. The remaining portions of the elevator system of the present embodiment other than those portions illustrated in FIGS. 19 and 20 are constructed in the same manner as shown in FIGS. 1 through 4.

[0055] In the drawings, those reference numerals which are the same as those provided in FIGS. 1 through 5 designate corresponding elements. Reference numeral 40 designates a first upper pulley which is rotatively mounted on the roof or the upper exterior surface of the car 2 close to its edge at a position above the hoisting machine 6, and is disposed so as to correspond to the sheave 25. One circumferential edge of the first upper pulley 40 is directly opposite one circumferential edge of the sheave 25. Reference numeral 41 designates a second upper pulley which is rotatively mounted on the roof or the upper exterior surface of the car 2, and is provided close to the other edge of the roof opposite to the first upper pulley 40. Further, the second upper pulley 41 is located at a position close to the entrance door 15.

[0056] Reference numeral 34 designates a position (hereinafter referred to as a "rear-end suspension position") where the rear portion of the car 2 is suspended by the main cable 12 extending between the sheave 25 and the top pulley 11. Reference numeral 12 designates a main cable. One end of the main cable 12 is attached to the upper end of the shaft 1 by means of the anchor 13, and the other end of the main cable 12 is attached to the upper end of the shaft 1 at a position corresponding to the second upper pulley 41_by means of another anchor 14. The main cable 12 is wound around the counterweight pulley 10, the top pulley 11, the rear-end suspension position 34 on the sheave 25, the first upper pulley 40, and the second upper pulley 41, in the sequence given.

[0057] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, even the elevator system of the tenth embodiment shown in FIGS. 19 and 20 yields the same working-effect as that yielded in the embodiment shown in FIGS. 1 through 4.

[0058] In the tenth embodiment shown in FIGS. 19 and 20, the car 2 is suspended by the main cable 12 by way of the first upper pulley 40 and the second upper pulley 41. The anchor 14 suspends the front side of the car 2, and the rear portion of the car 2 is suspended by the main cable 12 at the rear-end suspension position 34. More specifically, the car 2 is suspended by the main cable 12 at the rear-end suspension position 34 formed on the sheave 25, as well as at the position on the upper surface of the car 2 which is spaced apart from the rear-end suspension position 34 in a diagonal direction. As a result, the portion of the car 2 close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car 2 and an offset load exerted on a rail for guiding the car 2. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be reduced.

[0059] Since the first upper pulley 40 and the sec-

ond upper pulley 41 are mounted on the roof of the car 2, the pit of the shaft 1 can be made shallow. Accordingly, cost incurred for constructing the shaft 1 and installing the elevator system in the shaft 1 can be reduced.

Eleventh Embodiment

[0060] FIG. 21 is a conceptual transverse plan view showing an elevator system according to an eleventh embodiment of the present invention. The remaining portions of the elevator system of the present embodiment other than those portions illustrated in FIG. 21 are constructed in the same manner as shown in FIGS. 1 through 4 and FIGS. 19 and 20. In FIG. 21, those reference numerals which are the same as those provided in FIGS. 1 through 4 and FIGS. 19 and 20 designate corresponding elements. Reference numeral 9 designates a counterweight which is provided within the shaft 1 and is disposed so as to correspond to the sidewall 30 adjacent to the entrance door 15. Reference numeral 6 designates a hoisting machine disposed on the car 2; more specifically, on the exterior side surface of the sidewall 30.

[0061] In the elevator system of the foregoing configuration, the hoisting machine 6 is disposed on the exterior side surface of the car 2, and the maintenance means 19 is provided on the wall surface of the car 2. Accordingly, although not described in detail, the elevator system of the eleventh embodiment shown in FIG. 21 yields the same working-effect as that yielded in the first through fourth embodiments.

[0062] In the eleventh embodiment shown in FIG. 21, the car 2 is suspended by the main cable 12 by way of the first upper pulley 40 and the second upper pulley 41. The anchor 14 suspends the front side of the car 2, and the rear portion of the car 2 is suspended by the main cable 12 at the rear-end suspension position 34. More specifically, the car 2 is suspended by the main cable 12 at the rear-end suspension position 34 formed on the sheave 25, as well as at the position on the upper surface of the car 2 which is spaced apart from the rear-end suspension position 34 in a diagonal direction. As a result, the portion of the car 2 close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car 2 and an offset load exerted on a rail for guiding the car 2. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be reduced.

[0063] Since the first upper pulley 40 and the second upper pulley 41 are mounted on the roof of the car 2, the pit of the shaft 1 can be made shallow. Accordingly, cost incurred for constructing the shaft 1 and installing the elevator system in the shaft 1 can be reduced.

[0064] The features and the effects of the present invention as described above may be summarized as follows.

[0065] According to one aspect of the present invention, in an elevator system, a car travels vertically along a predetermined path within a shaft. A counterweight which is moved vertically along another predetermined path within the shaft. A hoisting machine is constituted to assume a shallow depth dimension, and is provided on the exterior side surface of the car. A top pulley is rotatively mounted on the upper end of the shaft, and whose rotor axis is oriented horizontally. A main cable is connected to the upper end of the shaft at both ends, and is wound around a pulley mounted on the counterweight, the top pulley, and the hoisting machine, in this sequence. A sheave constitutes the principal section of the hoisting machine, and has the main cable wound therearound, and whose rotor axis is oriented horizontally. Further, maintenance means including an access port is provided on the side surface of the car, and is opened so as to correspond to a portion of the hoisting machine to be subjected to maintenance.

[0066] Therefore, the hoisting machine is disposed on the exterior side surface of the car, and the maintenance means is provided on the wall of the car. In the car, a service engineer opens the door of the maintenance means and conducts an inspection of and performs maintenance on the hoisting machine by way of an access port. Thus, the service engineer does not need to stoop to inspect the hoisting machine and can perform operation while in a natural posture. Further, the service engineer is not required to pay special attention so as to avoid accidentally dropping a tool or a like instrument into the shaft, thereby improving the efficiency of maintenance. Further, since the hoisting machine is disposed on the exterior side surface of the car, there can be prevented damage to the hoisting machine, which would otherwise be caused when the lower portion of the shaft is flooded.

[0067] In another aspect of the present invention, in the elevator system, a deflector wheel is rotatively provided on the same exterior side surface of the car where the hoisting machine is provided. A first lower pulley is rotatively mounted on the lower surface of the car, and is placed at a position corresponding to the hoisting machine. A second lower pulley which is rotatively mounted on the lower surface of the car, and is placed close to the edge of the car opposite the first lower pulley. Further, the main cable is at one end connected to the upper end of the shaft, and the other end is connected to the upper end of the shaft at a position corresponding to the second lower pulley, as viewed from above. The main cable is wound around the pulley of the counterweight, the top pulley, the deflector wheel, the hoisting machine where a suspension position is formed, the first lower pulley, and the second lower pulley, in this sequence.

[0068] Therefore, the hoisting machine is disposed on the exterior side surface of the car, and the maintenance means is provided on the wall of the car. In the

car, a service engineer opens the door of the maintenance means and conducts an inspection of and performs maintenance on the hoisting machine by way of an access port. Thus, the service engineer does not need to stoop to inspect the hoisting machine and can perform operation while in a natural posture. Further, the service engineer is not required to pay special attention so as to avoid accidentally dropping a tool or a like instrument into the shaft, thereby improving the efficiency of maintenance. Further, since the hoisting machine is disposed on the exterior side surface of the car, there can be prevented damage to the hoisting machine, which would otherwise be caused when the lower portion of the shaft is flooded.

[0069] Further, the car is suspended by the main cable, by way of the first and second lower pulley, at a suspension position formed on the deflector wheel, as well as at a position on the lower surface of the car spaced apart from the suspension position in a diagonal direction. As a result, the portion of the car close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car and an offset load exerted on a rail for guiding the car. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be required.

[0070] In another aspect of the present invention, in the elevator system, a deflector wheel is rotatively provided on the same exterior side surface of the car where the hoisting machine is provided. A first side pulley is rotatively provided on the exterior side surface of the car, and is placed at a position corresponding to the hoisting machine. A second side pulley is rotatively provided on the exterior side surface of the car, and is placed at a position spaced apart from the first side pulley. Further, the main cable is connected at one end to the upper end of the shaft, and the other end is connected to the upper end of the shaft at a position corresponding to the second side pulley, as viewed from above. The main cable is wound around the pulley of the counterweight, the top pulley, the hoisting machine where a suspension position is formed, the deflector wheel, the first pulley, and the second side pulley, in this sequence.

[0071] Therefore, the hoisting machine is disposed on the exterior side surface of the car, and the maintenance means is provided on the wall of the car. In the car, a service engineer opens the door of the maintenance means and conducts an inspection of and performs maintenance on the hoisting machine by way of an access port. Thus, the service engineer does not need to stoop to inspect the hoisting machine and can perform operation while in a natural posture. Further, the service engineer is not required to pay special attention so as to prevent avoid accidentally dropping a tool or a like instrument into the shaft, thereby improving the efficiency of maintenance. Further, since the hoisting machine is disposed on the exterior side surface of the car, there can be prevented damage to the hoisting machine, which would otherwise be caused when the lower portion of the shaft is flooded.

[0072] Further, the car is suspended by the main cable, by way of the first and second side pulleys, at a suspension position formed on the deflector wheel, as well as at a position on the lower surface of the car spaced apart from the suspension position in a diagonal direction. As a result, the portion of the car close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car and an offset load exerted on a rail for guiding the car. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be decreased.

[0073] Further, the first and second side pulleys are provided on the side surface of the car, and hence an upper margin space originating from the highest stopping position of the car within the shaft or a lower margin space originating from the lowest stopping position of the car can be diminished, thus shortening the entire length of the shaft. Accordingly, cost incurred for constructing the shaft and installing the elevator system in the shaft can be reduced.

[0074] In another aspect of the present invention, in the elevator system, a first upper pulley is rotatively provided on the upper surface of the car, and is placed at a position corresponding to the hoisting machine. A second upper pulley is rotatively provided on the upper surface of the car, and is placed close to the edge of the upper surface of the car opposite the first upper pulley. Further, the main cable whose is connected at one end to the upper end of the shaft, and the other end is connected to the upper end of the shaft and is placed at a position corresponding to the second upper pulley. The main cable is wound around the pulley of the counterweight, the top pulley, the hoisting machine where a suspension position is formed, the first upper pulley, and the second upper pulley, in this sequence.

[0075] Therefore, the hoisting machine is disposed on the exterior side surface of the car, and the maintenance means is provided on the wall of the car. In the car, a service engineer opens the door of the maintenance means and conducts an inspection of and performs maintenance on the hoisting machine by way of an access port. Thus, the service engineer does not need to stoop to inspect the hoisting machine and can perform operation while in a natural posture. Further, the service engineer is not required to pay special attention so as to avoid accidentally dropping a tool or a like instrument into the shaft, thereby improving the efficiency of maintenance. Further, since the hoisting machine is disposed on the exterior side surface of the car, there can be prevented damage to the hoisting machine, which would otherwise be caused when the lower portion of the shaft is flooded.

[0076] Further, the car is suspended by the main cable, by way of the first and second upper pulleys, at a

suspension position formed on the deflector wheel, as well as at a position on the upper surface of the car spaced apart from the suspension position in a diagonal direction. As a result, the portion of the car close to its center of gravity is suspended, thereby diminishing an offset load exerted on the car and an offset load exerted on a rail for guiding the car. Consequently, the structure of the elevator system can be simplified, and cost required for constructing the elevator system can be decreased.

[0077] In another aspect of the present invention, in the elevator system, an indentation is formed in the surface of the counterweight facing the hoisting machine such that the hoisting machine fits into the indentation, as viewed in the horizontal plane of projection.

[0078] Therefore, when viewed within the horizontal plane of projection, the hoisting machine fits into the indentation. Accordingly, the transverse dimension of the shaft can be reduced, and as a result, cost incurred for constructing the shaft and installing the elevator system within the shaft can be reduced.

[0079] In another aspect of the present invention, in the elevator system, an elevator control panel or a console panel for use with the car is provided so as to protrude outwardly on the same wall of the car where the hoisting machine is provided, and is placed at a position spaced apart from the hoisting machine in either side to the vertical direction.

[0080] Therefore, when viewed within the horizontal plane of projection, the hoisting machine, the control panel, and the console panel are arranged so as to overlap one another in the vertical direction of the hoisting machine provided on the wall of the car. Consequently, the area of the hoisting machine within the horizontal plane with respect to the transverse direction can be effectively used. The transverse dimension of the shaft can be reduced accordingly, and as a result, cost incurred for constructing the shaft and installing the elevator system within the shaft can be reduced.

[0081] Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may by practiced otherwise than as specifically described.

[0082] The entire disclosure of a Japanese Patent Application No. 11-050864, filed on February 26, 1999 including specification, claims, drawings and summary, on which the Convention priority of the present application is based, are incorporated herein by reference in its entirety.

Claims

1. An elevator system comprising:

a car (2) which travels vertically along a predetermined path within a shaft (1);

a counterweight (9) which travels vertically along another predetermined path within the shaft; said counterweight having a pulley (10) mounted thereon;

a hoisting machine (6) including a sheave (25) provided on the exterior side surface of the car, the rotor axis of said sheave being oriented horizontally;

a top pulley (11) rotatively mounted on the upper end of the shaft with the rotor axis thereof being oriented horizontally;

a main cable (12) connected to the upper end of the shaft at both ends thereof respectively; said main cable being wound around said pulley mounted on the counterweight, the top pulley, and the sheave;

an access port (17) provided on the side surface of the car corresponding to the hoisting machine to be subjected to maintenance.

2. The elevator system as defined in claim 1, further comprising:

a deflector wheel (31) rotatively provided on the exterior side surface of the car (2) where the hoisting machine (6) is provided;

a first lower pulley (32) rotatively mounted on the lower surface of the car close to an edge at a position corresponding to the hoisting machine;

a second lower pulley (33) rotatively mounted on the lower surface of the car close to another edge of the car opposite the first lower pulley;

wherein the main cable (12) is wound around the pulley of the counterweight (9), the top pulley (11), the deflector wheel, the sheave (25), the first lower pulley, and the second lower pulley.

3. The elevator system as defined in claim 1, further comprising:

a deflector wheel (31) rotatively provided on the exterior side surface of the car (2) where the hoisting machine (6) is provided;

a first side pulley (35) rotatively provided on the exterior side surface of the car at a position corresponding to the hoisting machine;

a second side pulley (36) rotatively provided on the exterior side surface of the car at a position spaced apart from the first side pulley;

wherein the main cable (12) is wound around the pulley of the counterweight (9), the top pulley (11), the sheave (25), the deflector wheel, the first side pulley, and the second side pulley.

4. The elevator system as defined in claim 1, further comprising:

a first upper pulley (40) rotatively provided on the upper surface of the car (2) close to an edge at a position corresponding to the hoisting machine (6);

a second upper pulley (41) rotatively provided on the upper surface of the car close to another edge of the car opposite the first upper pulley;

wherein the main cable (12) is wound around the pulley of the counterweight (9), the top pulley (11), the sheave (25), the first upper pulley, and the second upper pulley.

5. The elevator system as defined in one of claims 1 through 4, wherein an indentation (37) is formed in the surface of the counterweight (9) facing the hoisting machine (6) to permit the hoisting machine to pass through.

6. The elevator system as defined in one of claims 1 through 5, further comprising an elevator control panel (38) or a console panel (39) for use with the car (2) provided to protrude outwardly on the wall of the car where the hoisting machine (6) is provided at a position spaced apart from the hoisting machine in the vertical direction.

Fig. 1

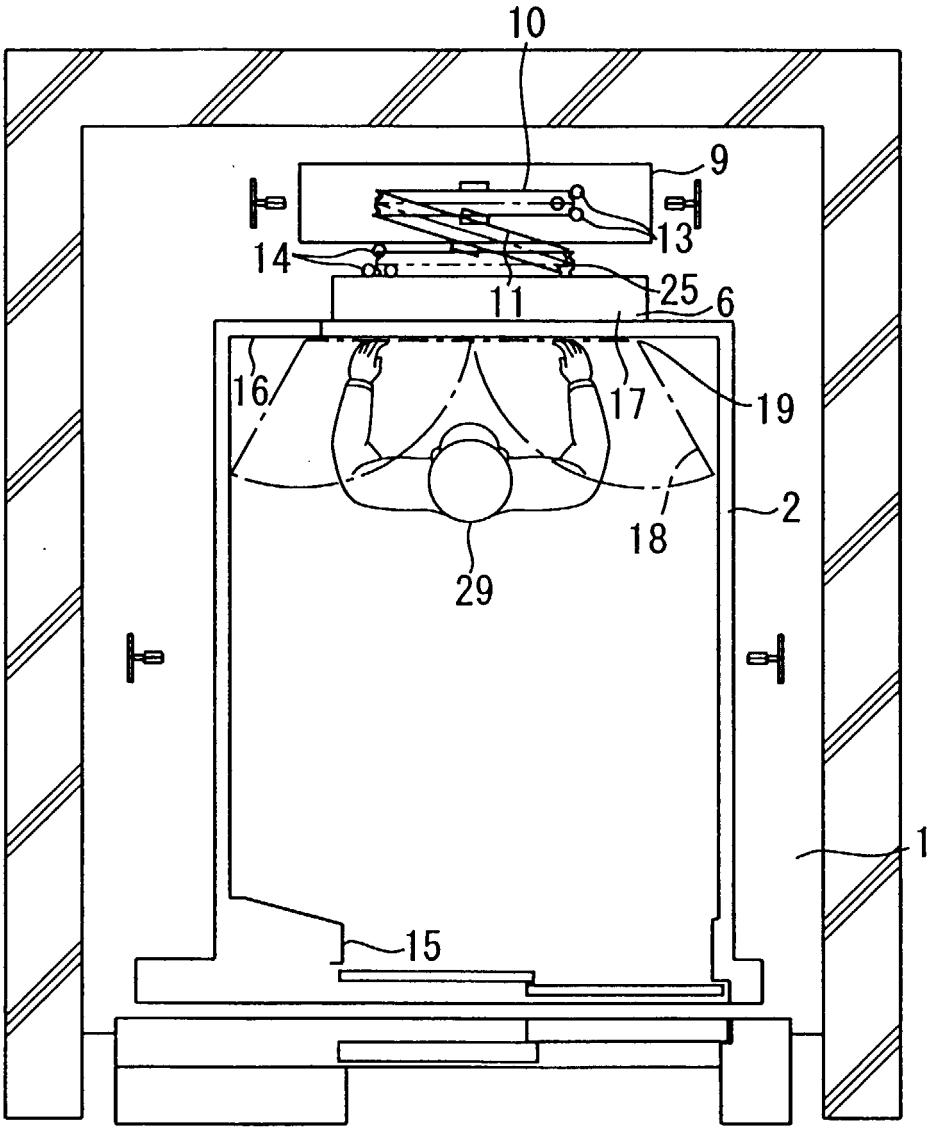


Fig. 2

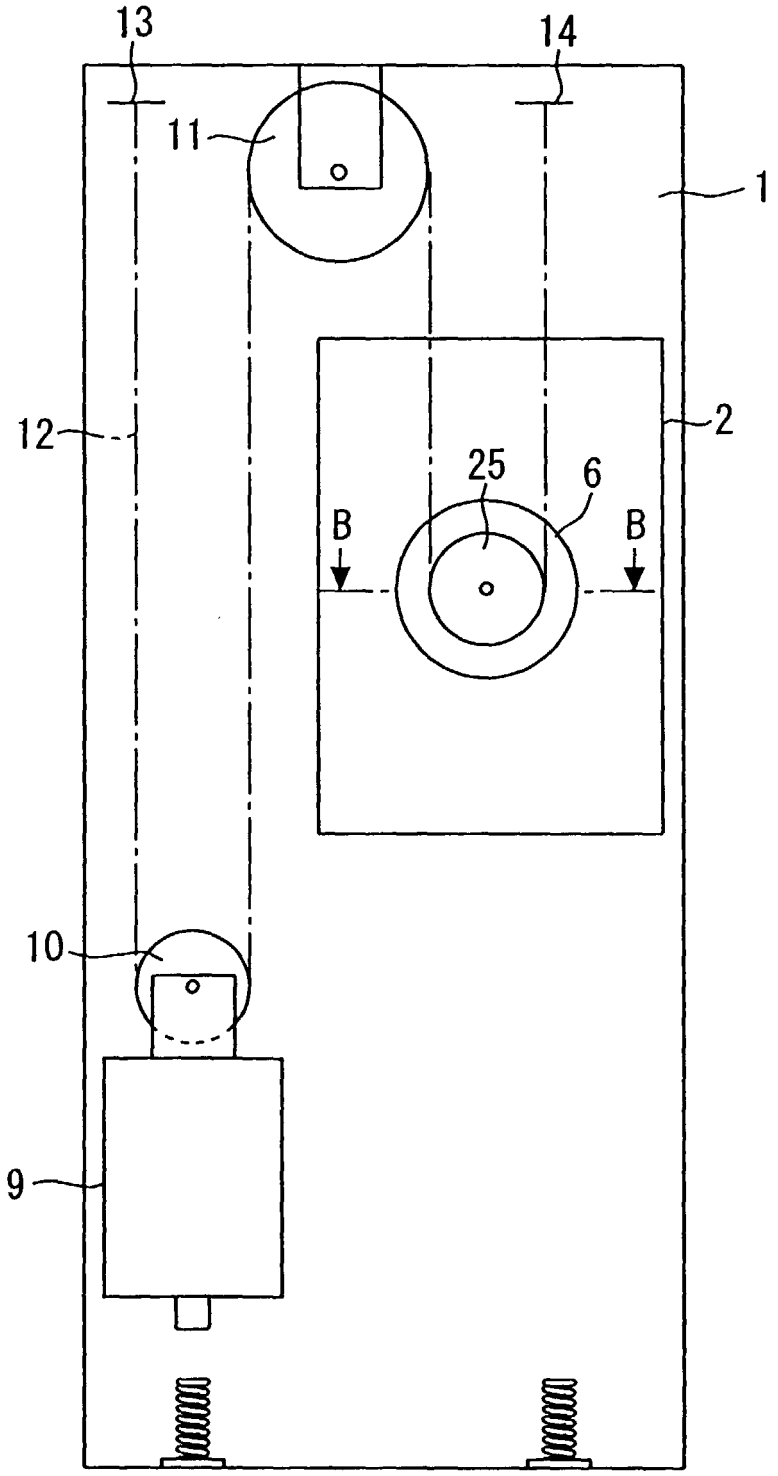


Fig. 3

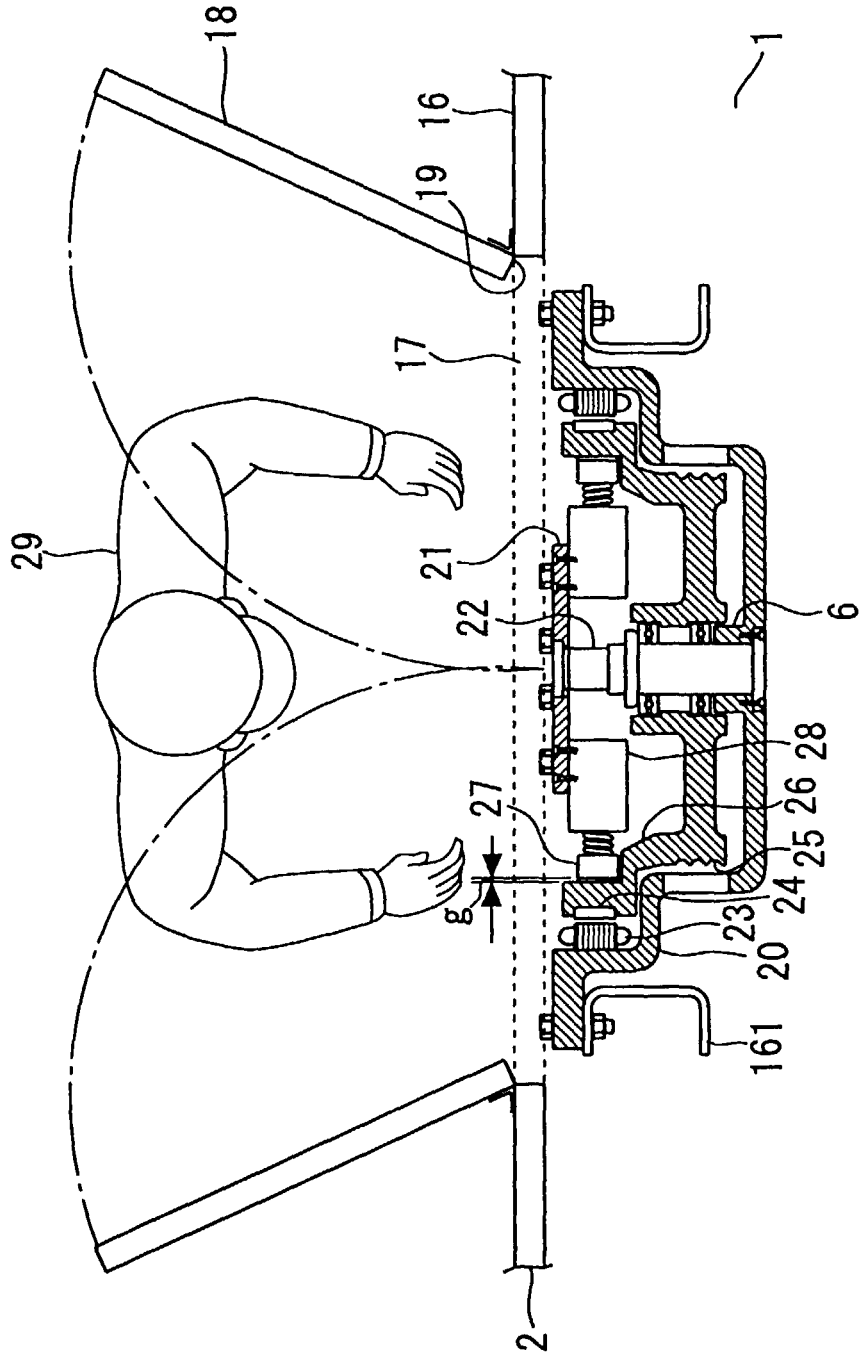


Fig. 4

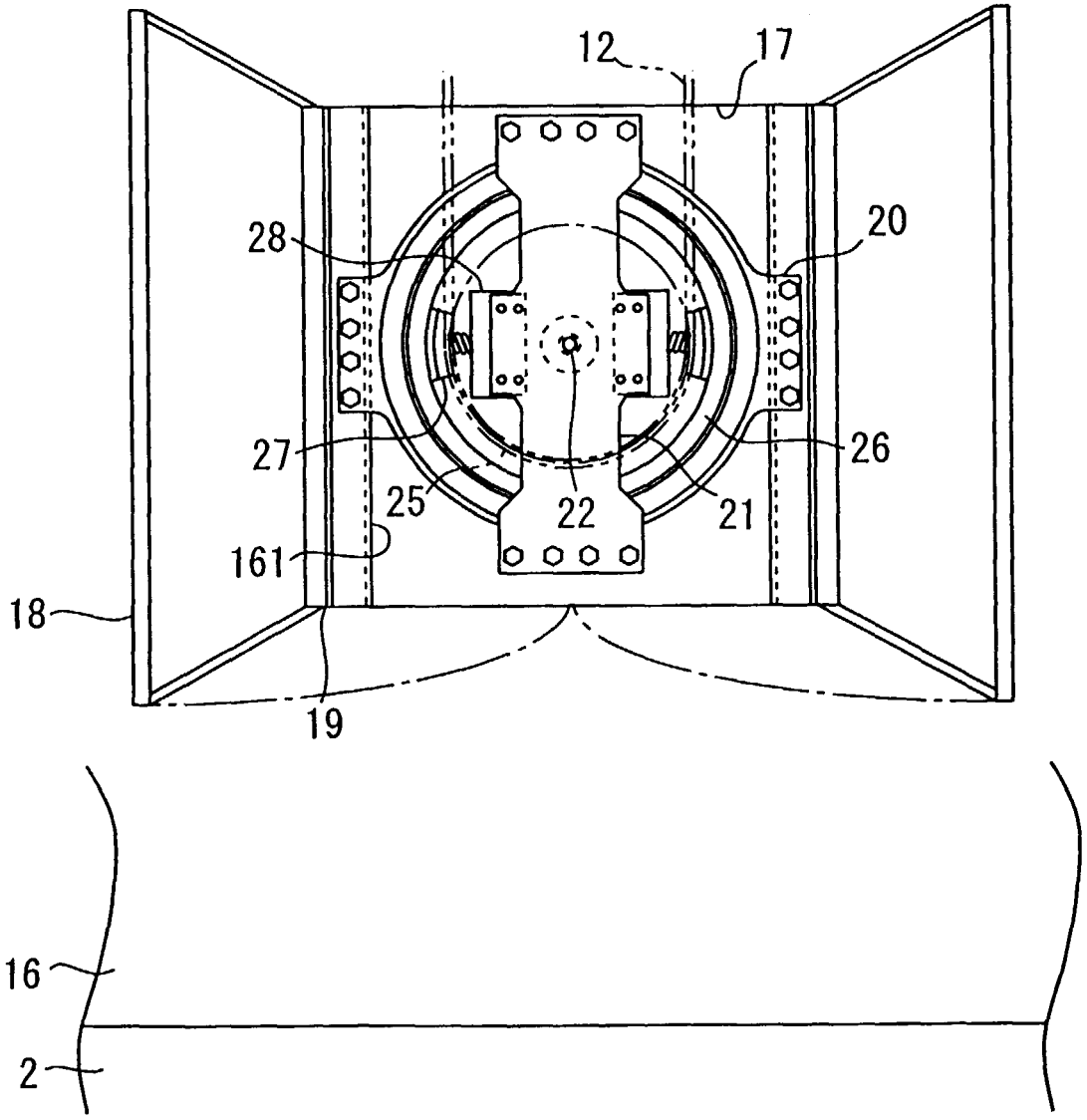


Fig. 5

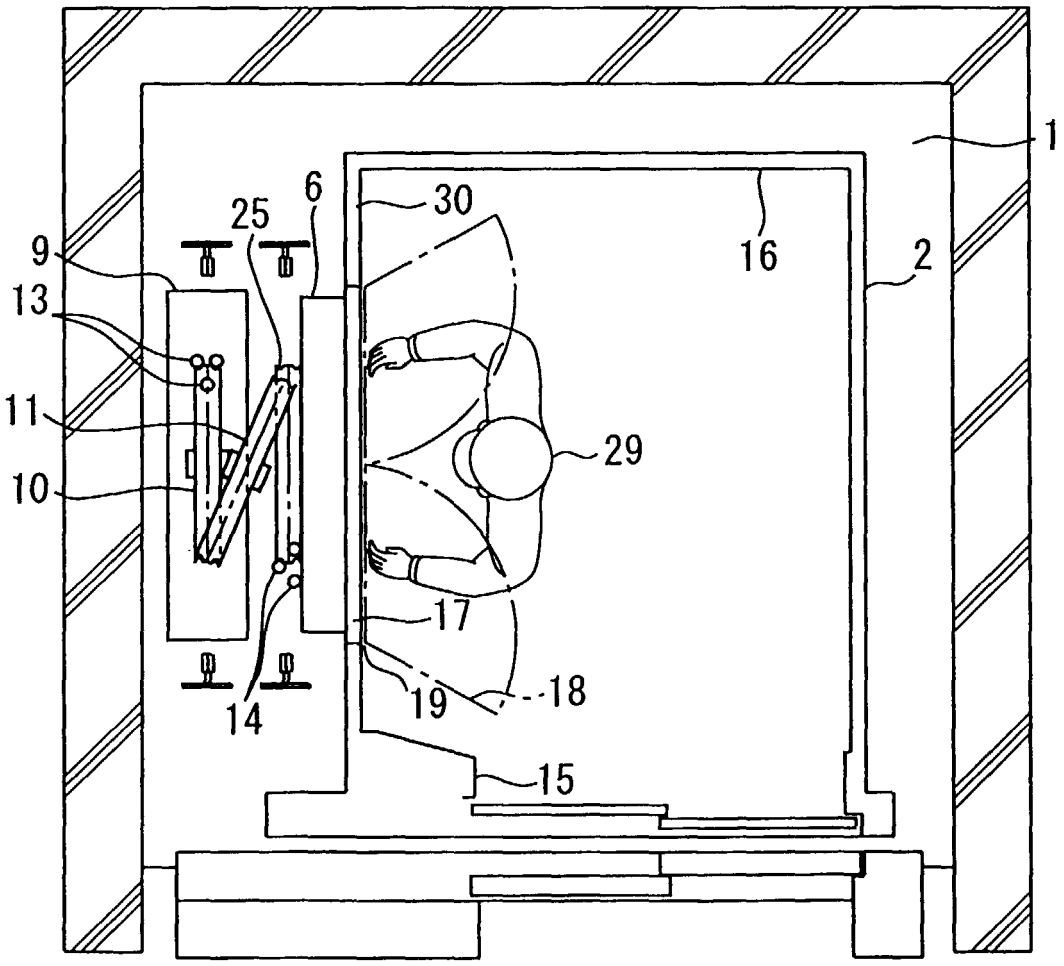


Fig. 6

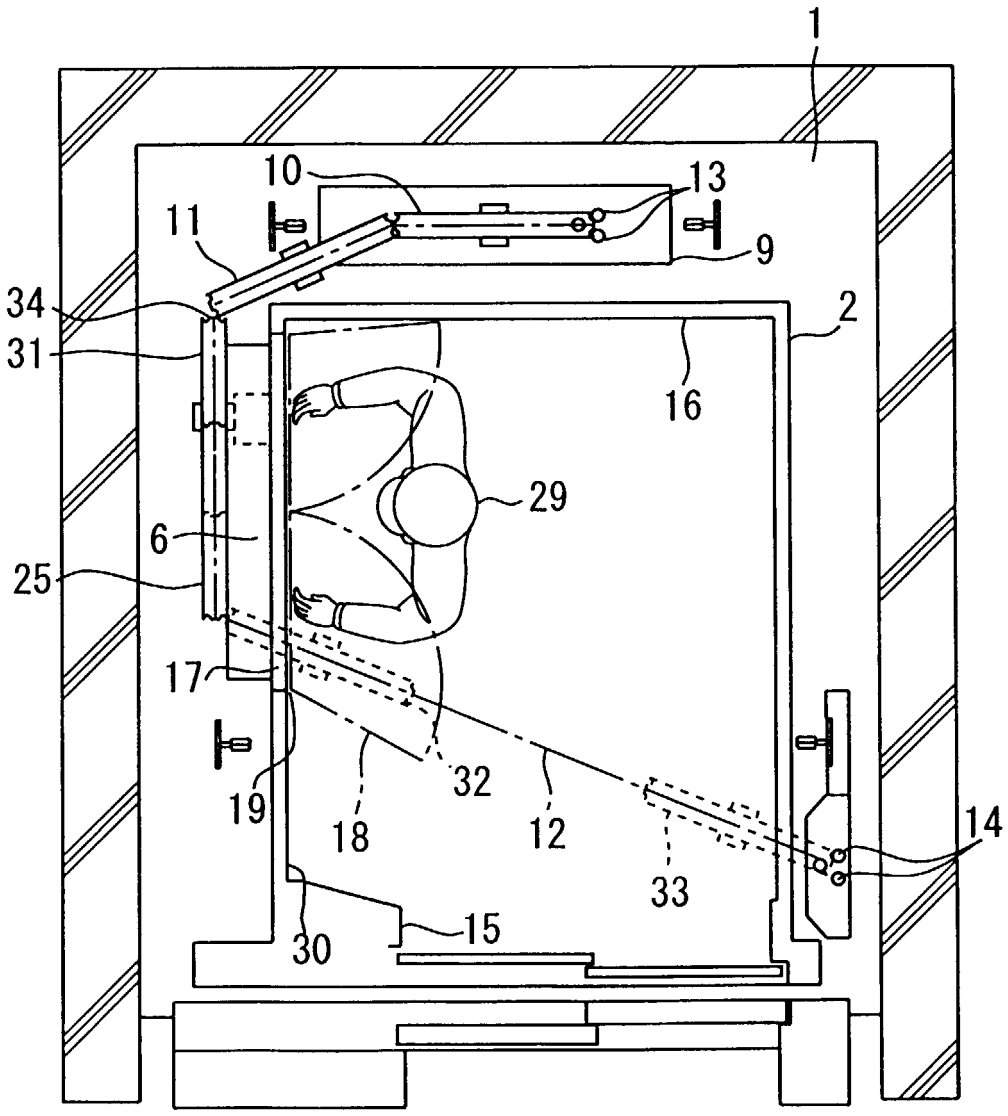


Fig. 7

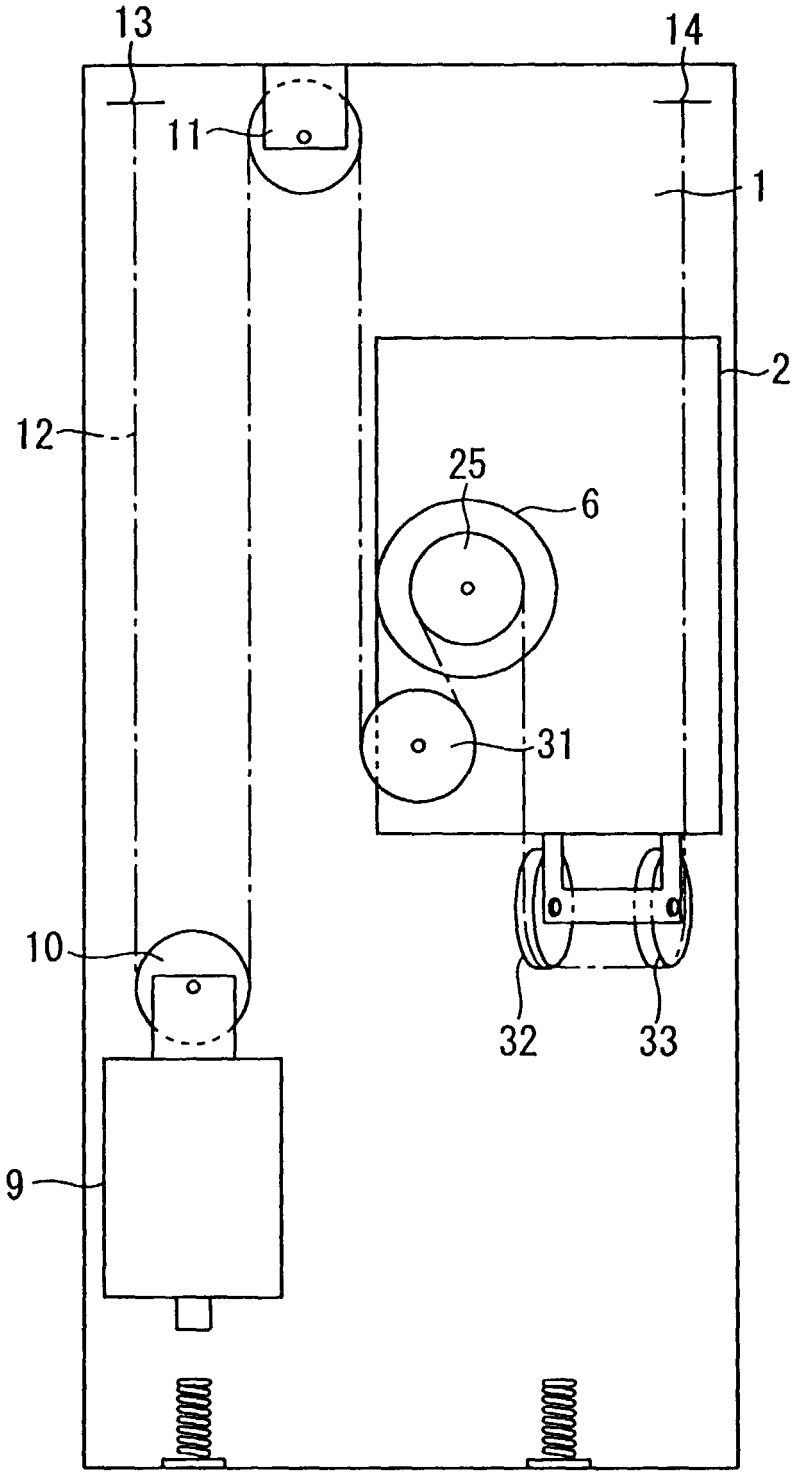


Fig. 8

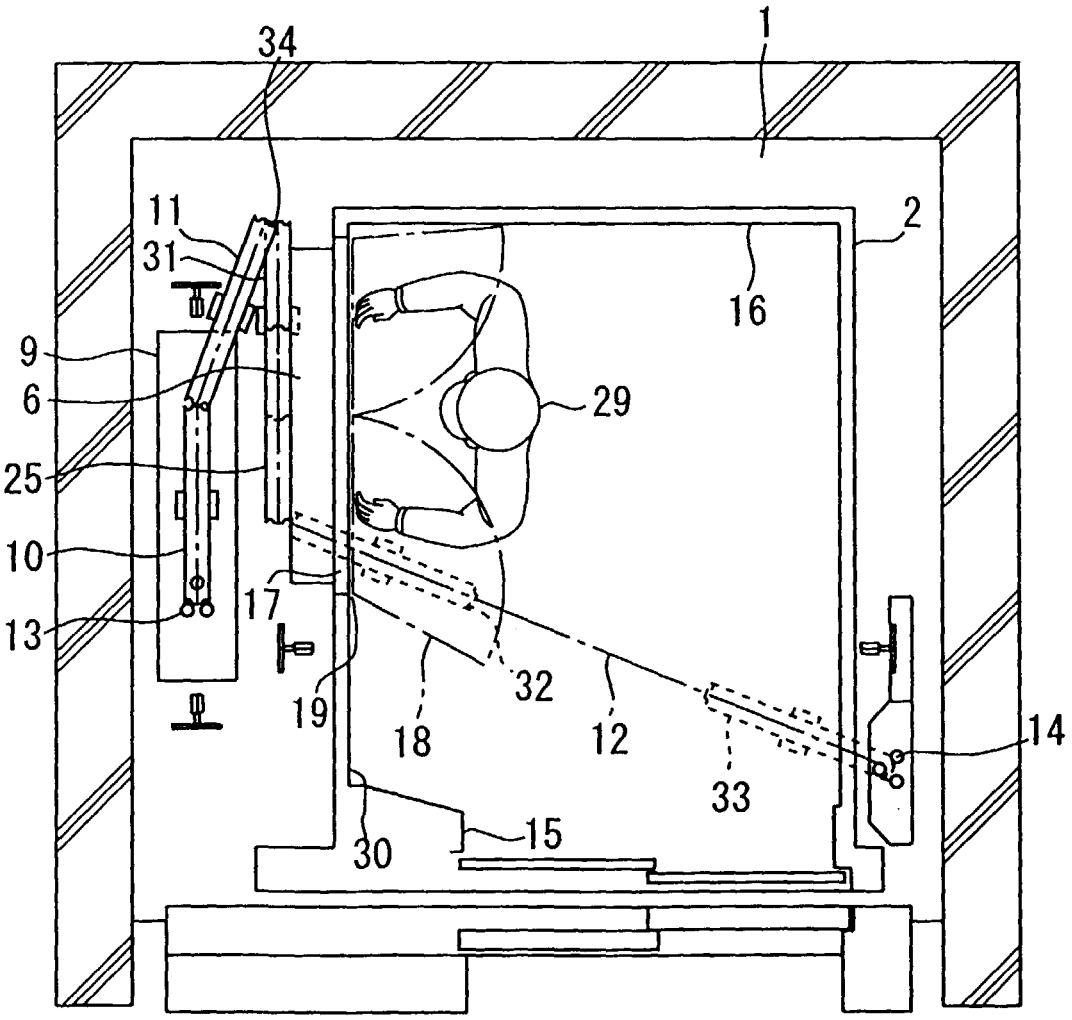


Fig. 9

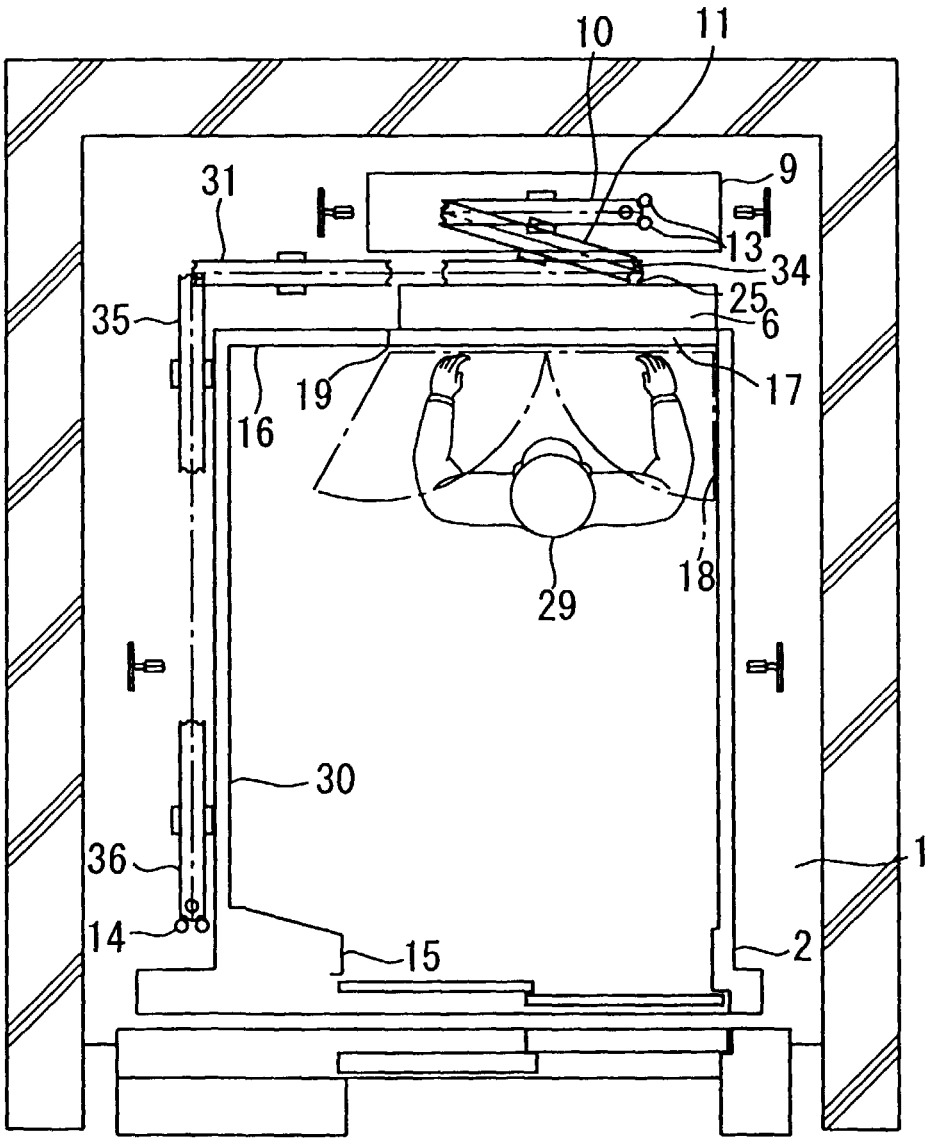


Fig. 1 O

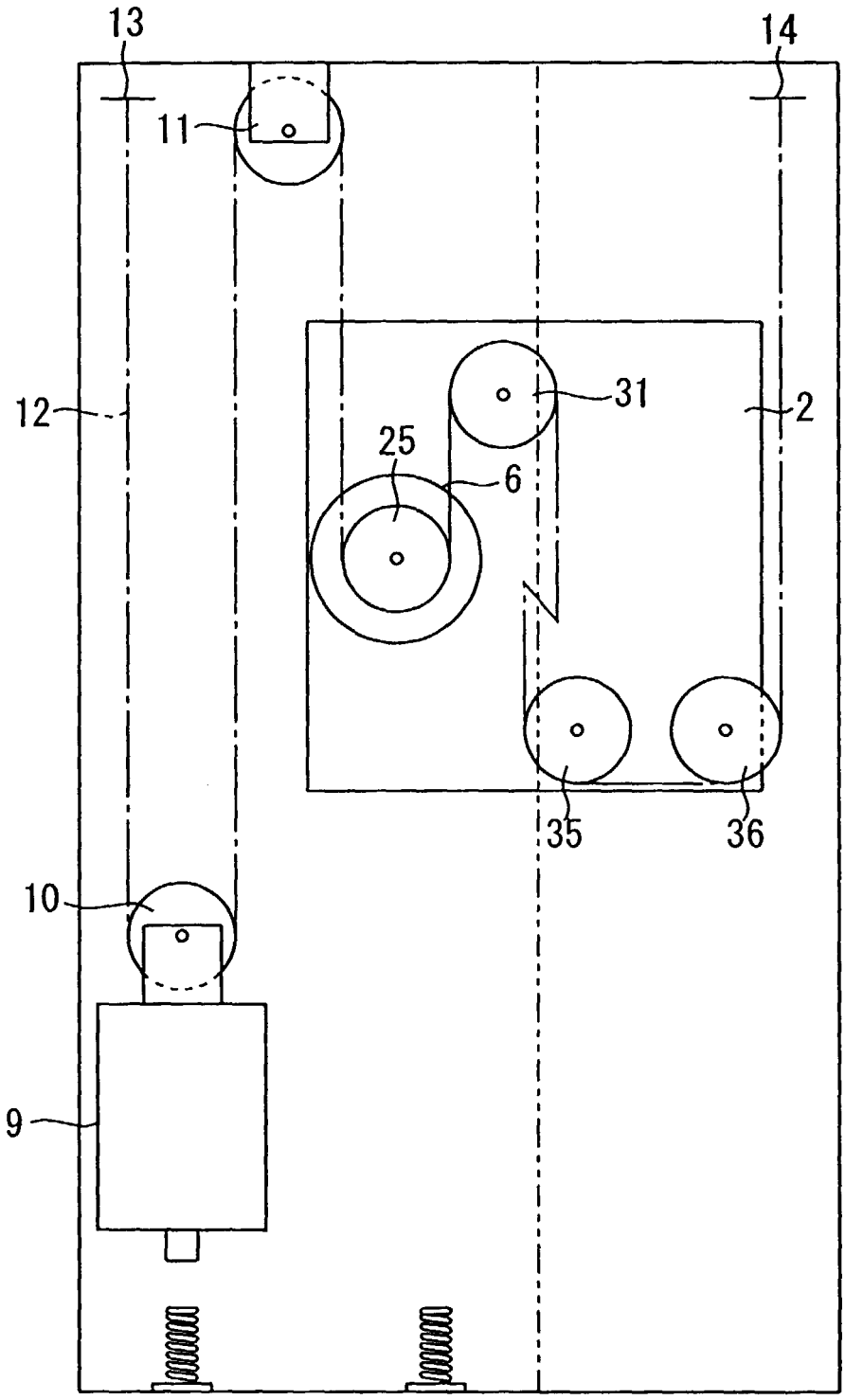


Fig. 1 1

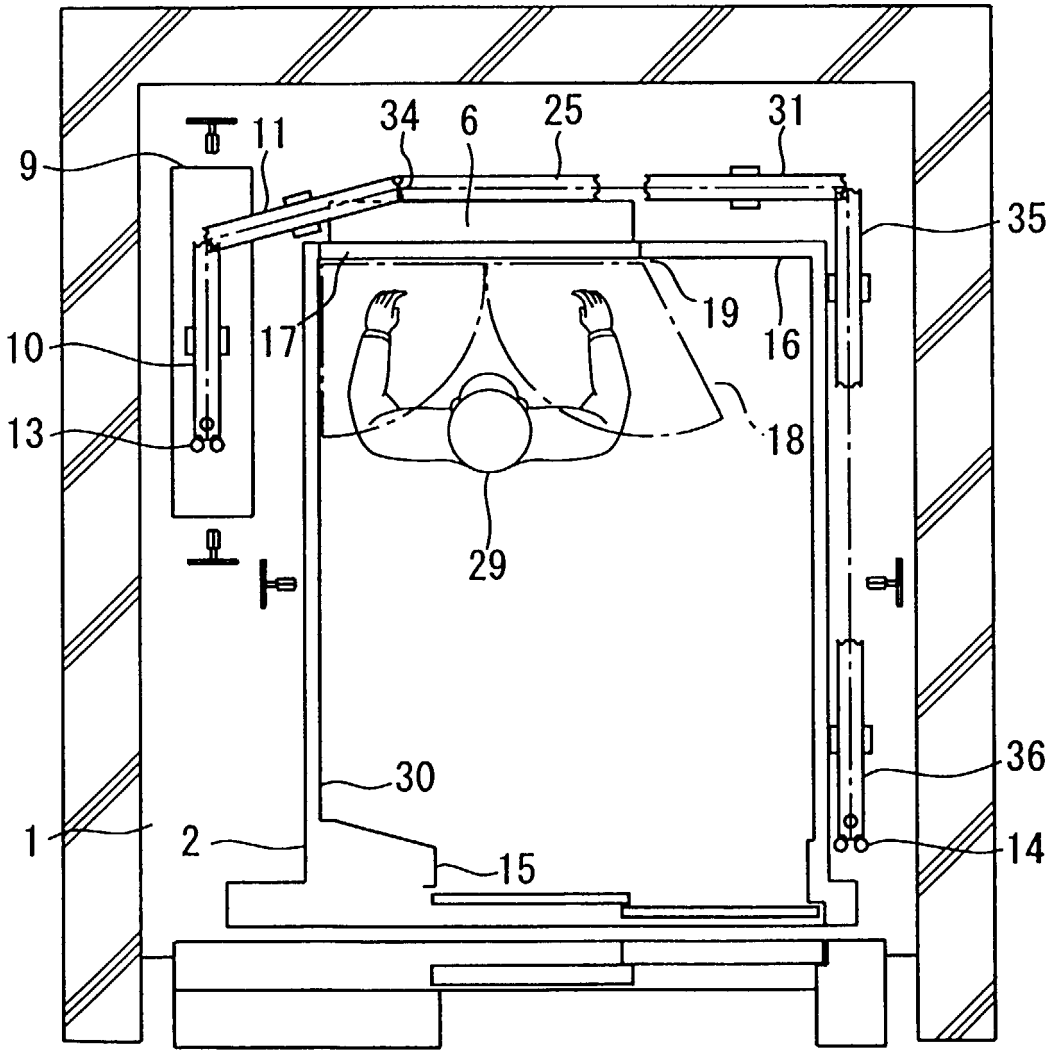


Fig. 1 2

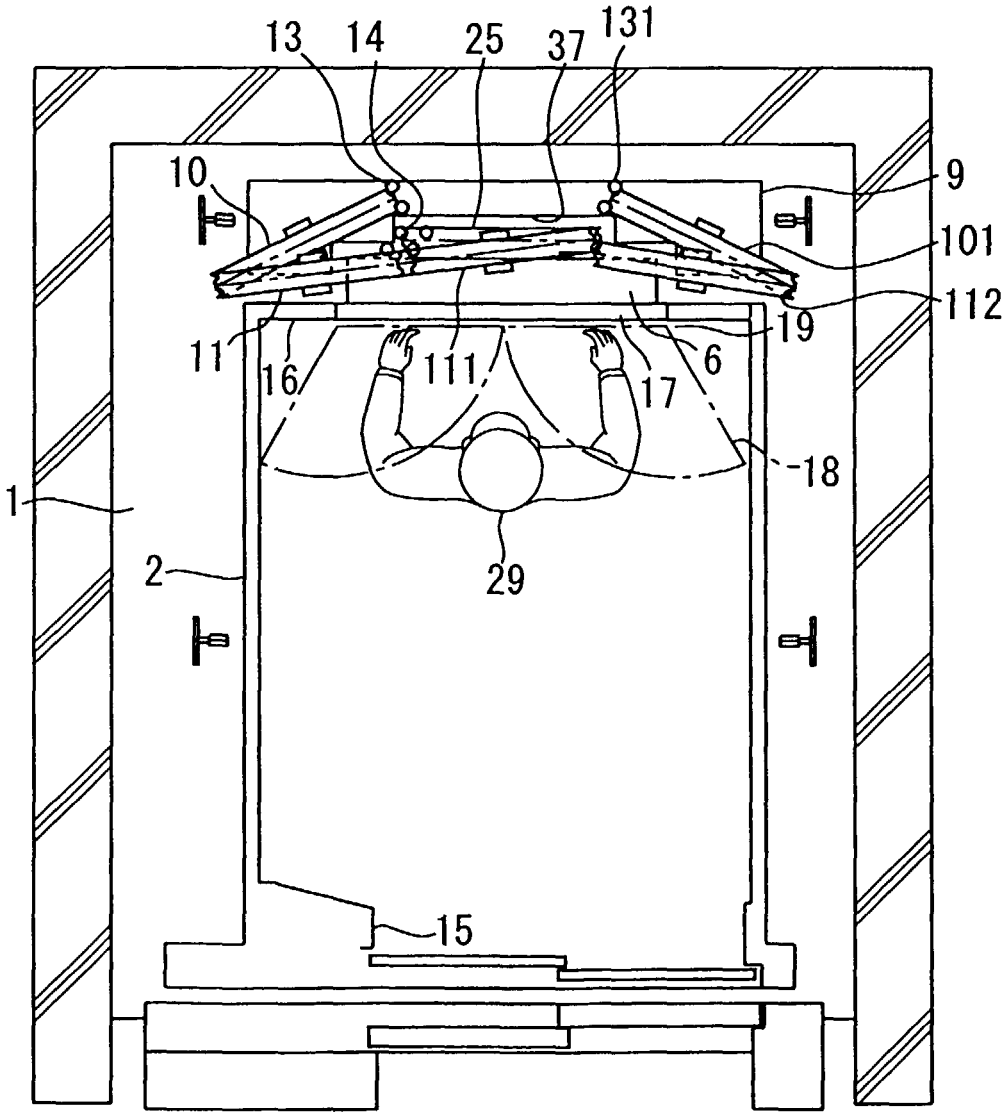


Fig. 1 3

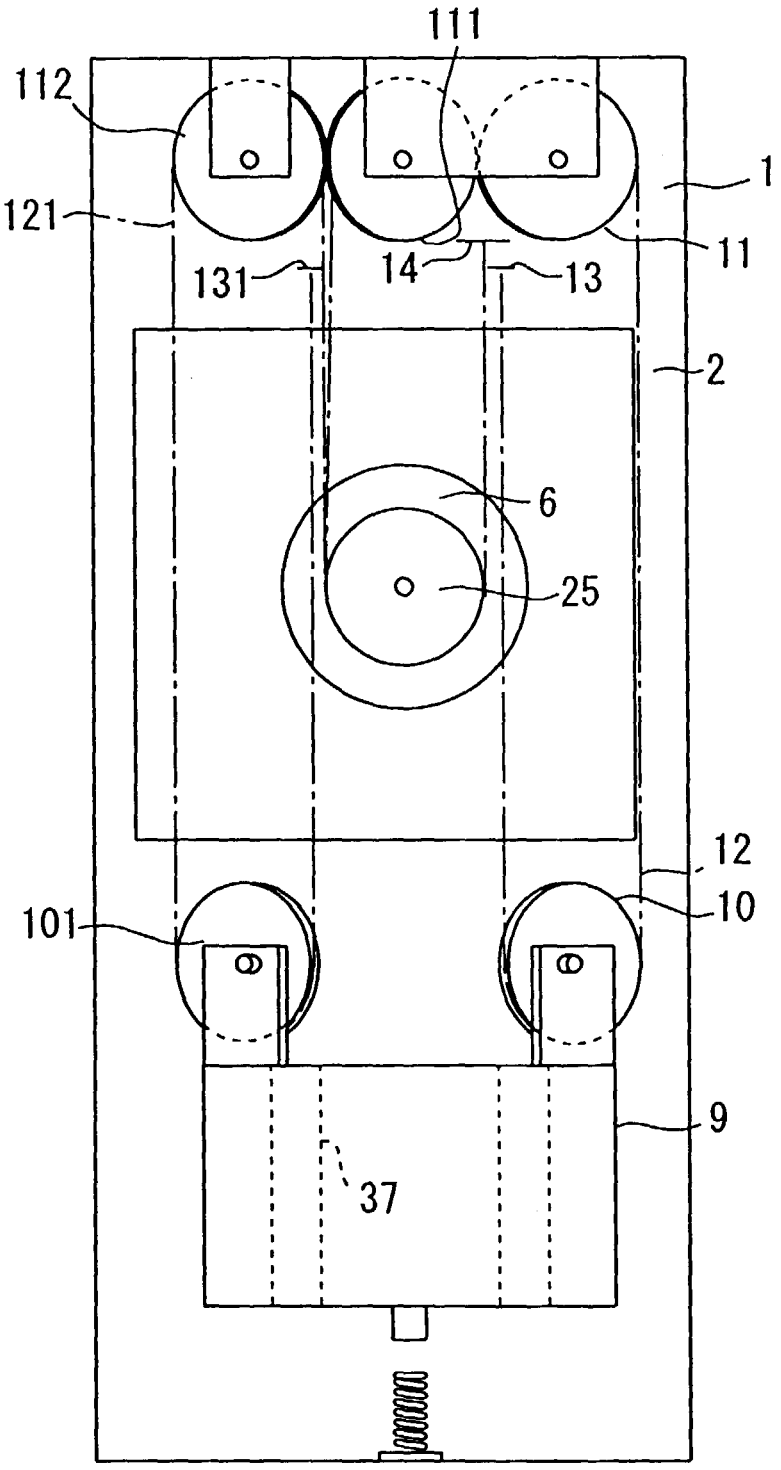


Fig. 1 4

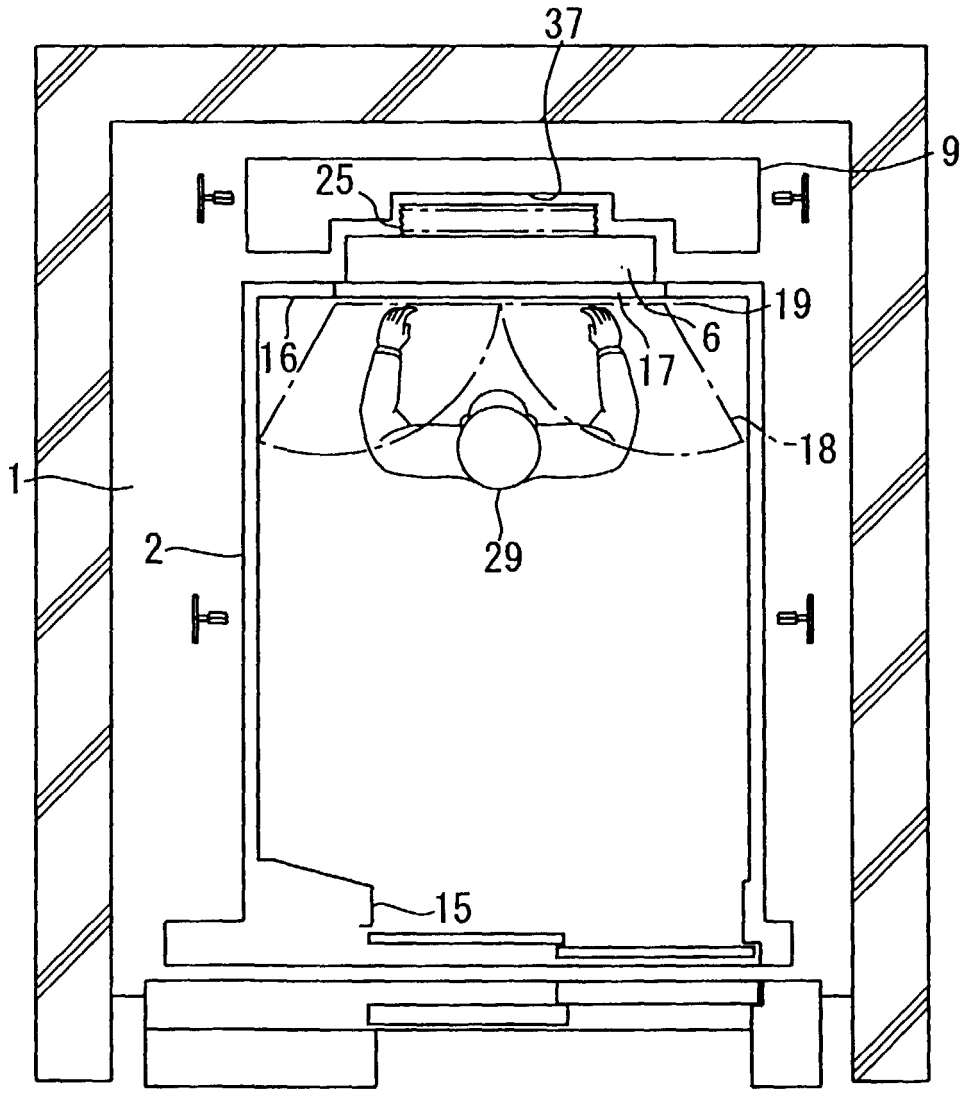


Fig. 1 5

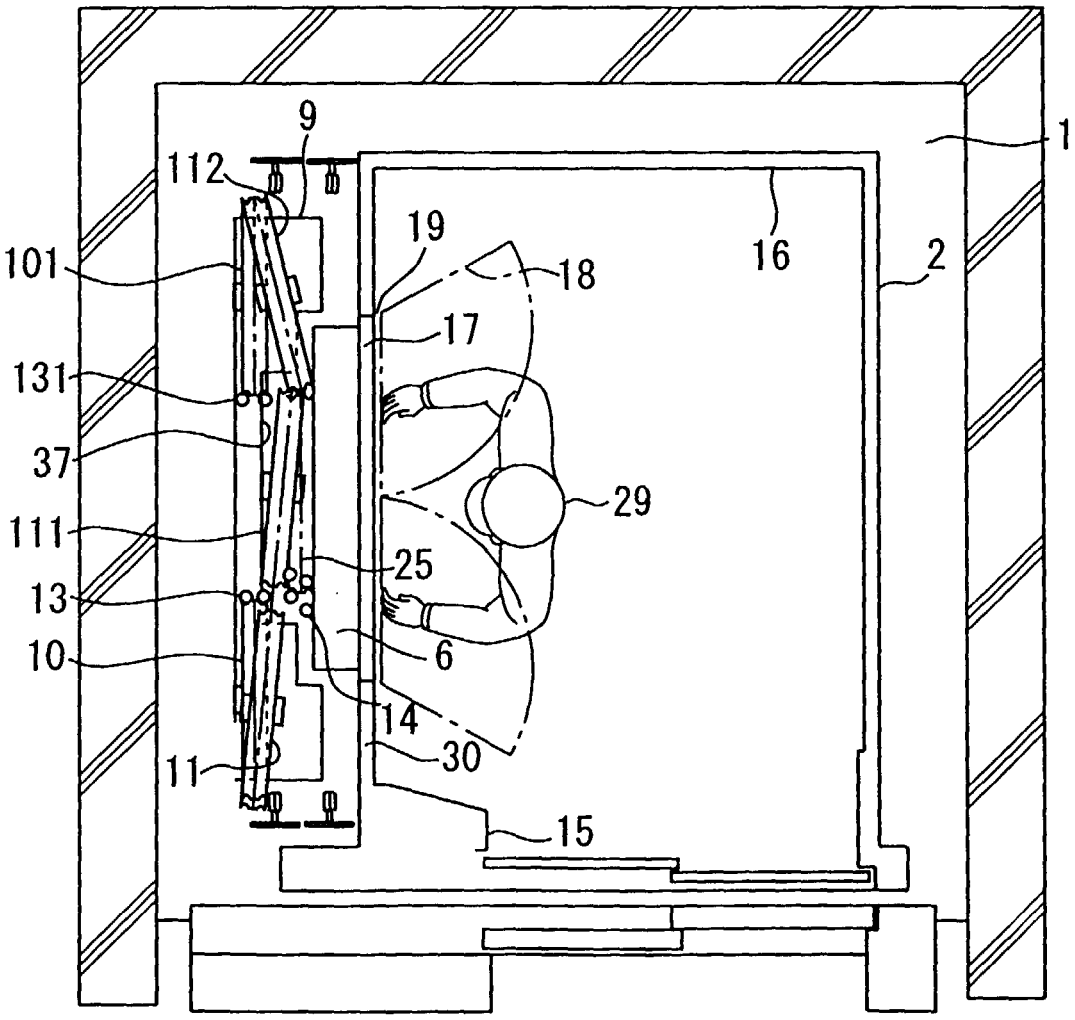


Fig. 1 6

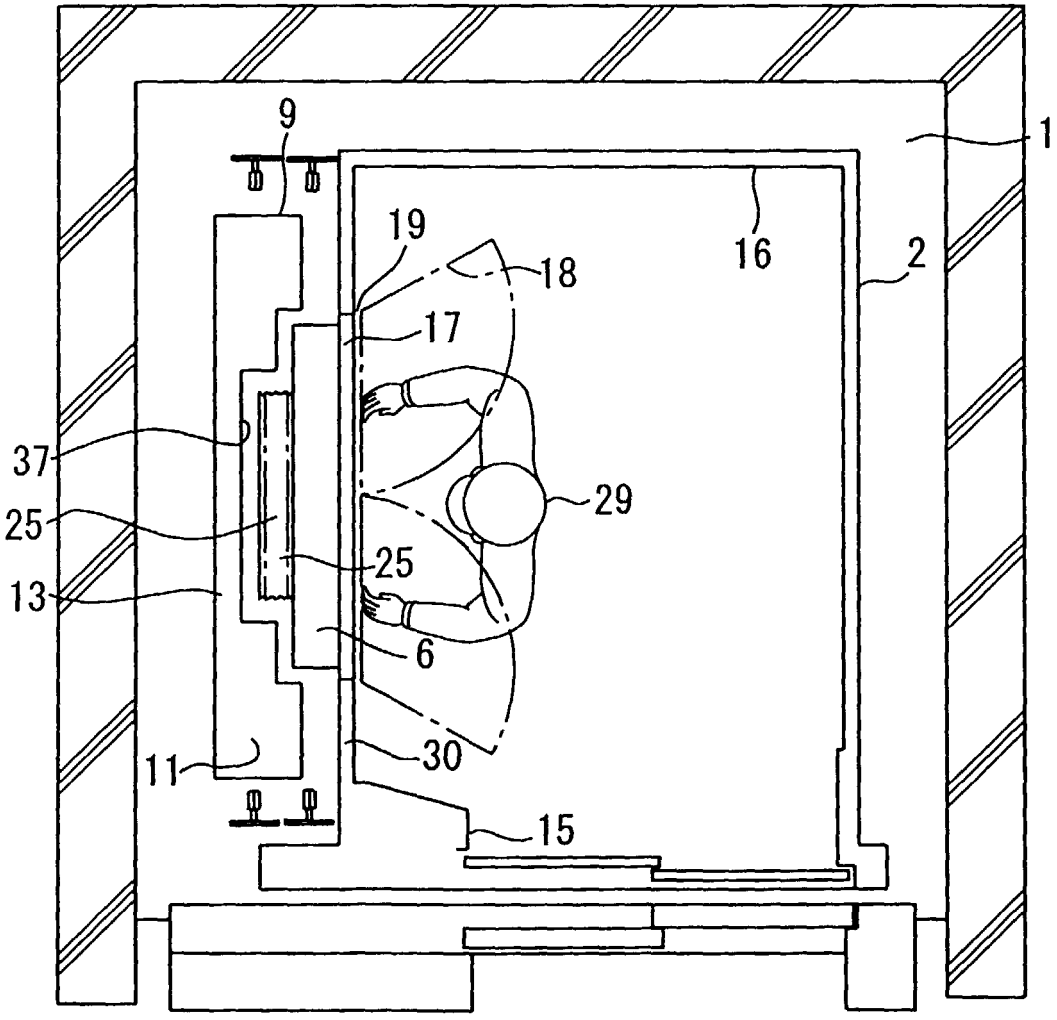


Fig. 1 7

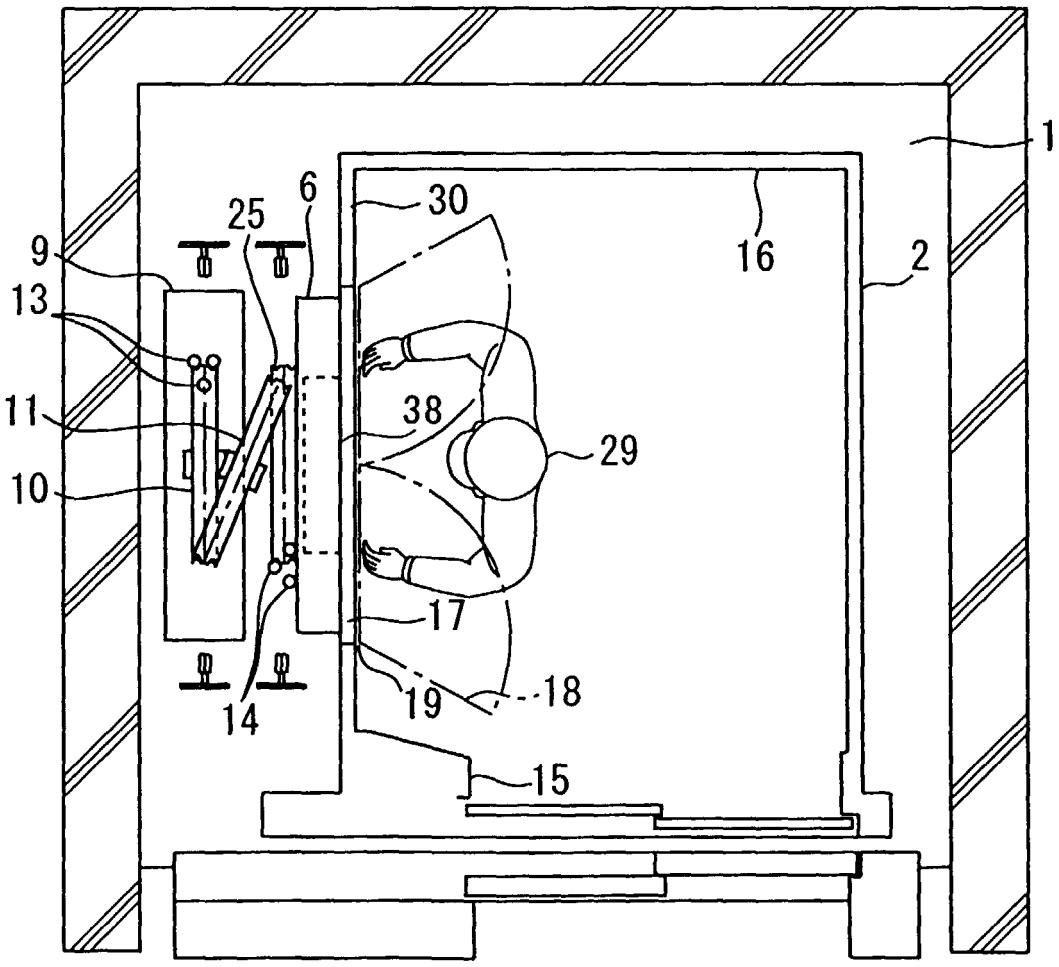


Fig. 1 8

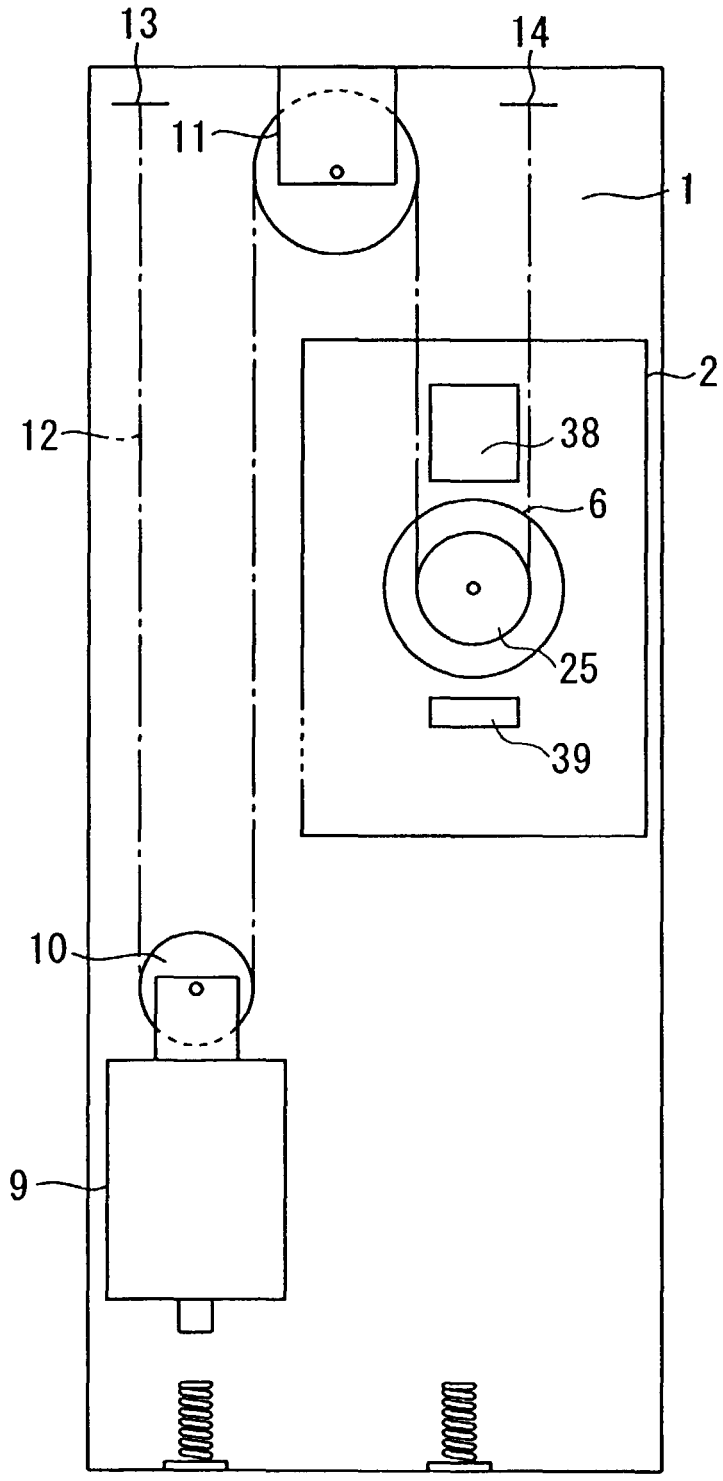


Fig. 1 9

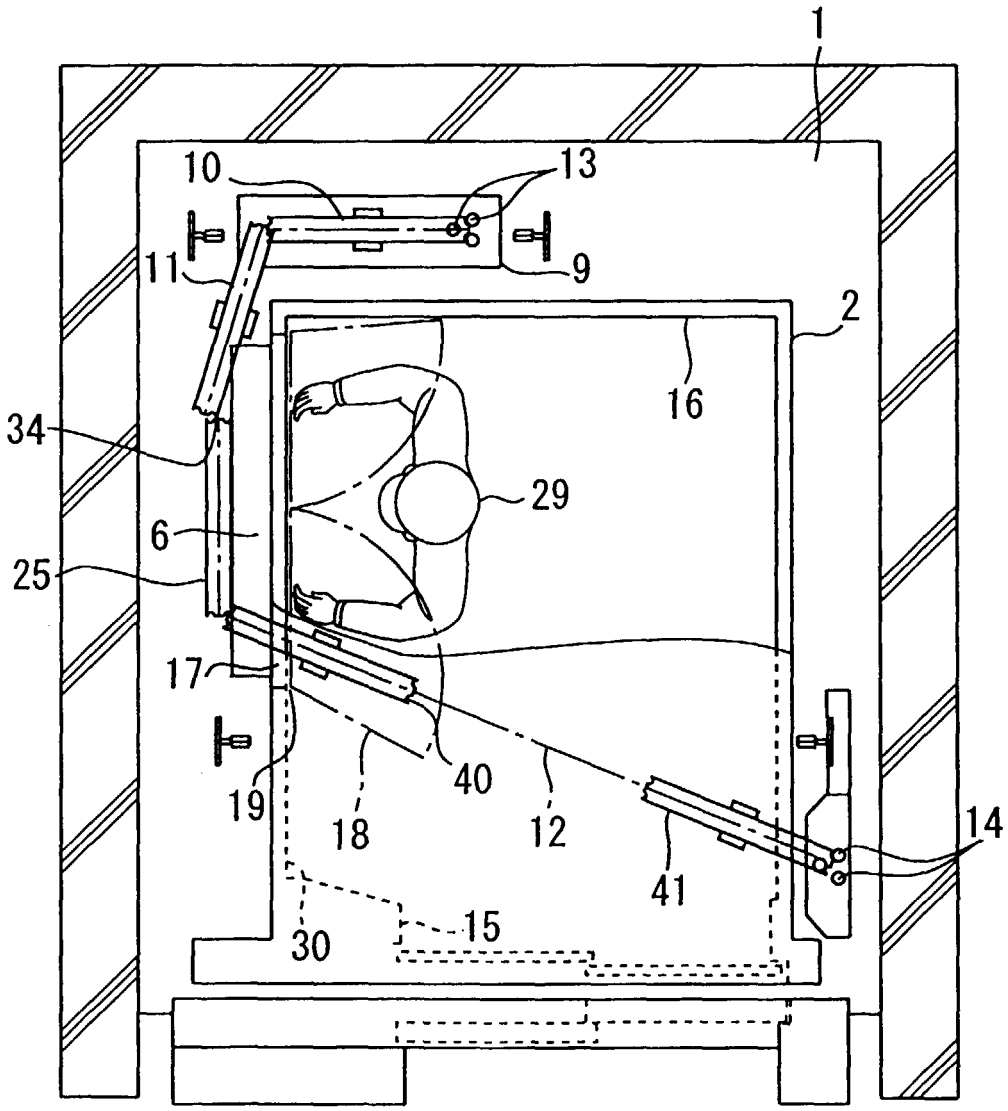


Fig. 2 O

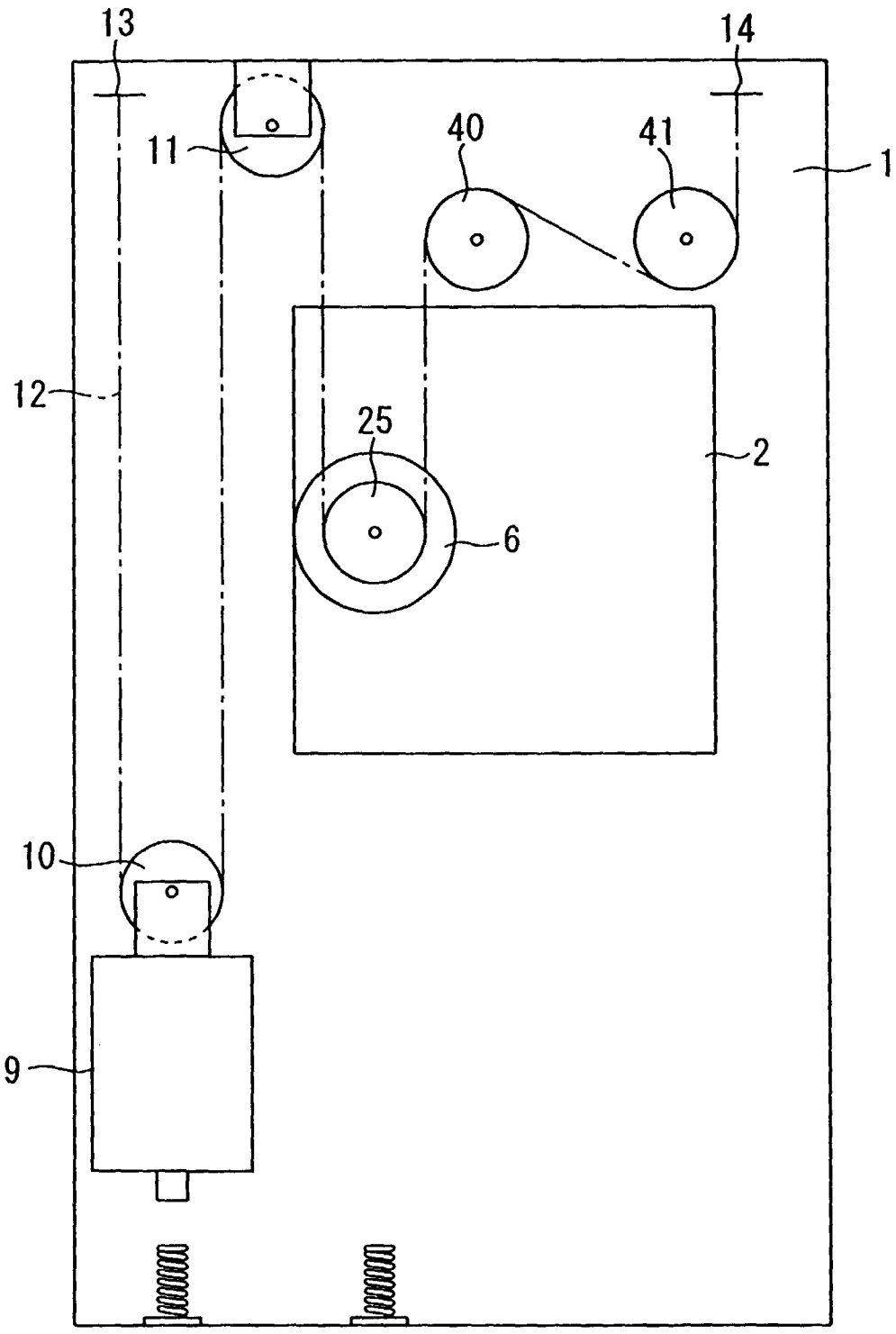


Fig. 2 1

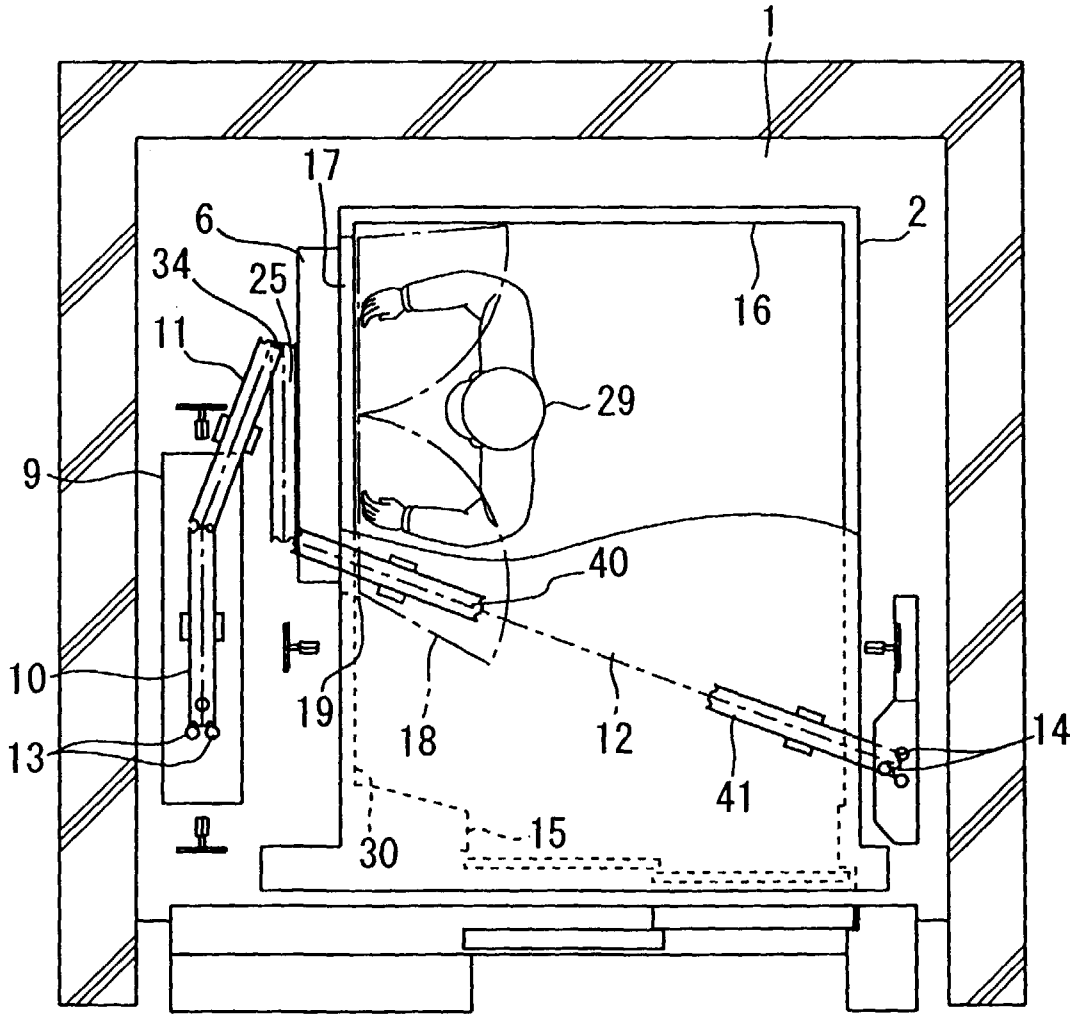


Fig. 2 2

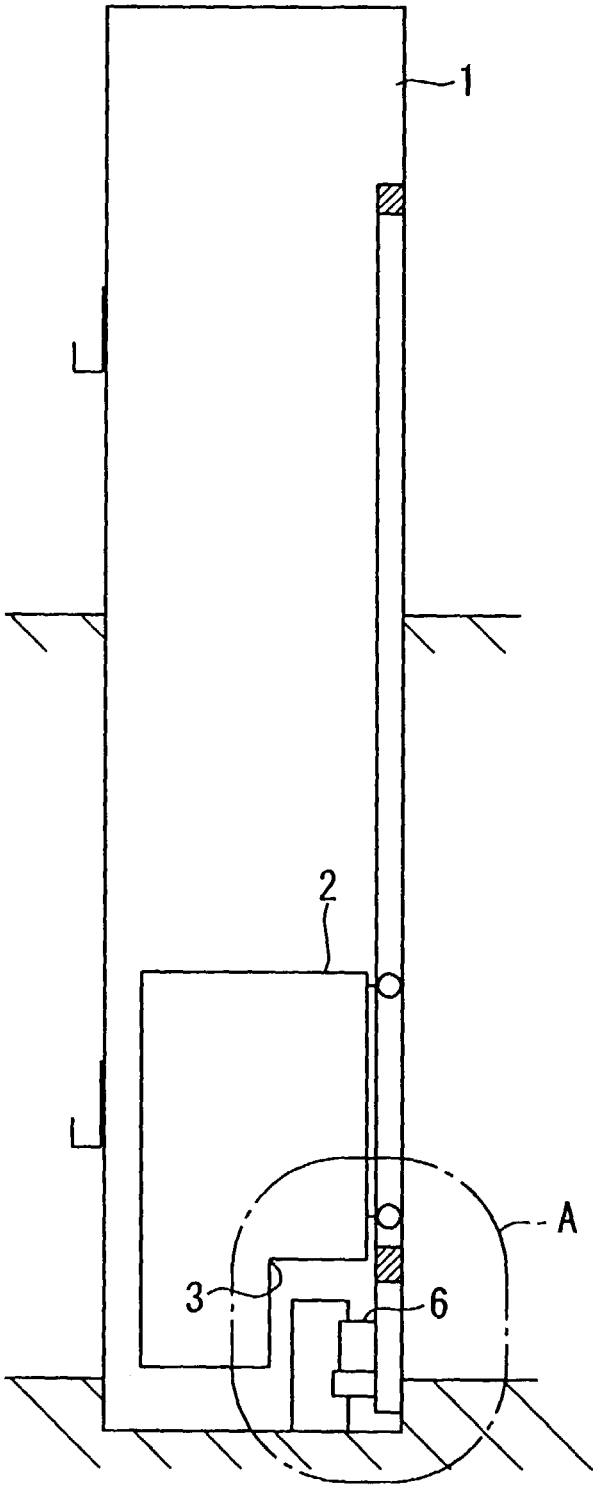


Fig. 2 3

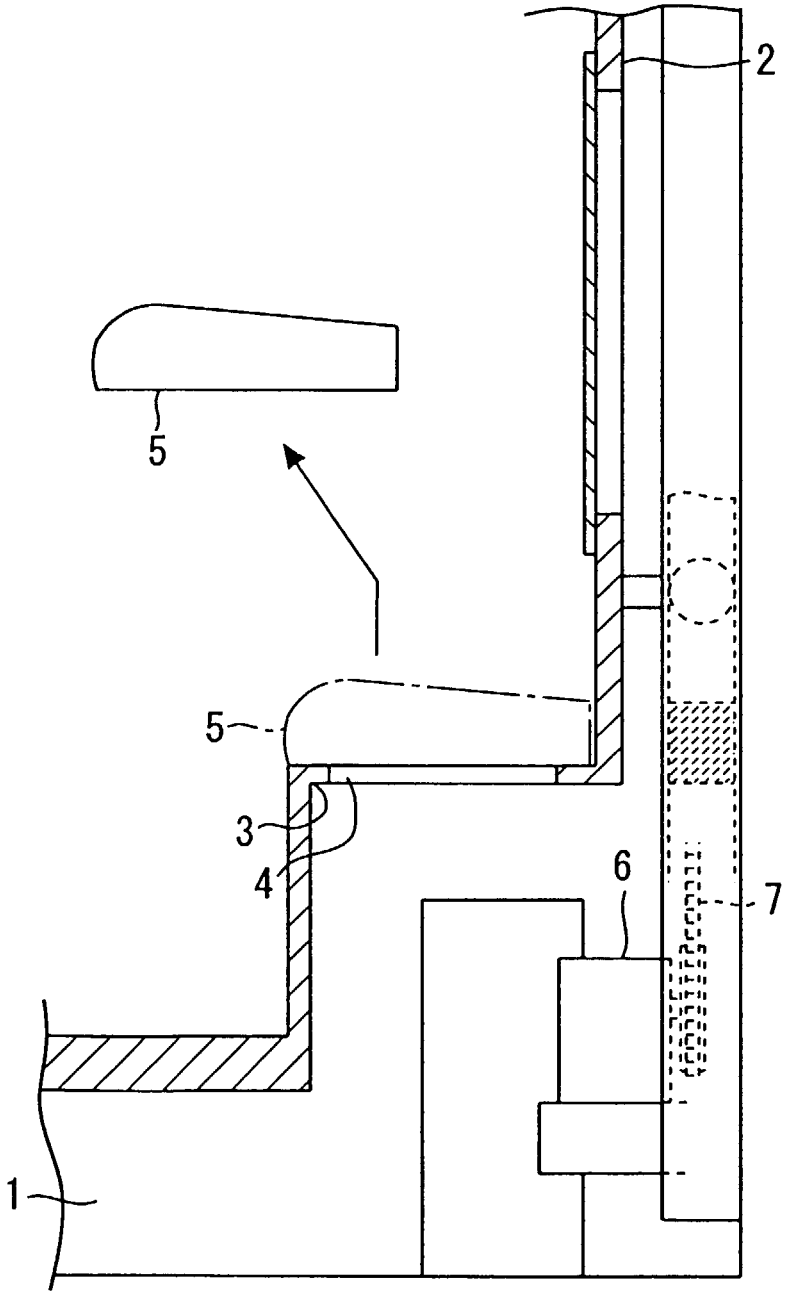
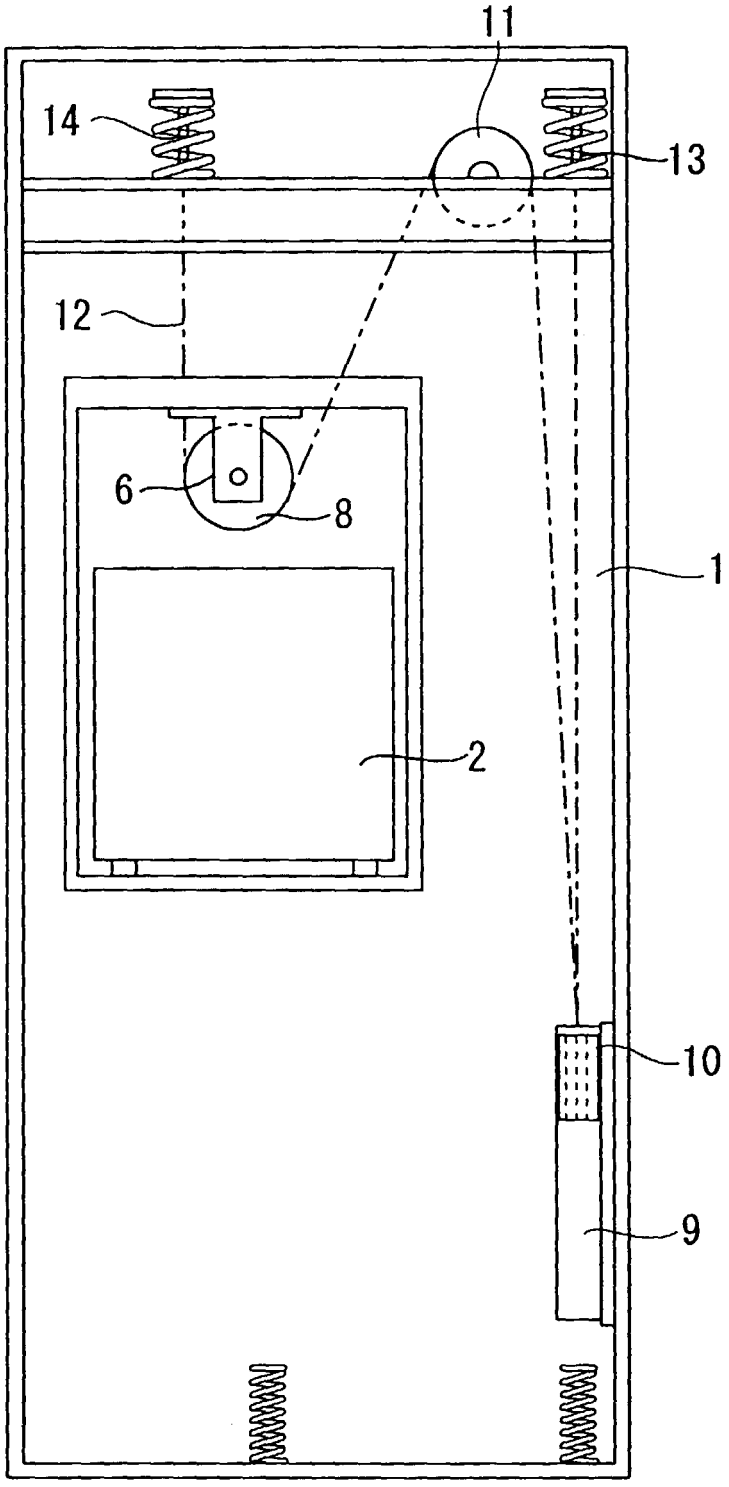


Fig. 2 4



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EUROPEAN SEARCH REPORT

Application Number
EP 00 10 3418

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 June 2000	Salvador, D

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