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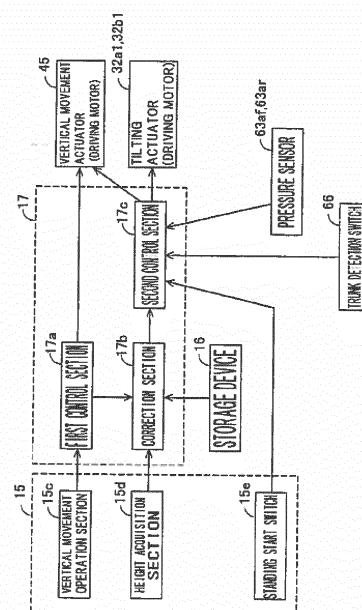
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(54) **ASSISTANCE ROBOT**

(57) Provide is an assistant robot capable of performing standing actions in accordance with the seating posture of persons in need of assistance and the physical characteristics of persons in need of assistance. An assistant robot 10 includes a base table 21, a vertical movement operation section 15c which enables a person in need of assistance M1 or an assistant to operate changes of the vertical-direction location of the holding section 13, a first control section 17a which controls the actuator 45 in accordance with an operation in the vertical movement operation section 15c and moves the holding section 13 in a vertical manner, a memory section 16 which stores in advance action trajectories of the actuators 45, 32a1, and 32b1 which are intended to transfer the holding section 13 from a standard seating posture to a standard standing posture, a correction section 17b which corrects the action trajectories of the actuators 45, 32a1, and 32b1 on the basis of the vertical-direction location of the holding section 13 moved using the first control section 17a and the vertical-direction location of the standard seating posture, and a second control section 17c which controls the actuators 45, 32a1, and 32b1 on the basis of the corrected action trajectories and transfers the holding section 13 to a predetermined standing posture.

FIG. 6



Description

Technical Field

[0001] The present invention relates to an assistant robot that helps the standing action of a person in need of assistance.

Background Art

[0002] Assistant robots described in PTL 1 to PTL 4 are known. These types of assistant robots help actions transferring a seating posture to a standing posture. These assistant robots transfer a person in need of assistance to a standing posture in a state in which a part of the upper body of the person in need of assistance in a seating posture is held.

Citation List

Patent Literature

[0003]

PTL 1: JP-A-09-066082

PTL 2: JP-A-2012-030077

PTL 3: JP-A-2008-067849

PTL 4: JP-A-2012-217686

Summary of Invention

Technical Problem

[0004] However, in order to help standing actions in a more stable state, there is a demand for standing actions performed in accordance with the seating posture of persons in need of assistance and the physical characteristics of persons in need of assistance.

[0005] An object of the present invention is to provide an assistant robot capable of performing standing actions in accordance with the seating posture of persons in need of assistance and the physical characteristics of persons in need of assistance. In addition, the object of the present invention is to provide an assistant robot capable of performing the standing actions using a simple constitution.

Solution to Problem

[0006] An assistant robot according to the present invention includes a base table; a holding section which holds a part of a body of a person in need of assistance and is capable of moving with respect to the base table at least in a vertical and inclined manner; an actuator which performs actions of the holding section with respect to the base table; a vertical movement operation section which is used by the person in need of assistance or an assistant to operate changes in a vertical-direction

location of the holding section; a first control section which controls the actuator in accordance with the operation of the vertical movement operation section and vertically moves the holding section; a memory section which memorizes in advance an action trajectory of the actuator for moving the holding section from a standard seating posture to a standard standing posture; a correction section which corrects the action trajectory of the actuator on the basis of a vertical-direction location of the holding section moved using the first control section and a vertical-direction location of the standard seating posture; and a second control section which controls the actuator on the basis of the corrected action trajectory and moves the holding section to a predetermined standing posture.

[0007] When the person in need of assistance or the assistant operates the vertical movement operation section, it becomes possible to move the location of the holding section to an arbitrary location while the person in need of assistance is in a seating position. In addition, the action trajectory of the actuator for moving to a predetermined standing posture is corrected in accordance with the vertical-direction location of the moved holding section. That is, the starting location at which the person in need of assistance moves to a standing posture is freely determined in accordance with the seating height of the person in need of assistance and the physical characteristics of the person in need of assistance. Particularly, since the starting location is freely determined at an arbitrary location by the operation of the person in need of assistance or an assistant, operability becomes favorable, and standing actions are stably performed.

[0008] Another assistant robot according to the present invention includes a base table; a holding base section which is capable of moving with respect to the base table at least in a vertical manner; and a holding section which is provided so as to be attachable to and detachable from the holding base section, holds a part of a body of a person in need of assistance, and is an attachment that is formed in accordance with physical characteristics of the person in need of assistance. Since an attachment that is attachable to and detachable from the holding base section is used as the holding section, an appropriate holding section in accordance with the physical characteristics of a person in need of assistance is applied. As a result, stable standing actions are performed.

[0009] In addition, still another assistant robot according to the present invention includes a base table; a holding base section which is capable of moving with respect to the base table at least in a vertical manner; a holding section which holds a part of a body of a person in need of assistance and is coupled using a cam mechanism so as to be capable of moving with respect to the holding base section in a forward, backward, and inclined manner; a first actuator which moves the holding base section with respect to the base table in a vertical manner; and a second actuator which moves the holding section with

respect to the holding base section in a forward, backward, and inclined manner. The holding section is moved in a forward, backward, and inclined manner using a simple constitution.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a view of a first embodiment of an assistant robot according to the present invention seen from the right side.

[Fig. 2] Fig. 2 is a view of an outline of an internal structure of the assistant robot in a stretched state illustrated in Fig. 1 seen from the right side.

[Fig. 3] Fig. 3 is a view of the outline of the internal structure of the assistant robot in the stretched state illustrated in Fig. 1 seen from the back.

[Fig. 4A] Fig. 4A is a view of a vicinity of a holding section illustrated in Fig. 1 seen from above.

[Fig. 4B] Fig. 4B is a view of the vicinity of the holding section in a state in which an elbow rest pad in the holding section illustrated in Fig. 4A has been moved seen from above.

[Fig. 5] Fig. 5 is a sectional view illustrating a detection device in the holding section illustrated in Fig. 1.

[Fig. 6] Fig. 6 is a functional block diagram regarding a control device illustrated in Fig. 1.

[Fig. 7A] Fig. 7A is a view of an appearance of the assistant robot supporting a seating person in need of assistance seen from the right side.

[Fig. 7B] Fig. 7B is a view of an appearance of the assistant robot supporting a standing person in need of assistance seen from the right side.

[Fig. 8] Fig. 8 is a view illustrating a standing action of the assistant robot.

[Fig. 9] Fig. 9 is a flowchart illustrating processes performed using a first control section illustrated in Fig. 6.

[Fig. 10] Fig. 10 is a flowchart illustrating processes performed using a correction section illustrated in Fig. 6.

[Fig. 11] Fig. 11 is a flowchart illustrating processes performed using a second control section illustrated in Fig. 6.

[Fig. 12] Fig. 12 is a view illustrating another standing action of the assistant robot.

[Fig. 13] Fig. 13 is a view illustrating still another standing action of the assistant robot.

[Fig. 14] Fig. 14 is a view of the assistant robot in which another holding section is mounted seen from the right side.

[Fig. 15A] Fig. 15A is a view of a vicinity of another holding section illustrated in Fig. 14 seen from above.

[Fig. 15B] Fig. 15B is a view of the vicinity of the holding section in a state in which a gap between right and left armpit grip sections in another holding section illustrated in Fig. 14 has been changed seen

from above.

[Fig. 16] Fig. 16 is a view of the assistant robot in which a holding section in which a cam mechanism is used is mounted seen from the right side.

[Fig. 17] Fig. 17 is a view of constituent components of the cam mechanism illustrated in Fig. 16 seen from above.

[Fig. 18] Fig. 18 is a partial sectional view of a view of a part of the assistant robot of Fig. 16 seen from the right side.

[Fig. 19] Fig. 19 is a view of a part of the assistant robot in a state in which the holding section has been moved seen from the right side.

[Fig. 20] Fig. 20 is a partial sectional view of a view of a part of the assistant robot of Fig. 19 seen from the right side.

[Fig. 21] Fig. 21 is a view of a part of the assistant robot in a state in which a part of a cam groove has been used seen from the right side.

Description of Embodiments

(1. Constitution of assistant robot)

[0011] Hereinafter, an embodiment of an assistant robot according to the present invention will be described. An assistant robot 10 supports a part (for example, the upper body) of the body of a person in need of assistance M1 and helps standing and seating. As illustrated in Fig. 1 to 3, the assistant robot 10 includes a base section 11, an actuator 12, a holding section 13, handles (gripping sections) 14, an operation device 15, a storage device (memory section) 16, and a control device 17. Hereinafter, the structure of the assistant robot 10 (a constitution excluding the storage device 16 and the control device 17) will be described with reference to Figs. 1 to 5. In addition, in the following description, front, back, left, and right is set to be front, back, left, and right when the travelling direction of the assistant robot 10 is considered as forward.

[0012] The base section 11 includes a base table 21, a base section cover 22, and a riding plate 23. The base table 21 is formed in a substantial U shape so as to be open backwards (the left direction in Fig. 1) when seen in a plan. Specifically, the base table 21 includes right and left frames 21a and 21b and a coupling frame 21c that couples end portions (the front end portion in the present embodiment (the right direction in Figs. 1 and 2)) of the right and left frames 21a and 21b. The right and left frames 21a and 21b are disposed at a gap necessary for the person in need of assistance M1 to enter the assistant robot.

[0013] Right and left back wheels 21d and 21e are respectively provided at the back end portions of the right and left frames 21a and 21b. Meanwhile, the right and left back wheels 21d and 21e may be respectively driven using a motor. Right and left front wheels 21h and 21i are respectively provided at the front end portions of the

right and left frames 21a and 21b. The right and left front wheels 21h and 21i can be rotated in accordance with the travelling direction of the assistant robot 10.

[0014] As illustrated in Fig. 1, the base section cover 22 is a cover that covers the base table 21 from above. The base section cover 22 is, similar to the base table 21, formed in a substantial U shape so as to be open backwards when seen in a plan. As illustrated in Figs. 2 and 3, the riding plate 23 is provided at the U-shaped opening portion of the base table 21. When the person in need of assistance M1 rides on the riding plate 23, the assistant robot 10 functions as a towing vehicle. In addition, the riding plate 23 can be set into a standing state as illustrated using a two-dot-dashed line in Fig. 2. In this case, the assistant robot 10 functions as a wheeled walker.

[0015] As illustrated in Figs. 2 and 3, the actuator 12 (30) includes a slide section 31 and a tilting section 32. The slide section 31 moves the holding section 13 with respect to the base table 21 in a vertical manner. The tilting section 32 moves the holding section 13 with respect to the base table 21 in an inclined manner.

[0016] The slide section 31 (40) includes right and left slide sections 41 and 42. As illustrated in Fig. 3, the left slide section 41 includes a slide base section 41a, a first slide section 41b, and a second slide section 41c. A base section of the left slide section 41 is mounted in the left frame 21a of the base table 21. That is, the slide base section 41a is mounted so as to be inclined forwards at a predetermined angle (for example, 80 degrees) with respect to the base table 21. The first slide section 41b is constituted so as to slide in the longitudinal direction (axis movement direction) with respect to the slide base section 41a and be almost stored in the slide base section 41a when the first slide section contracts. The second slide section 41c is constituted so as to slide in the longitudinal direction (axis movement direction) with respect to the first slide section 41b and be almost stored in the first slide section 41b when the second slide section contracts.

[0017] An arm section 43 (holding base section) which is provided so as to extend backwards is mounted in the upper end of the second slide section 41c. In the present embodiment, the arm section 43 intersects the longitudinal direction of the left slide section 41. The holding section 13 is mounted in the front end portion of the arm section 43 so as to be turning.

[0018] Furthermore, the slide section 31 includes a driving motor 45 (a vertical movement actuator or a first actuator) that slides the first and second slide sections 41b and 41c. The driving motor 45 is constituted so that the power of the driving motor is transferred to a second belt 48 through a speed change mechanism 46 and a first belt 47. The second belt 48 is hung at a pulley 48a and a pulley 48b. The pulley 48a is mounted in the lower end portion of the slide base section 41a so as to be capable of rotating. The pulley 48b is mounted in the upper end portion of the slide base section 41a so as to

be capable of rotating. The lower end portion of the first slide section 41b is fixed to the second belt 48.

[0019] A third belt 49 is hung at a pulley 49a and a pulley 49b. The pulley 49a is mounted in the lower end portion of the first slide section 41b so as to be capable of rotating. The pulley 49b is mounted in the upper end portion of the first slide section 41b so as to be capable of rotating. A lower end portion 41c1 of the second slide section 41c is fixed to one side of the third belt 49. An upper end portion 41a1 of the slide base section 41a is fixed to the other side of the third belt 49.

[0020] The left slide section 41 includes a slide cover 41d (illustrated in Fig. 1) that covers the first slide section 41b and the second slide section 41c. The slide cover 41d is formed in a tubular shape. The slide cover 41d may be constituted of one tubular body or may be constituted of a two-stage slide in which two tubular bodies slide.

[0021] As illustrated in Figs. 2 and 3, the right slide section 42 includes, similar to the left slide section 41, a slide base section 42a, a first slide section 42b, and a second slide section 42c. The base section of the right slide section 42 is mounted in the right frame 21b of the base table 21. An arm section 44 (holding base section) which is provided so as to extend backwards is mounted in the upper end of the second slide section 42c. The holding section 13 is mounted in the front end portion of the arm section 44 so as to be capable of turning.

[0022] Furthermore, the output of the driving motor 45 is transferred to a second belt 52 through the speed change mechanism 46 and a first belt 51. The second belt 52 is hung at a pulley 52a and a pulley 52b. The pulley 52a is mounted in the lower end portion of the slide base section 42a so as to be capable of rotating. The pulley 52b is mounted in the upper end portion of the slide base section 42a so as to be capable of rotating. The lower end portion of the first slide section 42b is fixed to the second belt 52.

[0023] A third belt 53 is hung at a pulley 53a and a pulley 53b. The pulley 53a is mounted in the lower end portion of the first slide section 42b so as to be capable of rotating. The pulley 53b is mounted in the upper end portion of the first slide section 42b so as to be capable of rotating. A lower end portion 42c1 of the second slide section 42c is fixed to one side of the third belt 53. An upper end portion 42a1 of the slide base section 42a is fixed to the other side of the third belt 53.

[0024] The right slide section 42 includes a slide cover 42d (illustrated in Fig. 1) that covers the first slide section 42b and the second slide section 42c. The slide cover 42d is constituted in the same manner as the slide cover 41d.

[0025] When the driving motor 45 is driven in a positive direction, the second belt 48 is rotated, and the first slide section 41b stretches in the axis movement direction with respect to the slide base section 41a. At the same time, the third belt 49 is rotated in accordance with the lifting of the first slide section 41b, and the second slide section

41c stretches in the axis movement direction with respect to the first slide section 41b. The stretching action of the right slide section 42 is also the same as that of the left slide section 41.

[0026] On the other hand, when the driving motor 45 is driven in a reverse direction, the second belt 48 is rotated in a direction opposite to that during stretching, and the first slide section 41b contracts in the axis movement direction with respect to the slide base section 41a. At the same time, the third belt 49 is rotated in a direction opposite to that during stretching in accordance with the lowering of the first slide section 41b, and the second slide section 41c contracts in the axis movement direction with respect to the first slide section 41b. The contraction action of the right slide section 42 is also the same as that of the left slide section 41. Therefore, the arm sections 43 and 44 and the holding section 13 move with respect to the base table 21 in a vertical manner. Meanwhile, as the slide section 31, a ball screw or the like can also be used in addition to a belt.

[0027] The tilting section 32 includes right and left tilting sections 32a and 32b. The left tilting section 32a includes a driving motor 32a1 (tilting actuator), a transformation mechanism 32a2, and an output rod 32a3. The transformation mechanism 32a2 is embedded with, for example, a ball screw and transforms the rotation output of the driving motor 32a1 to a linear movement and outputs the linear movement to the output rod 32a3. The output rod 32a3 advances and retracts in the axis direction with respect to the transformation mechanism 32a2. The driving motor 32a1 and the transformation mechanism 32a2 are mounted in the lower end portion of the second slide section 41c. The right tilting section 32a is mounted so as to be capable of moving with respect to the second slide section 41c and the arm section 43 in an inclined manner. The output end of the output rod 32a3 is mounted in the front end portion of the holding section 13 so as to be capable of moving in an inclined manner.

[0028] The right tilting section 32b includes, similar to the left tilting section 32a, a driving motor 32b1 (tilting actuator), a transformation mechanism 32b2, and an output rod 32b3. The driving motor 32b1 and the transformation mechanism 32b2 are mounted in the lower end portion of the second slide section 42c. The right tilting section 32b is mounted so as to be capable of moving with respect to the second slide section 42c and the arm section 44 in an inclined manner. The output end of the output rod 32b3 is mounted in the front end portion of the holding section 13 so as to be capable of moving in an inclined manner.

[0029] When the driving motor 32a1 is driven in a positive direction, the output rod 32a3 advances (stretches) in an output direction. At the same time, when the driving motor 32b1 is driven in a positive direction, the output rod 32b3 advances (stretches) in an output direction. As a result, the holding section 13 rotates (is inclined backwards) around a rotation axis A1 counterclockwise (in Figs. 1 and 2). On the other hand, when the driving motor

32a1 is driven in the reverse direction, the output rod 32a3 retracts (contracts). At the same time, when the driving motor 32b1 is driven in a positive direction, the output rod 32b3 retracts (contracts). As a result, the holding section 13 rotates (is inclined forwards) around the rotation axis A1 clockwise (in Figs. 1 and 2). Therefore, the holding section 13 moves with respect to the base table 21 and the arm sections 43 and 44 in an inclined manner.

[0030] The holding section 13 is capable of moving with respect to the base table 21 at least in a vertical and inclined manner. In addition, the holding section 13 is capable of moving with respect to the arm sections 43 and 44 in an inclined manner. Furthermore, the holding section 13 is an attachment that is attachable to and detachable from (exchangeable) the arm sections 43 and 44. That is, the holding section 13 is formed in accordance with the physical characteristics of the person in need of assistance M1. The holding section 13 suitable for the person in need of assistance M1 using the assistant robot 10 is mounted in the arm sections 43 and 44.

[0031] The back end portion of the holding section 13 is mounted so as to be capable of turning around the rotation axis A1 of the arm sections 43 and 44. The front end portion of the holding section 13 is adjusted to a predetermined angle with respect to the horizontal surface using the tilting section 32 and is supported at that location. The holding section 13 holds a part (for example, the upper body) of the body of the person in need of assistance M1 and helps standing, seating, and walking (moving).

[0032] The holding section 13 is a member that supports the upper body when, for example, the holding section faces the person in need of assistance M1 during the standing action and the seating action of the person in need of assistance M1. As illustrated in Fig. 4A, the holding section 13 is formed in a substantial U shape so as to be open backwards (in the downward direction in Fig. 4A) when seen in a plan. The holding section 13 is constituted in a state in which two plate members 61 and 62 (holding section main bodies or attachment main bodies) that are formed in a substantial U shape when seen in a plan are stacked one on the other. As illustrated in Fig. 5, a detection device 63 that detects the distribution of weight of the person in need of assistance M1 is provided between the plate member 61 and the plate member 62.

[0033] The detection device 63 is constituted of multiple pressure sensors 63a. In the present embodiment, the pressure sensors 63a are disposed at four corner portions of the holding section 13. Two of the pressure sensors 63a are provided on the right side of the detection device in the forward-and-backward direction (the right-and-left direction in Fig. 5) of the person in need of assistance M1, and the remaining two pressure sensors are provided on the left side in the forward-and-backward direction. The pressure sensors 63a provided ahead of the person in need of assistance M1 are front-side pres-

sure sensors 63af. The pressure sensors 63a provided behind the person in need of assistance M1 are back-side pressure sensors 63ar. The pressure sensors 63a are sensors that detect the distortion amounts of elastic bodies which change due to the change of loads as voltage changes, semiconductor-type pressure sensors in which, when a pressure is applied to a silicon chip, the gauge resistance changes in accordance with bending and is transformed to electrical signals, or the like. Meanwhile, the detection device 63 may be constituted of a planar pressure sensor.

[0034] As illustrated in Fig. 4A, a pair of elbow rest pads 64 and 64 (elbow rest sections) is provided at the back end portion of the upper surface of the holding section 13. A pair of handles 14 and 14 (gripping sections) is provided at the front end portion of the upper surface of the holding section 13. The person in need of assistance M1 respectively grips the handles 14 and 14 with the right and left hands.

[0035] As illustrated in Fig. 4B, the right and left elbow rest pads 64 and 64 are respectively provided in the plate member 61 (the holding section main body) so that the gap therebetween can be changed in the right-and-left direction of the person in need of assistance M1. Furthermore, the right and left elbow rest pads 64 and 64 are respectively provided so that the gaps with the handles 14 and 14 can be changed in the forward-and-backward direction. For example, the right and left elbow rest pads 64 and 64 may be attachable to and detachable from the plate member 61, and a mechanism that is guided so as to become capable of moving in the forward-and-backward direction and in the right-and-left direction may be employed.

[0036] The locations of the right and left elbow rest pads 64 and 64 are appropriately adjusted in accordance with the physical characteristics of the person in need of assistance M1. Therefore, the person in need of assistance M1 is maintained in a comfortable posture, and the person in need of assistance M1 is able to easily stabilize the posture when the person in need of assistance M1 acts to be in a standing posture from a seating posture.

[0037] A trunk detection switch 66 (trunk detector) is provided in the center of the holding section 13 in the forward-and-backward direction and in the right-and-left direction. The trunk detection switch 66 protrudes upwards more than the upper surface of the plate member 61 and detects contact with the trunk of the person in need of assistance M1.

[0038] The operation device 15 is provided in the front end portion of the upper surface of the holding section 13. The operation device 15 includes a display section 15a that displays images and operation sections 15b that receive input operations from a user (an assistant or the person in need of assistance M1). The display section 15a is constituted of a liquid crystal display and displays an image for selecting the action modes of the assistant robot 10 and the like. The operation section 15b includes cursor keys used to move a cursor in upward, downward,

right, and left directions, a cancel key used to cancel inputs, determination keys used to determine selection contents, and the like and is constituted so that commanders can be input from users through the keys.

[0039] The operation device 15 has at least a function of a vertical movement operation section 15c which enables the person in need of assistance M1 or an assistant to operate changes of the vertical-direction location of the holding section 13, a function of a height acquisition section 15d which acquires the height of the person in need of assistance M1, and a function of a standing start switch 15e. The vertical movement operation section 15c, the height acquisition section 15d, and the standing start switch 15e may be displayed on the display section 15a. Meanwhile, the operation device 15 has a display function of the display section 15a and an input function of the operation section 15b and may be constituted of a touch panel used to operate devices by pressing displays on screens.

[0040] As illustrated in Fig. 1, the lower surface of the holding section 13 is mounted so that a cover 65 faces downwards. The cover 65 is formed in a plate shape or a fan shape and shields a void between the holding section 13 and the arm section 43 (or the arm section 44).

(2. Description of storage device and control device)

[0041] The storage device 16 and the control device 17 will be described with reference to Figs. 6 to 13. The storage device 16 (memory section) stores the action trajectories of the driving motor 45 as a vertical movement actuator and the driving motors 32a1 and 32b1 as tilting actuators which are intended to transfer the holding section 13 from a standard seating posture to a standard standing posture in a case in which an imaginary person in need of assistance M1 corresponding to previously-specified standard physical characteristics is caused to stand from a seating state.

[0042] The standard seating posture of the holding section 13 refers to a posture of the holding section 13 supporting the front arms of the person in need of assistance M1 in a state in which an imaginary person in need of assistance M1 seats in a seating portion of a previously-specified height as illustrated in Fig. 7A. The standard standing posture refers to a posture of the holding section 13 supporting the front arms of the person in need of assistance M1 in a state in which the imaginary person in need of assistance M1 stands as illustrated in Fig. 7B.

[0043] In a case in which the assistant robot 10 is caused to act according to the action trajectories of the actuators 45, 32a1, and 32b1 which are memorized in the storage device 16, an action trajectory Tas1 of a shoulder of the person in need of assistance M1 is indicated by the broken line in Fig. 8. That is, the person in need of assistance M1 stands while being inclined forwards.

[0044] The control device 17 controls the driving motor 45 as a vertical movement actuator and the driving mo-

tors 32a1 and 32b1 as tilting actuators on the basis of diverse information. The control device 17 includes a first control section 17a, a correction section 17b, and a second control section 17c.

[0045] The first control section 17a determines the input of an operation to the vertical movement operation section 15c by the person in need of assistance M1 or an assistant as illustrated in Fig. 9 (S11). In a case in which an operation is input to the vertical movement operation section 15c, the first control section 17a controls the driving motor 45 as a vertical movement actuator in accordance with the vertical movement operation (S12).

[0046] Specifically, when the person in need of assistance M1 is in a seating state, the person in need of assistance M1 or an assistant operates to move the vertical movement operation section 15c upwards, the first control section 17a controls the driving motor 45 and moves the holding section 13 upwards. On the other hand, when the person in need of assistance M1 is in a seating state, the person in need of assistance M1 or an assistant operates to move the vertical movement operation section 15c downwards, the first control section 17a controls the driving motor 45 and moves the holding section 13 downwards.

[0047] That is, when the person in need of assistance M1 is in a seating state, the first control section 17a moves the holding section 13 so that the height of the holding section 13 matches the height of the front arms of the person in need of assistance M1. The height of the front arms of the person in need of assistance M1 in the seating state varies depending on the height of the seating portion and the physical characteristics of the person in need of assistance M1. Therefore, when the person in need of assistance M1 operates the vertical movement operation section 15c, the height of the holding section 13 is easily matched to the height of the front arms of the person in need of assistance M1.

[0048] The correction section 17b corrects the action trajectories which are memorized in the storage device 16 and serve as standards on the basis of the vertical-direction location of the holding section 13 moved using the first control section 17a and the height of the person in need of assistance M1. The correction section 17b acquires the vertical-direction location of the holding section 13 in a state of being acted using the first control section 17a as illustrated in Fig. 10 (S21). Next, the correction section 17b acquires the height of the person in need of assistance M1 which has been acquired using the height acquisition section 15d (S22) and acquires the action trajectories which are memorized in the storage device 16 (S23).

[0049] The correction section 17d corrects the action trajectories which are memorized in the storage device 16 on the basis of the acquired information. For example, as illustrated in Fig. 12, in a case in which the person in need of assistance M1 sits in a high seating portion and the height of the person in need of assistance M1 is the same as that of the person in need of assistance M1

having standard physical characteristics which are memorized in the storage device 16, an action trajectory Tas2 of the shoulder of the person in need of assistance M1 from the corrected action trajectory of the actuator becomes an action trajectory indicated by the solid line. Here, the broken line in Fig. 12 indicates the action trajectory Tas1 of the shoulder of the person in need of assistance M1 which is memorized in the storage device 16.

[0050] In addition, in a case in which the person in need of assistance M1 has a smaller body than the person in need of assistance M1 having standard physical characteristics, an action trajectory Tas3 of the shoulder of the person in need of assistance M1 from the corrected action trajectory of the actuator becomes an action trajectory indicated by the solid line in Fig. 13. The broken line in Fig. 13 indicates the action trajectory Tas1 of the shoulder of the person in need of assistance M1 which is memorized in the storage device 16.

[0051] A second control section 17e controls the driving motor 45 as a vertical movement actuator and the driving motors 32a1 and 32b1 as tilting actuators on the basis of the action trajectories of the actuator which have been corrected using the correction section 17d.

[0052] As illustrated in Fig. 11, the second control section 17e determines whether the standing start switch 15e is in an ON state (S31). When the standing start switch 15e is in an ON state, the second control section 17e determines whether the trunk detection switch 66 is in an ON state (S32). A state in which the trunk detection switch 66 is turned ON refers to a state in which the person in need of assistance M1 also clings to the trunk detection switch 66. When any of the above-described determinations is not satisfied, the second control section 17e repeats the processes up to S31 again. That is, since the second control section 17e performs a standing action in a case in which the trunk detection switch 66 is in an ON state, it is possible to realize the stable standing action of the person in need of assistance M1.

[0053] In a case in which the standing start switch 15e and the trunk detection switch 66 are in an ON state, the second control section 17e acquires the action trajectory of the actuator which has been corrected using the correction section 17d (S33). Subsequently, the second control section 17e acquires a variety of loads that are detected using the pressure sensors 63a (S34) and controls to cause the holding section to stand in accordance with the corrected action trajectory of the actuator and the loads. For example, in a case in which the person in need of assistance M1 is significantly inclined forwards, the second control section 17e controls to regulate the forward inclination of the person in need of assistance M1. In addition, in a case in which the person in need of assistance M1 is significantly inclined backwards, the second control section 17e controls to regulate the backward inclination of the person in need of assistance M1. The second control section 17e repeats the processes of S34 and S35 until the holding section reaches the standing

location and terminates the processes in a case in which holding section has reached the standing location (S36).

[0054] According to what has been described above, when the person in need of assistance M1 or an assistant operates the vertical movement operation section 15c, it becomes possible to move the location of the holding section 13 to an arbitrary location while the person in need of assistance M1 is in a seating position. In accordance with the vertical-direction location of the moved holding section 13, the action trajectory of the actuator for moving to a predetermined standing posture is corrected. That is, the starting location at which the holding section is transferred to the standing posture is freely determined in accordance with the seating height of the person in need of assistance M1 and the physical characteristics of the person in need of assistance M1. Particularly, since the starting location is freely determined at an arbitrary location by the operation by the person in need of assistance M1 or an assistant, operability becomes favorable, and standing actions are stably performed. The physical characteristics mentioned herein include the length of the trunk of the person in need of assistance M1, the size of the hip, the upper arm length, and the like. Furthermore, the action trajectories of the actuator are corrected in accordance with the height of the person in need of assistance M1. Therefore, the assistant robot 10 is capable of performing appropriate standing actions in accordance with the physical characteristics of the person in need of assistance M1.

[0055] Furthermore, the elbow rest pads 64 and 64 are provided so that the gap therebetween can be changed in the right-and-left direction of the person in need of assistance M1 and the gaps with the handles 14 and 14 can be changed in the forward-and-backward direction. That is, the holding section 13 is operated in accordance with the physical characteristics of the person in need of assistance M1. Therefore, the assistant robot 10 is capable of more reliably and stably performing the standing action of the person in need of assistance M1.

(3. Attachment)

[0056] As described above, the holding section 13 is an attachment that is attachable to and detachable from the arm sections 43 and 44. The holding section 13 including the elbow rest pads 64 and 64 and the handles 14 and 14 becomes exchangeable with a new holding section in accordance with the person in need of assistance M1.

[0057] Furthermore, in addition to the holding section 13 having the above-described structure, a holding section 113 illustrated in Figs. 14 to 15B is applicable. The person in need of assistance M1 holds the holding section 113 with the right and left armpits. The holding section 113, the holding section 113 is an attachment that is attachable to and detachable from the arm sections 43 and 44.

[0058] The holding section 113 includes a holding sec-

tion main body 166 on the upper surface of the plate member 61. The holding section main body 166 includes a central fixed section 166a that is fixed to the center of the plate member 61 and right and left armpit grip sections 166b and 166c. The right and left armpit grip sections 166b and 166c are capable of sliding with respect to the central fixed section 166a. That is, the shape of the holding section main body 166 is appropriately changed in accordance with the physical characteristics of the person in need of assistance M1.

[0059] As described above, since the holding sections 13 and 113 are attachments that are attachable to and detachable from the arm sections 43 and 44, an appropriate one of the holding sections 13 and 113 is applied in accordance with the physical characteristics of the person in need of assistance M1 and the disease conditions and the like of the person in need of assistance M1. As a result, stable standing actions are performed. The physical characteristics mentioned herein refer to the body type of the person in need of assistance M1 such as a large body or a small body.

(4. Cam mechanism)

[0060] In the above description, the holding sections 13 and 113 rotate around the rotation axis A1 with respect to the arm sections 43 and 44. Here, in a case in which the assistant robot 10 performs a standing action from a seating state with respect to the person in need of assistance M1, the assistant robot 10 desirably lifts while inclining forward the person in need of assistance M1. The assistant robot 10 having the above-described constitution is capable of lifting while inclining the person in need of assistance M1 forwards. Hereinafter, an assistant robot 200 capable of performing a larger forward inclination action using a cam mechanism will be described.

[0061] As illustrated in Figs. 16 to 18, the assistant robot 200 includes arm sections 243 and 244 (holding base sections) that are provided at the upper ends of the second slide sections 41c and 42c so as to extend forwards. The arm sections 243 and 244 couple the front end side of the arm sections 243 and 244 using a coupling section 245. Furthermore, each of the arm sections 243 and 244 includes two cam pins 243a and 243a or 244a and 244a that protrude outside to the right and the left.

[0062] A holding section 213 includes cam plates 266 and 267 that are fixed to the right and left parts on the lower surface of the plate member 62. The cam plates 266 and 267 couple the back end side of the cam plates 266 and 267 using a coupling section 268. Cam grooves 266a and 267a are formed in the cam plates 266 and 267. The cam grooves 266a and 267a are formed so as to have a linear front side and an arc back side. The cam pins 243a and 244a are inserted into the cam grooves 266a and 267a so as to be capable of moving along the cam grooves 266a and 267a. That is, the holding section 213 is coupled using cam mechanisms so as to be ca-

pable of moving with respect to the arm sections 243 and 244 in a forward, backward, and inclined manner.

[0063] Furthermore, the assistant robot 200 includes a linear movement actuator 232 (a second actuator). One end of the linear movement actuator 232 is provided in the coupling section 245 so as to be capable of moving in an inclined manner, and the other end of the linear movement actuator 232 is provided in the coupling section 268 so as to be capable of moving in an inclined manner.

[0064] The linear movement actuator 232 is controlled using the second control section 17e. As illustrated in Figs. 16 and 18, when the linear movement actuator 232 contracts from a state in which the linear movement actuator 232 is stretched, the holding section 213 becomes as illustrated in Figs. 19 and 20. That is, when the linear movement actuator 232 contracts, the holding section 213 is moved forwards due to the linear portions of the cam grooves 266a and 267a. Furthermore, the holding section 213 is inclined forwards due to the arc portions of the cam grooves 266a and 267a. Therefore, the holding section 213 is moved in a forward, backward, and inclined manner with respect to the arm sections 243 and 244 using one linear movement actuator 232. The above-described actions of the holding section 213 become possible using a simple constitution.

[0065] In addition, in a case in which the person in need of assistance M1 has a small body, as illustrated in Fig. 21, the second control section 17e does not use the full ranges of the cam grooves 266a and 267a and can also be set to use part of the cam grooves 266a and 267a. That is, the correction section 17b corrects the action trajectory of the actuator 232 so that the action ranges of the cam grooves 266a and 267a vary depending on the physical characteristics of the person in need of assistance M1. Therefore, appropriate forward, backward, and tilting is realized in accordance with the physical characteristics of the person in need of assistance M1.

Reference Signs List

[0066] 10, 200: assistant robot, 13, 113, 213: holding section, 14: handle (gripping section), 15c: vertical movement operation section, 15d: height acquisition section, 15e: standing start switch, 16: storage device (memory section), 17: control device, 17a: first control section, 17b: correction section, 17c: second control section, 17d: correction section, 17e: second control section, 21: base table, 31: slide section, 32: tilting section, 32a1, 32b1: driving motor (actuator), 43, 44, 243, 244: arm section (holding base section), 45: driving motor (first actuator), 61, 62: plate member (attachment main body), 64: elbow rest pad (elbow rest section), 66: trunk detection switch, 232: linear movement actuator (second actuator), M1: person in need of assistance

Claims

1. An assistant robot comprising:

a base table;
a holding section which holds a part of a body of a person in need of assistance and is capable of moving with respect to the base table at least in a vertical and inclined manner;
an actuator which performs actions of the holding section with respect to the base table;
a vertical movement operation section which is used by the person in need of assistance or an assistant to operate changes in a vertical-direction location of the holding section;
a first control section which controls the actuator in accordance with the operation of the vertical movement operation section and vertically moves the holding section;
a memory section which memorizes in advance an action trajectory of the actuator for moving the holding section from a standard seating posture to a standard standing posture;
a correction section which corrects the action trajectory of the actuator on the basis of a vertical-direction location of the holding section moved using the first control section and a vertical-direction location of the standard seating posture; and
a second control section which controls the actuator on the basis of the corrected action trajectory and moves the holding section to a predetermined standing posture.

2. The assistant robot according to Claim 1, wherein the assistant robot includes a height acquisition section which acquires a height of the person in need of assistance from the person in need of assistance or the assistant, the correction section corrects an action trajectory of the actuator on the basis of the vertical-direction location and a vertical-direction location of the standard seating posture and on the basis of the height and the standard standing posture, and the second control section moves the holding section to the predetermined standing posture in accordance with the height.

3. The assistant robot according to Claim 1 or 2, wherein the assistant robot includes a trunk detector which is provided in the holding section and detects contact of a trunk of the person in need of assistance, and the second control section moves the holding section to the predetermined standing posture in a case in which the trunk detector detects the contact of the trunk of the person in need of assistance.

4. The assistant robot according to any one of Claims 1 to 3,
wherein the assistant robot includes a holding base section which is capable of moving with respect to the base table at least in a vertical manner, and the holding section is provided so as to be attachable to and detachable from the holding base section, holds a part of the body of the person in need of assistance, and is an attachment that is formed in accordance with physical characteristics of the person in need of assistance.
5. The assistant robot according to Claim 4,
wherein the attachment includes
an attachment main body; and
right and left elbow rest sections and right and left gripping sections which are provided in the attachment main body,
the right and left elbow rest sections are respectively provided in the attachment main body so that a gap therebetween can be changed in a right-and-left direction of the person in need of assistance, and the right and left elbow rest sections and the right and left gripping sections are provided so that a gap therewith can be relatively changed in a forward-and-backward direction of the person in need of assistance.
6. The assistant robot according to any one of Claims 1 to 5,
wherein the assistant robot includes a holding base section which is capable of moving with respect to the base table at least in a vertical manner, and the holding section is coupled using a cam mechanism so as to be capable of moving with respect to the holding base section in a forward, backward, and inclined manner and moves with respect to the holding base section in a forward, backward, and inclined manner using one actuator.
7. The assistant robot according to Claim 6,
wherein the cam mechanism includes a cam groove that extends at least in the forward-and-backward direction, and
the correction section corrects the action trajectory of the actuator so that an action range of the cam groove varies depending on the physical characteristics of the person in need of assistance.
8. An assistant robot comprising:

a base table;
a holding base section which is capable of moving with respect to the base table at least in a vertical manner; and
a holding section which is provided so as to be attachable to and detachable from the holding base section, holds a part of a body of a person

in need of assistance, and is an attachment that is formed in accordance with physical characteristics of the person in need of assistance.

9. An assistant robot comprising:

a base table;
a holding base section which is capable of moving with respect to the base table at least in a vertical manner;
a holding section which holds a part of a body of a person in need of assistance and is coupled using a cam mechanism so as to be capable of moving with respect to the holding base section in a forward, backward, and inclined manner;
a first actuator which moves the holding base section with respect to the base table in a vertical manner; and
a second actuator which moves the holding section with respect to the holding base section in a forward, backward, and inclined manner.

Fig. 1

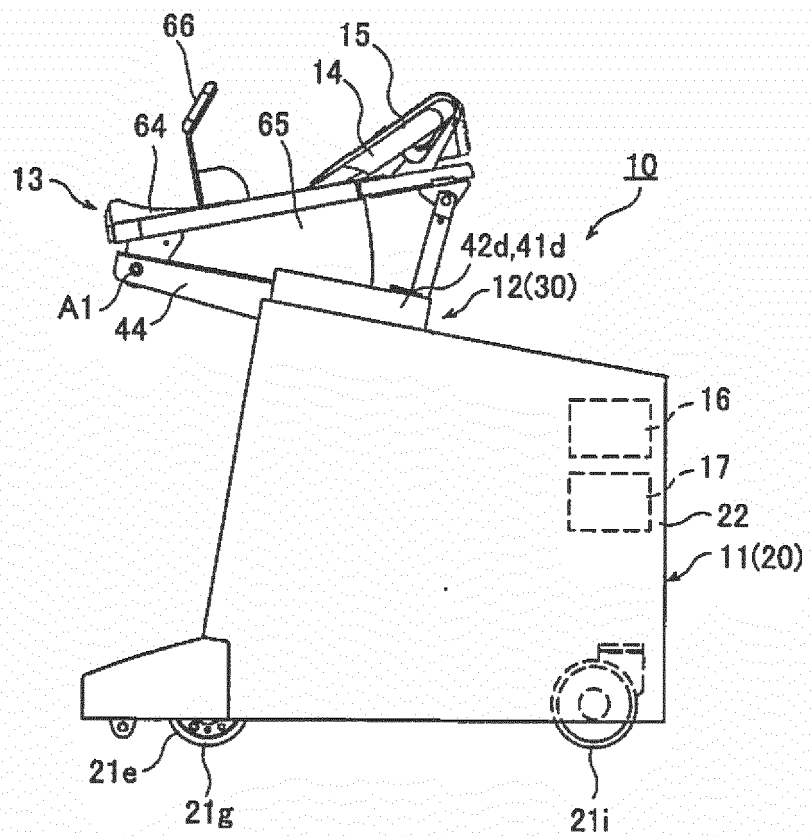


FIG. 2

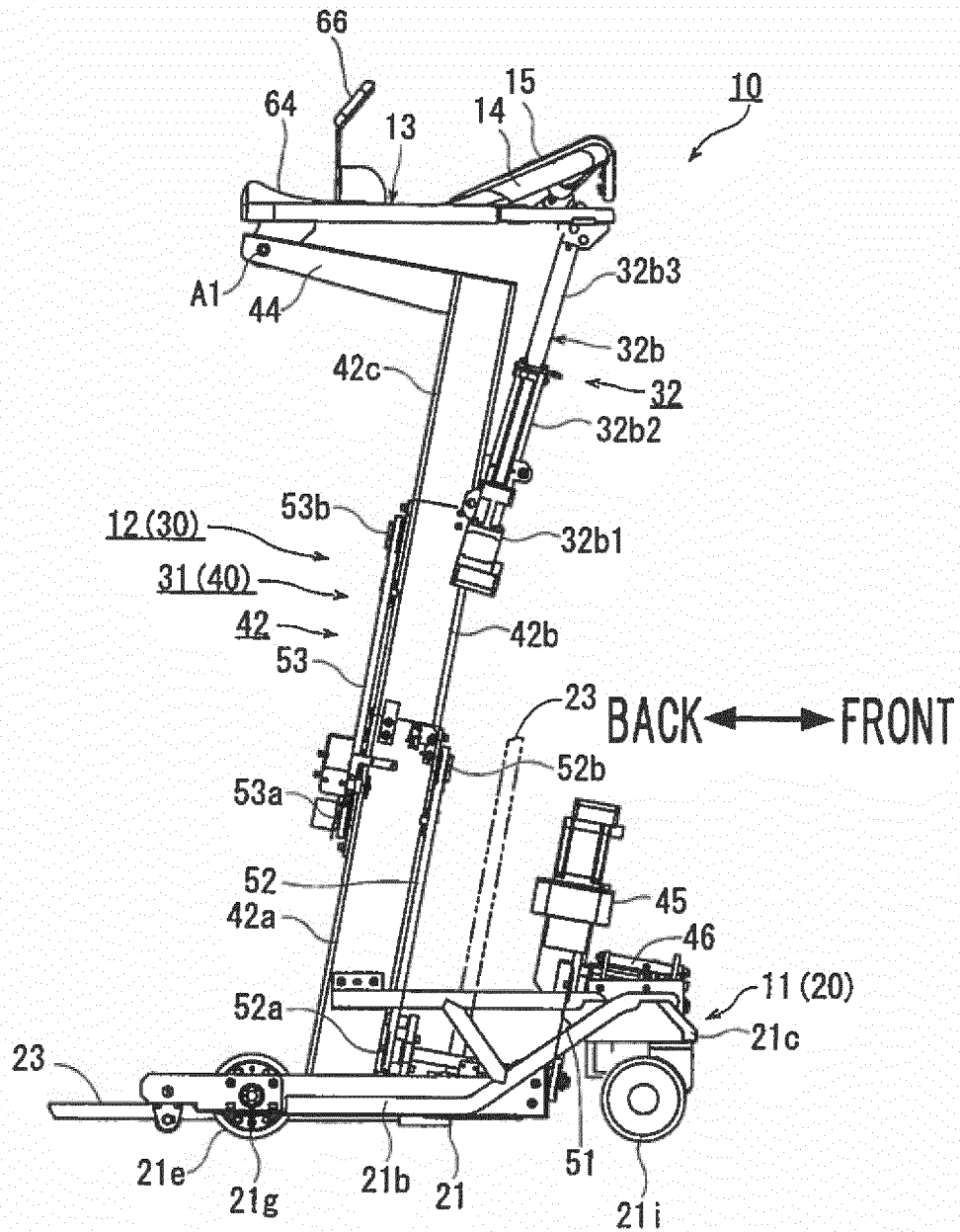


Fig. 3

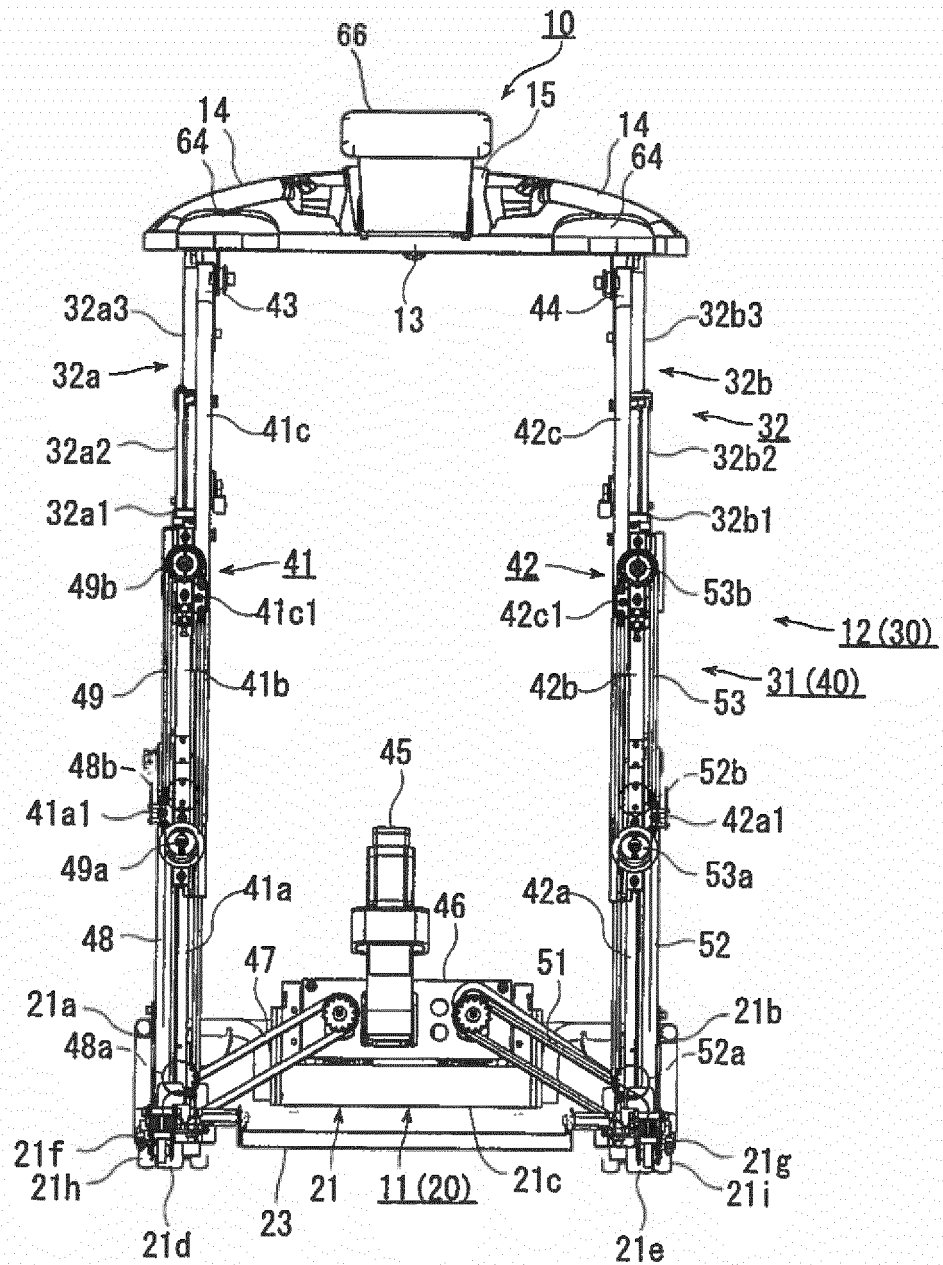


Fig. 4A

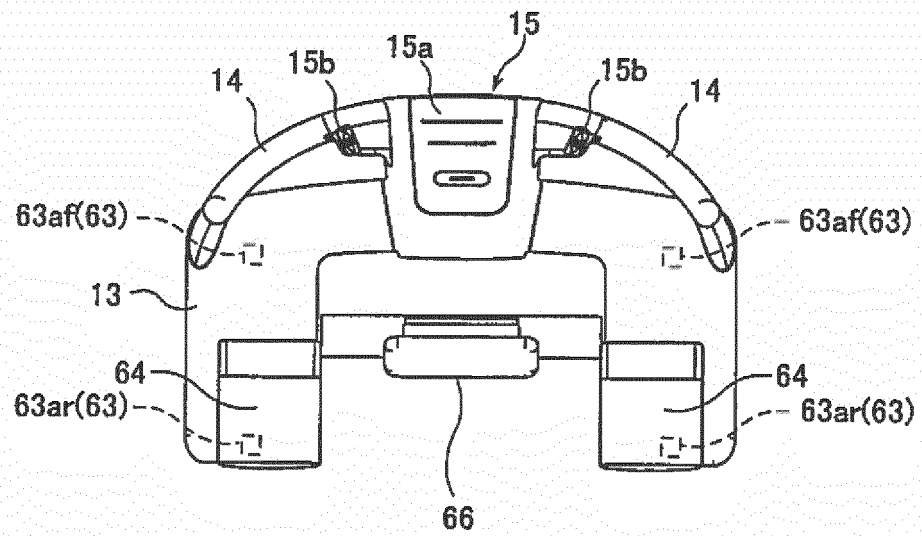


Fig. 4B

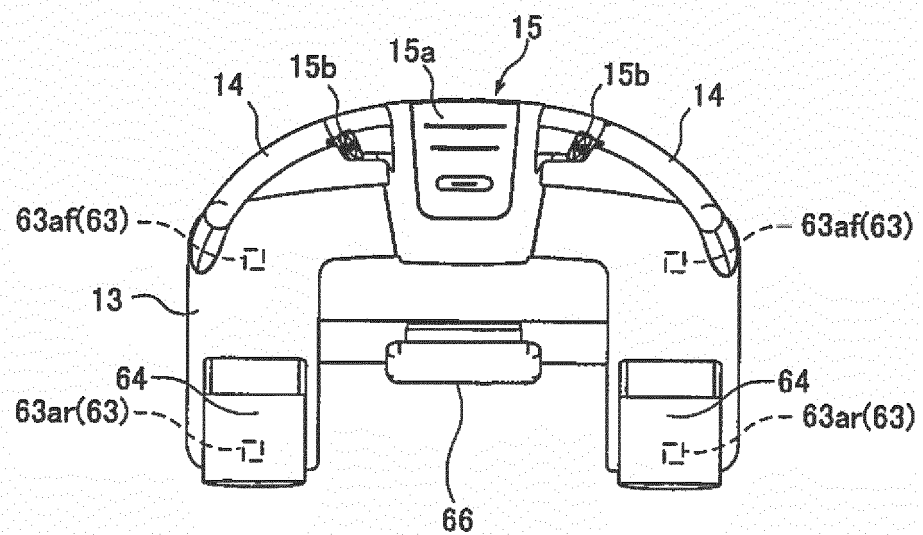


Fig. 5

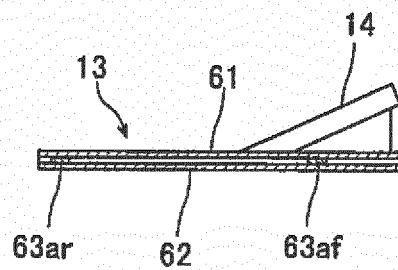


FIG. 6

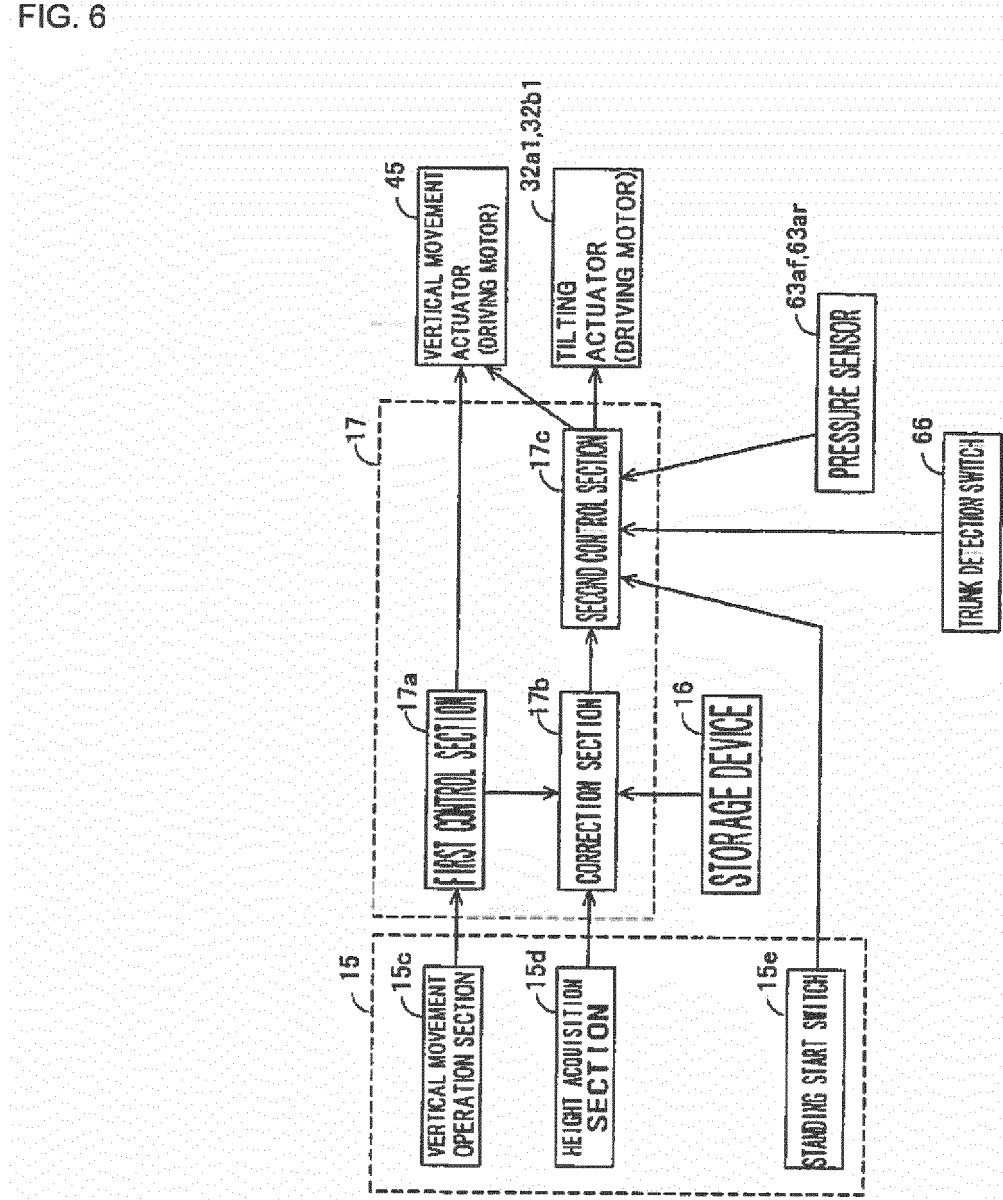


Fig. 7A

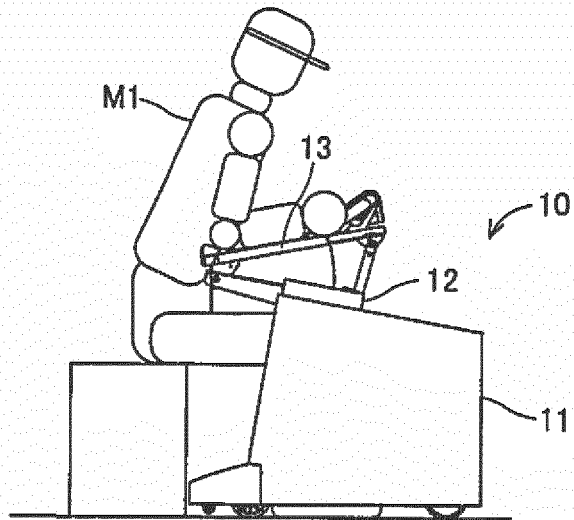


Fig. 7B

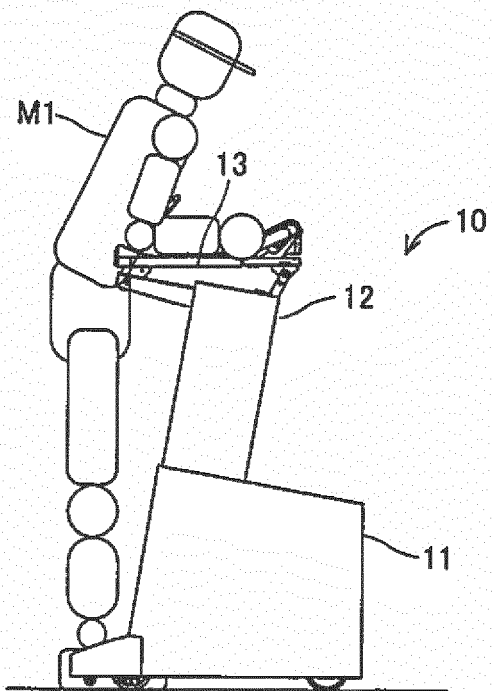


Fig. 8

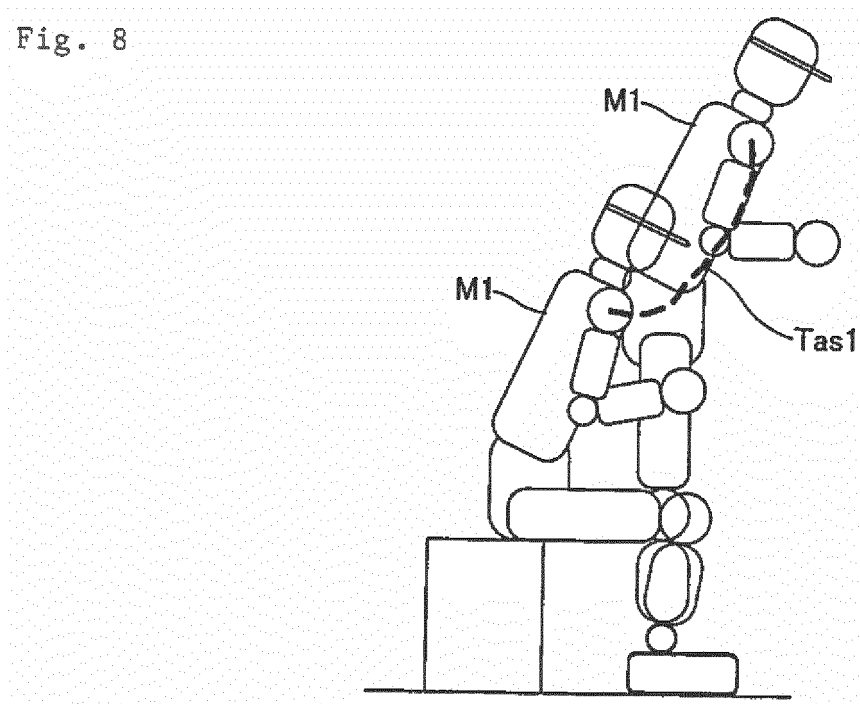


FIG. 9

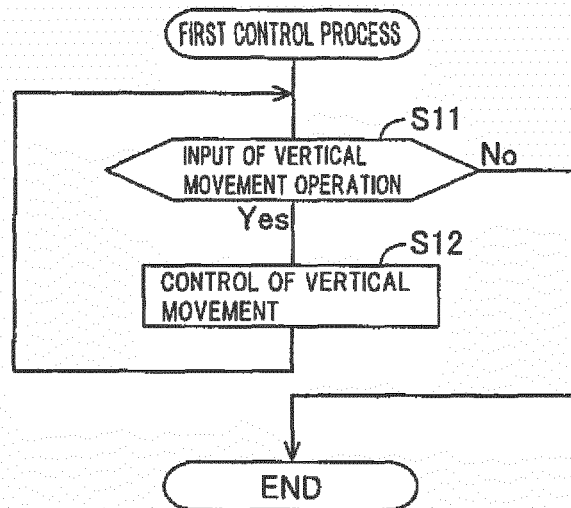


FIG. 10

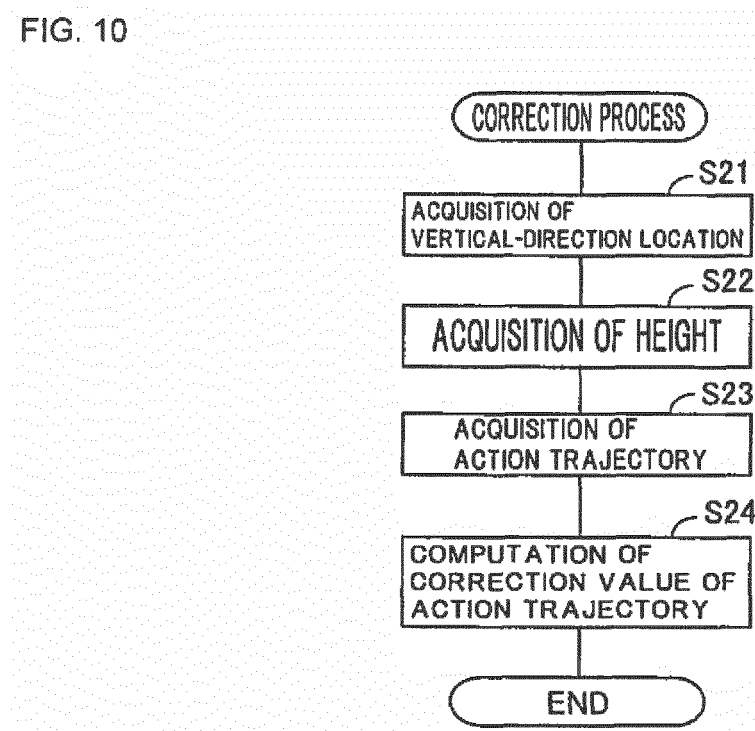


FIG. 11

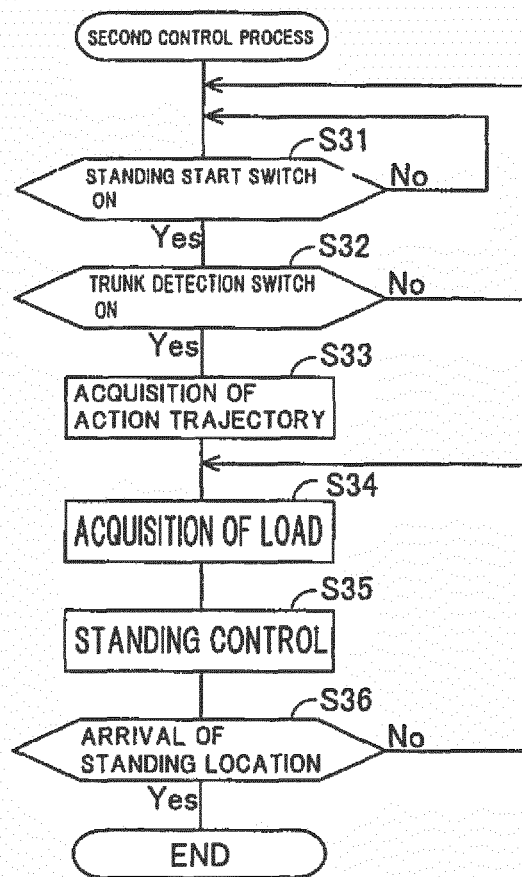


Fig. 12

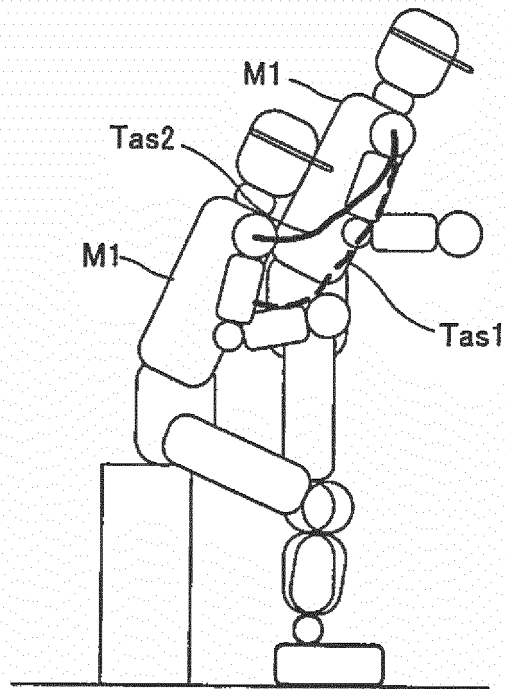


Fig. 13

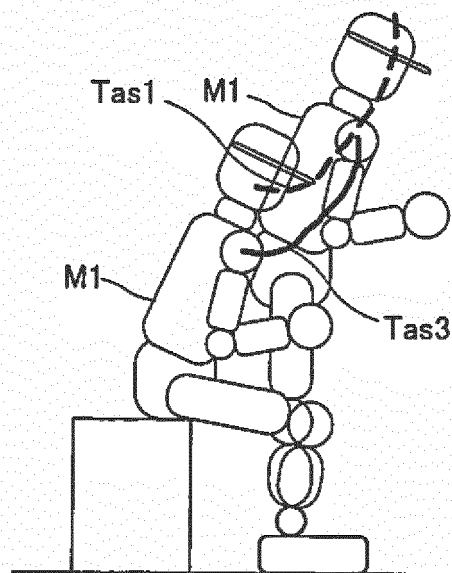


Fig. 14

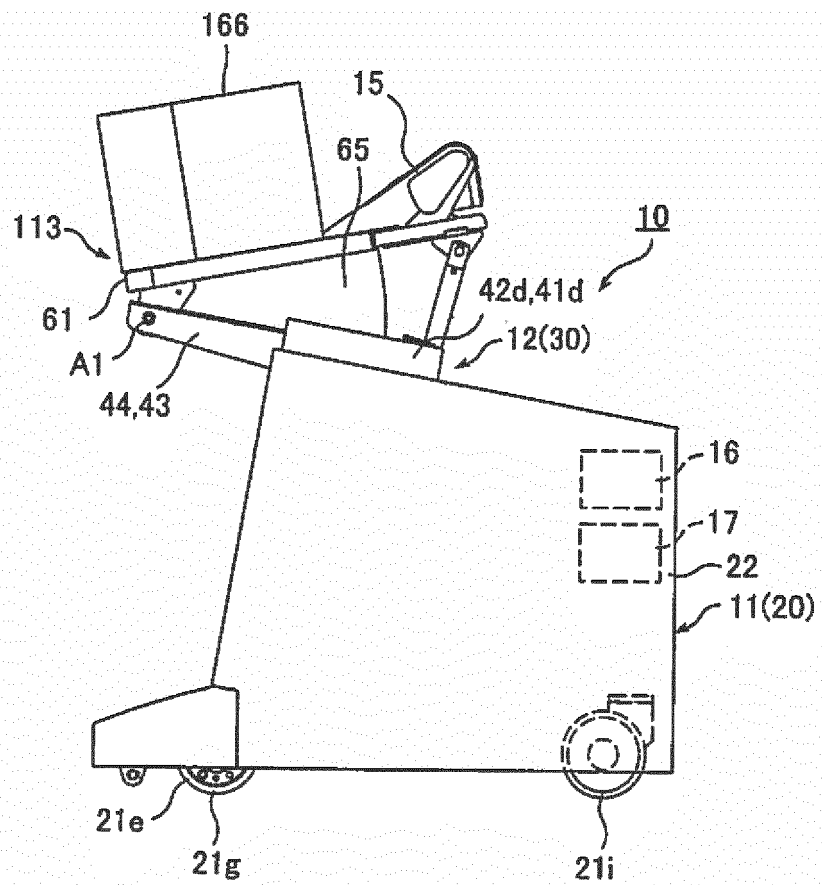


Fig. 15A

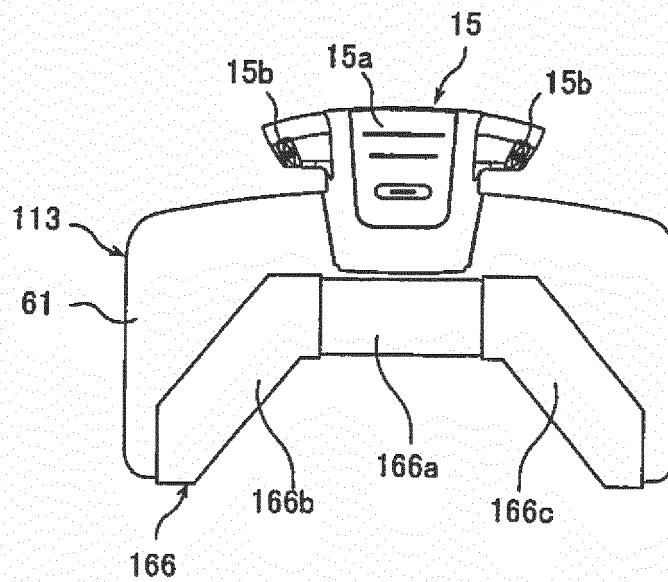


Fig. 15B

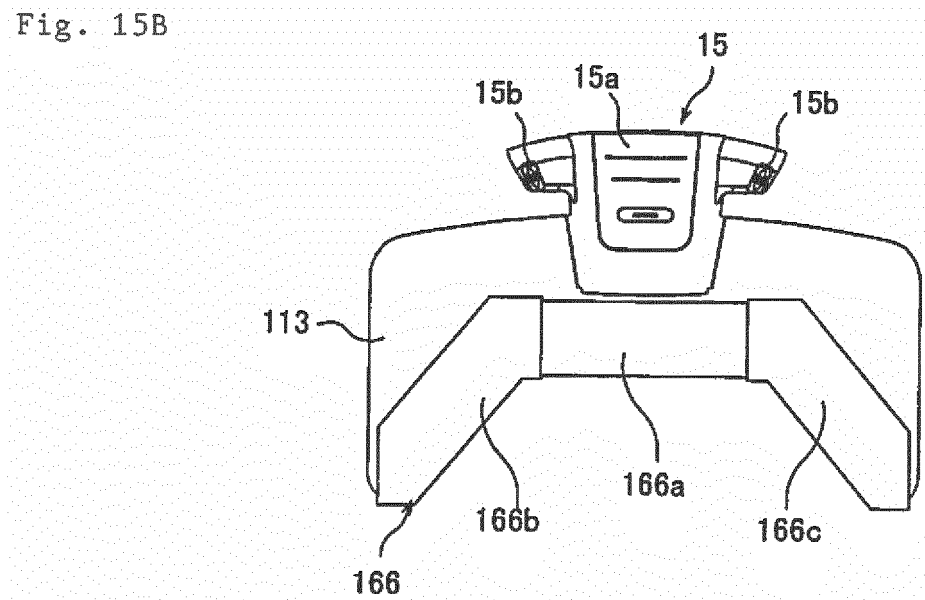


FIG. 16

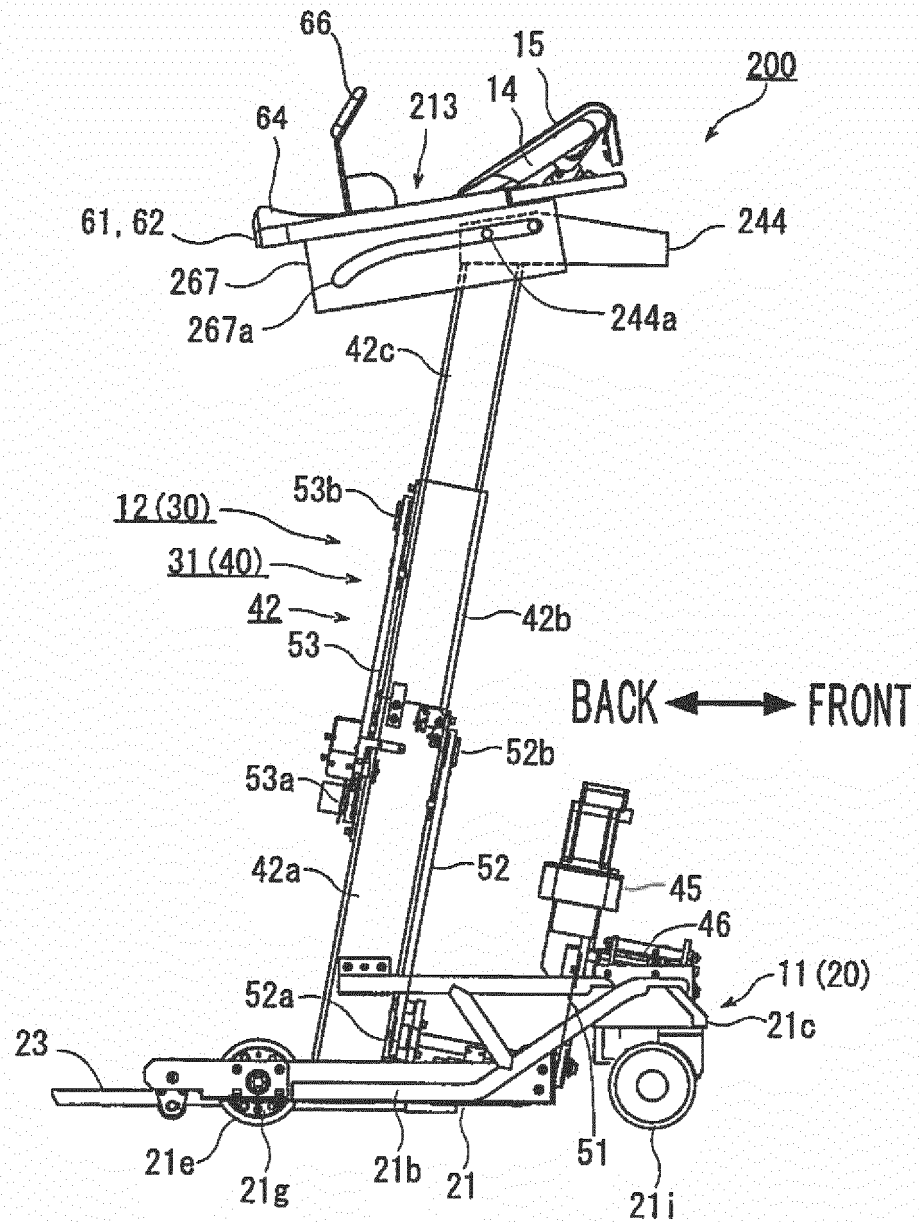


Fig. 17

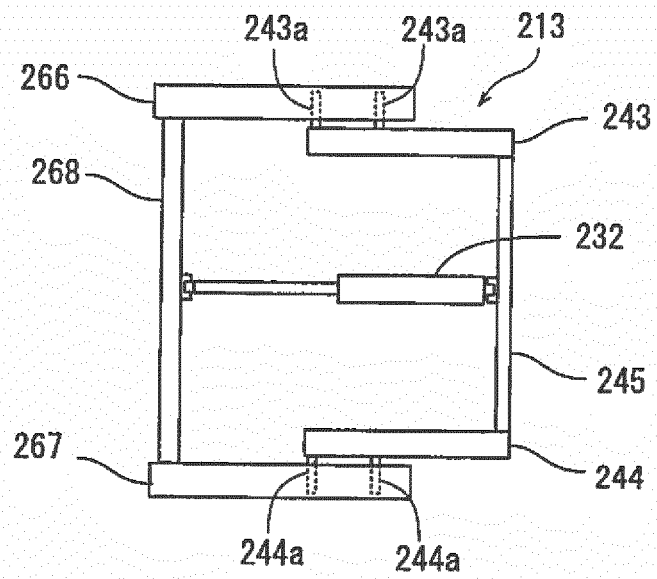


Fig. 18

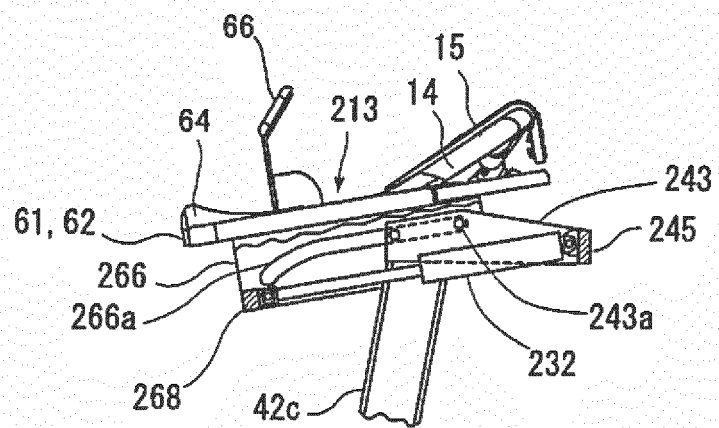


Fig. 19

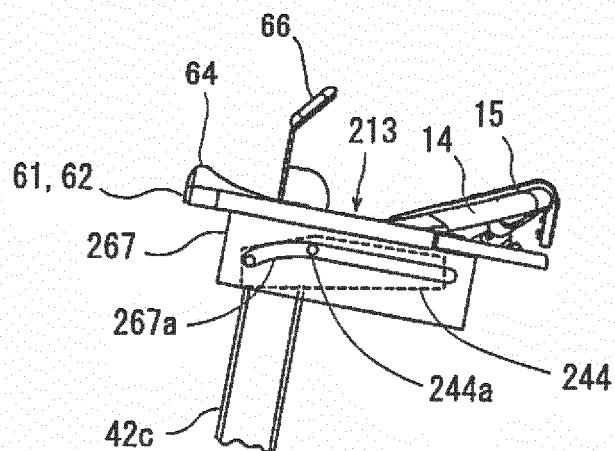


Fig. 20

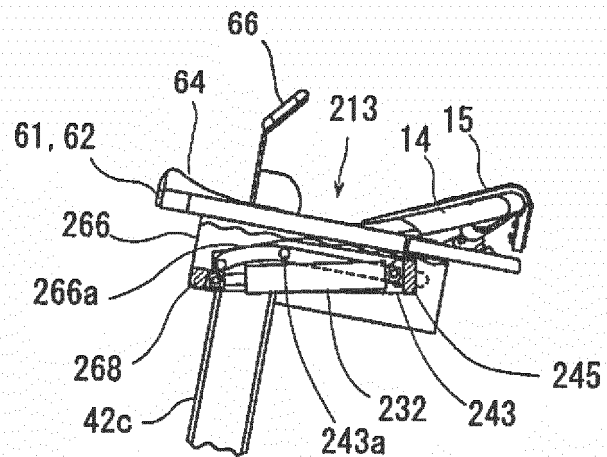
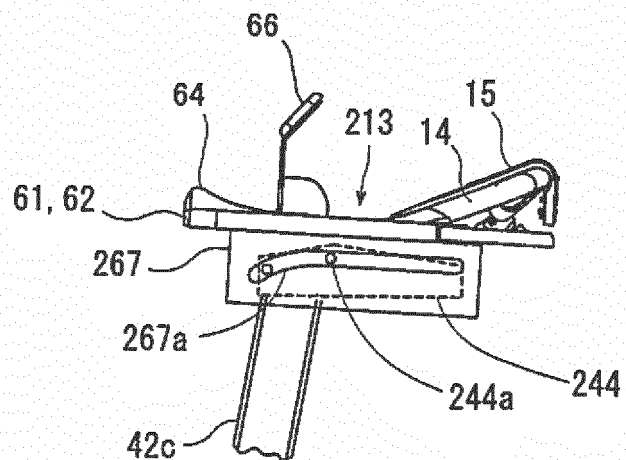


Fig. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/059268

A. CLASSIFICATION OF SUBJECT MATTER

A61G5/00(2006.01)i, A61H3/04(2006.01)i

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)

A61G5/00, A61H3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/118623 A1 (Fuji Machine Mfg. Co., Ltd.), 15 August 2013 (15.08.2013), entire text; all drawings (Family: none)	1-7
A	JP 2013-252258 A (Panasonic Corp.), 19 December 2013 (19.12.2013), entire text; all drawings (Family: none)	1-7
A	JP 2007-195814 A (Tokyo Metropolitan University), 09 August 2007 (09.08.2007), entire text; all drawings (Family: none)	1-7

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
28 April, 2014 (28.04.14)Date of mailing of the international search report
20 May, 2014 (20.05.14)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/059268

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2010-142562 A (Toyota Motor Corp.), 01 July 2010 (01.07.2010), entire text; all drawings (Family: none)	1-7
A	JP 2013-237407 A (Toyota Boshoku Corp.), 28 November 2013 (28.11.2013), paragraphs [0014] to [0024]; all drawings (Family: none)	1-2
A X	JP 2011-83364 A (Toyota Motor Corp.), 28 April 2011 (28.04.2011), entire text; all drawings (Family: none)	4-5 8
A	JP 4454460 B2 (Pigeon Corp.), 21 April 2010 (21.04.2010), paragraphs [0040] to [0049]; fig. 1, 7 (Family: none)	5
A Y	JP 2009-297463 A (TOTO Ltd.), 24 December 2009 (24.12.2009), paragraphs [0039] to [0043]; fig. 5 (Family: none)	6 9
Y	JP 3025292 B2 (Mazda Motor Corp.), 27 March 2000 (27.03.2000), column 4, lines 21 to 45; fig. 2 to 3 (Family: none)	9

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2012030077 A [0003]
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