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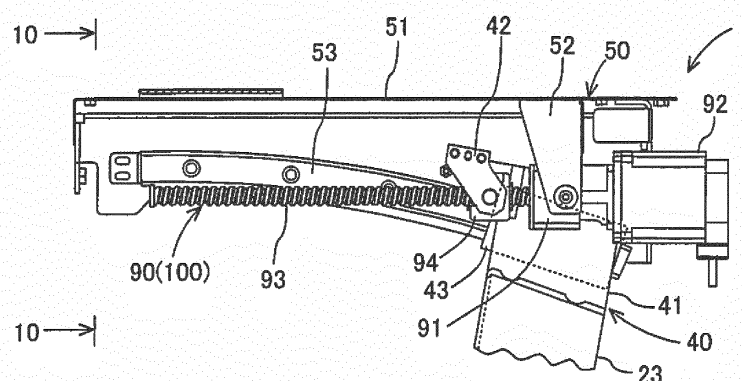
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(54) **ASSISTANCE ROBOT**

(57) An assistant robot in which a small-size actuator can be used is provided. One of a lifting and lowering section (40, 240, 340, or 440) and a holding section (50, 250, 350, or 450) includes guide paths (53, 253, 342, 343, and 451a) which guide the holding section (50, 250,

350, or 450) to move in a forward, backward, and inclined manner with respect to the lifting and lowering section (40, 240, 340, or 440). The other one includes a guided member (43, 243, 352, 353, 443, or 444) which moves along the guide path (53, 253, 342, 343, or 451a) .

Fig. 9



Description

Technical Field

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

Background Art

[0002] PTL 1 describes an assistant robot that assists the standing action of a person in need of assistance. Here, in order to stably transfer the person in need of assistance from a sitting posture to a stand-up posture, it is necessary to lift and move a holding section in a forward, backward, and inclined manner with respect to a base. Therefore, the assistant robot includes an arm section including multiple joints in order to enable the holding section which holds the person in need of assistance to lift and lower and move in a forward, backward, and inclined manner with respect to a base. The arm section includes a first joint that moves a first arm section in an inclined manner with respect to the base, a second joint that slides a second arm section with respect to the first arm section, and a third joint that moves the holding section in an inclined manner with respect to the second arm section.

Citation List

Patent Literature

[0003] PTL 1: Pamphlet of International Publication No. 2014/122751

Summary of Invention

Technical Problem

[0004] However, the first joint that moves the first arm section in an inclined manner with respect to the base is located at a location away from the holding section, and thus the moment generated due to the force that the holding section receives from the person in need of assistance becomes extremely great. Therefore, the size of an actuator for driving the first joint becomes large. That is, the size of the assistant robot becomes large as a whole.

[0005] An object of the present invention is to provide an assistant robot in which a small-size actuator can be used.

Solution to Problem

[0006] An assistant robot includes a base, a lifting and lowering section which lifts and lowers with respect to the base, a holding section which holds a part of a body of a person in need of assistance and moves in a forward, backward, and inclined manner with respect to the lifting

and lowering section, a lifting and lowering actuator which drives the lifting and lowering section to lift and lower with respect to the base, and a forward-and-backward movement actuator that drives the holding section in a forward, backward, and inclined manner with respect to the lifting and lowering section. One of the lifting and lowering section and the holding section includes a guide path which is formed to extend in a forward-and-backward direction and guides the holding section to move in a forward, backward, and inclined manner with respect to the lifting and lowering section, and the other of the lifting and lowering section and the holding section includes a guided member which moves along the guide path.

Advantageous Effects of Invention

[0007] The holding section moves in a forward, backward, and inclined manner with respect to the lifting and lowering section. In addition, the forward-and-backward movement actuator drives the holding section to move in a forward, backward, and inclined manner with respect to the lifting and lowering section. Therefore, the person in need of assistance is moved in a forward, backward, and inclined manner by the driving of the forward-and-backward movement actuator. As described above, in the present invention, the forward-and-backward movement actuator drives the holding section with respect to the lifting and lowering section. That is, compared with actuator of the related art which moment-drive the lifting and lowering section with respect to the base, the forward-and-backward movement actuator in the present invention have small size.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a view of an assistant robot 1 of a first embodiment seen from a right side in a travelling direction. The travelling direction is toward the right side of the drawing.

[Fig. 2] Fig. 2 is a plan view of the assistant robot 1 of Fig. 1. The travelling direction is toward the right side of the drawing.

[Fig. 3] Fig. 3 is a view of the assistant robot 1 seen from the back in the travelling direction.

[Fig. 4] Fig. 4 is a view of the assistant robot 1 seen from the front in the travelling direction.

[Fig. 5] Fig. 5 is a view of the assistant robot 1 in a state in which a holding section in the assistant robot 1 of Fig. 1 is lifted seen from the right side in the travelling direction.

[Fig. 6] Fig. 6 illustrates an internal structure of the assistant robot 1 of Fig. 1 and is a view of the assistant robot 1 seen from the right side in the travelling direction.

[Fig. 7] Fig. 7 is a view seen from the left side of the assistant robot 1 of Fig. 6, that is, a view of the as-

sistant robot 1 seen from the back in the travelling direction.

[Fig. 8] Fig. 8 is a sectional view in a direction of 8-8 in Fig. 7.

[Fig. 9] Fig. 9 is an enlarged view of a lifting and lowering section 40, a holding section 50, and forward-and-backward movement actuators 90 and 100 in an upper portion in Fig. 8. Here, Fig. 9 corresponds to a sectional view in a direction of 9-9 in Fig. 10.

[Fig. 10] Fig. 10 is a sectional view in a direction of 10-10 in Fig. 9.

[Fig. 11] Fig. 11 is a view illustrating a state in which the holding section 50 moves forwards and is inclined at the front from a state illustrated in Fig. 9.

[Fig. 12] Fig. 12 is a block diagram of a control device 120 in the assistant robot 1.

[Fig. 13] Fig. 13 is a view of the assistant robot 1 seen from the right side in the travelling direction when a person in need of assistance M1 is in a seating posture.

[Fig. 14] Fig. 14 is a view of the assistant robot 1 seen from the right side in the travelling direction when the person in need of assistance M1 is in a standing posture.

[Fig. 15] Fig. 15 is an enlarged view of a lifting and lowering section 240, a holding section 250, and a forward-and-backward movement actuator 260 in an assistant robot 200 of a second embodiment.

[Fig. 16] Fig. 16 is a view illustrating a state in which the holding section 250 moves forwards and is inclined at the front from a state illustrated in Fig. 15.

[Fig. 17] Fig. 17 is an enlarged view of a lifting and lowering section 340, a holding section 350, and a forward-and-backward movement actuator 360 in an assistant robot 300 of a third embodiment.

[Fig. 18] Fig. 18 is a view illustrating a state in which the holding section 350 moves forwards and is inclined at the front from a state illustrated in Fig. 17.

[Fig. 19] Fig. 19 is an enlarged view of a lifting and lowering section 440, a holding section 450, and a forward-and-backward movement actuator 460 in an assistant robot 400 of a fourth embodiment.

[Fig. 20] Fig. 20 is a view illustrating a state in which the holding section 450 moves forwards and is inclined at the front from a state illustrated in Fig. 19.

Description of Embodiments

<First embodiment>

(1. Overall constitution of assistant robot 1)

[0009] The overall constitution of an assistant robot 1 of a first embodiment will be described with reference to Figs. 1 to 5. The assistant robot 1 supports a part (for example, the upper body) of the body of a person in need of assistance M1 (illustrated in Figs. 13 and 14) and as-

sists standing actions and seating actions. As illustrated in Figs. 1 to 5, the assistant robot 1 includes a base 10, lifting and lowering arms 20 and 30, lifting and lowering sections 40, a holding section 50, lifting and lowering actuators 70 and 80, forward-and-backward movement actuators 90 and 100, and a control device 120. In the following description, each of front, back, left, and right is set to be front, back, left, and right when the travelling direction of the assistant robot 1 is considered as forward.

[0010] The base 10 is a portion that is placed on the ground. As illustrated in Fig. 2, the base 10 is formed in a U shape so as to be open backwards when seen in a plan. The base 10 includes four wheels 15 to 18 and is capable of moving forwards and backwards.

[0011] The lifting and lowering arms 20 and 30 are respectively provided on the right and left ends of the upper surface of the base 10 and are provided so as to be capable of stretching upwards. As illustrated in Figs. 1 and 5, the lifting and lowering arms 20 and 30 linearly stretch and contract in a direction in which the upper end is inclined forwards with respect to the lower end. The lifting and lowering sections 40 are provided on the upper ends of the lifting and lowering arms 20 and 30. When the lifting and lowering arms 20 and 30 stretch and contract in the vertical direction, the lifting and lowering sections 40 lift and lower with respect to the base 10. That is, as illustrated in Figs. 1 and 5, the lifting and lowering sections 40 linearly move forwards as the lifting and lowering sections lift with respect to the base 10.

[0012] The holding section 50 is located on the upper sides of the lifting and lowering sections 40 and is supported by the lifting and lowering sections 40. The holding section 50 moves in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40. The holding section 50 holds a part of the body of the person in need of assistance M1. The holding section 50 includes an attachment 60 that can be exchanged with other attachments depending on the person in need of assistance M1.

[0013] The lifting and lowering actuators 70 and 80 drive the lifting and lowering sections 40 to lift and lower with respect to the base 10. The lifting and lowering actuators 70 and 80 respectively drive the extension and contraction of the corresponding lifting and lowering arms 20 and 30. That is, the lifting and lowering sections 40 are driven using the lifting and lowering actuators 70 and 80 to lift and move forwards with respect to the base 10 to a location illustrated in Fig. 5 from a state illustrated in Fig. 1 and vice versa. The lifting and lowering actuators 70 and 80 are provided across the base 10 and the lifting and lowering arms 20 and 30.

[0014] The forward-and-backward movement actuators 90 and 100 drive the holding section 50 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40. That is, the holding section 50 is driven using the forward-and-backward movement actuators 90 and 100 to move forwards and be inclined at the front with respect to the lifting and low-

ering sections 40 to the location illustrated in Fig. 5 from the state illustrated in Fig. 1 and vice versa. The forward-and-backward movement actuators 90 and 100 are provided across the lifting and lowering sections 40 and the holding section 50. The control device 120 controls the lifting and lowering actuators 70 and 80 and the forward-and-backward movement actuators 90 and 100 in accordance with the operation of the person in need of assistance M1.

(2. Internal constitution of assistant robot 1)

[0015] As illustrated in Figs. 1 to 5, the assistant robot 1 includes a cover 11 for the base 10, covers 25 and 35 for the lifting and lowering arms 20 and 30 respectively, a cover 45 for the lifting and lowering sections 40, and the attachment 60 in the holding section 50. Therefore, the internal constitution of the assistant robot 1 obtained by removing these covers and attachment will be described with reference to Figs. 6 to 8. However, the lifting and lowering sections 40, the holding section 50, and the forward-and-backward movement actuators 90 and 100 will be described later.

[0016] The base 10 includes right and left frames 12 and 13 and a coupling frame 14 that couples the front end portions of the right and left frames 12 and 13. The right and left frames 12 and 13 are disposed at an interval necessary for the person in need of assistance M1 to enter. Right and left back wheels 15 and 16 are respectively provided in the back end portions of the right and left frames 12 and 13. Right and left front wheels 17 and 18 are respectively provided in the front end portions of the right and left frames 12 and 13. The right and left front wheels 17 and 18 revolve in accordance with the traveling direction of the assistant robot 1. Here, in the present embodiment, the right and left back wheels 15 and 16 and the right and left front wheels 17 and 18 are wheels having no driving forces, but the right and left back wheels 15 and 16 and the right and left front wheels 17 and 18 may be driven using a motor or the like.

[0017] The lifting and lowering arms 20 and 30 include first arm sections 21 and 31, second arm sections 22 and 32, and third arm sections 23 and 33. The first arm sections 21 and 31, the second arm sections 22 and 32, and the third arm sections 23 and 33 are formed to be long and linear. The first arm sections 21 and 31 are respectively fixed to the right and left frames 12 and 13 of the base 10. The first arm sections 21 and 31 are fixed to be inclined forwards with respect to the base 10 at a predetermined angle (for example, 80 degrees).

[0018] The second arm sections 22 and 32 slide in the longitudinal direction with respect to the first arm sections 21 and 31. When the second arm sections 22 and 32 contract, a majority of the second arm sections 22 and 32 are stored in the first arm sections 21 and 31. The third arm sections 23 and 33 slide in the longitudinal direction with respect to the second arm sections 22 and 32. The lifting and lowering sections 40 are fixed to the

upper ends of the third arm sections 23 and 33. When the third arm sections 23 and 33 contract, a majority of the third arm sections 23 and 33 are stored in the second arm sections 22 and 32.

[0019] Therefore, when the second arm sections 22 and 32 and the third arm sections 23 and 33 contract, a majority of the third arm sections 23 and 33 are stored in the first arm sections 21 and 31 and the second arm sections 22 and 32 as illustrated in Fig. 1. At this time, the lifting and lowering sections 40 are located at the lowermost location. Meanwhile, when the second arm sections 22 and 32 and the third arm sections 23 and 33 stretch, the third arm sections 23 and 33 are located at locations above the first arm sections 21 and 31 without overlapping the first arm sections 21 and 31 in the vertical direction as illustrated in Figs. 5 to 8. At this time, the lifting and lowering sections 40 are located at the uppermost location.

[0020] The lifting and lowering actuators 70 and 80 include rotary driving sources 71 and 81, first lifting and lowering mechanisms 72 and 82, and second lifting and lowering mechanisms 73 and 83. The rotary driving sources 71 and 81 include motors that output rotation driving forces. Appropriately, deceleration mechanisms may be provided in the rotary driving sources 71 and 81.

[0021] The first lifting and lowering mechanisms 72 and 82 are mechanisms which are coupled to the rotary driving sources 71 and 81 and lift and lower the second arm sections 22 and 32 with respect to the first arm sections 21 and 31. The first lifting and lowering mechanisms 72 and 82 are screw mechanisms. Meanwhile, as the first lifting and lowering mechanisms 72 and 82, it is possible to apply belt mechanisms. The first lifting and lowering mechanisms 72 and 82 include screw shafts 72a and 82a which are rotary-driven using the rotary driving sources 71 and 81 and nut members 72b and 82b. In the present embodiment, the screw shafts 72a and 82a are fixed to the first arm sections 21 and 31, and the nut members 72b and 82b are fixed to the second arm sections 22 and 32. That is, when the screw shafts 72a and 82a are rotated using the rotary driving sources 71 and 81, the nut members 72b and 82b lift and lower. The second arm sections 22 and 32 lift and lower with respect to the first arm sections 21 and 31 in the above-described manner.

[0022] The second lifting and lowering mechanisms 73 and 83 are mechanisms that lift and lower the third arm sections 23 and 33 with respect to the second arm sections 22 and 32. The second lifting and lowering mechanisms 73 and 83 are belt mechanisms. Meanwhile, as the second lifting and lowering mechanisms 73 and 83, it is possible to apply screw mechanisms. The second lifting and lowering mechanisms 73 and 83 include lower pulleys 73a and 83a and upper pulleys 73b and 83b which are provided at both ends of the second arm sections 22 and 32 in the longitudinal direction so as to be capable of rotating.

[0023] Furthermore, the second lifting and lowering

mechanisms 73 and 83 include belts 73c and 83c that are suspended at the lower pulleys 73a and 83a and the upper pulleys 73b and 83b. The belts 73c and 83c are fixed to upper end coupling members 21a and 31a of the first arm sections 21 and 31 on one side and are fixed to lower end coupling members 23a and 33a of the third arm sections 23 and 33 on the other side. That is, when the second arm sections 22 and 32 lift with respect to the first arm sections 21 and 31, the belts 73c and 83c rotate in synchronization with the lifting action. The third arm sections 23 and 33 lift with respect to the second arm sections 22 and 32 in synchronization with the rotating action. The lowering action of the second arm sections 22 and 32 and the third arm sections 23 and 33 is an action performed by reversing the above-described action.

(3. Structures of lifting and lowering sections 40, holding section 50, and forward-and-backward movement actuators 90 and 100)

[0024] The lifting and lowering sections 40, the holding section 50, and the forward-and-backward movement actuators 90 and 100 will be described with reference to Figs. 9 to 11. Here, in the following description, a coupled structure between the left side portion of the lifting and lowering section 40 and the left side portion of the holding section 50 will be described. Therefore, the right-side forward-and-backward movement actuator 100 will not be described. Although not described, the coupled structure between the right side portion of the lifting and lowering section 40 and the right side portion of the holding section 50 is a bilaterally symmetric structure of the left-side structure.

[0025] The lifting and lowering sections 40 are fixed to the upper ends of the third arm sections 23. In addition, the holding section 50 moves in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40. Here, in the assistant robot 1 of the present embodiment, the holding section 50 includes guide paths 53 which are rail members, the lifting and lowering sections 40 include guided members 43, screw shafts 93 of the forward-and-backward movement actuators 90 and 100 are provided in the holding section 50, and nut members 94 are provided in the lifting and lowering sections 40.

[0026] As illustrated in Figs. 9 and 10, the lifting and lowering sections 40 include base sections 41, oscillation support sections 42, and the guided members 43. As illustrated in Fig. 10, the base sections 41 are formed in a crank shape when seen in the forward-and-backward direction and are fixed to the upper ends of the third arm sections 23 and 33. As illustrated in Fig. 10, the oscillation support section 42 in the lifting and lowering section 40 is formed in a U shape so as to be open downwards when seen in the forward-and-backward direction and is fixed to one side surface (the right side of Fig. 10) of the base section 41. In addition, the guided member 43 is a mem-

ber that is held in the guide path 53 described below so as to be capable of moving. The guided member 43 has a groove on one side surface and is formed in a block shape. The guided member 43 is fixed to the other side surface (the left side in Fig. 10) of the base section 41. That is, the base section 41, the oscillation support section 42, and the guided member 43 which constitute the lifting and lowering section 40 are integrally formed.

[0027] The holding section 50 includes a main body frame 51, oscillation support sections 52, and the guide paths 53. The main body frame 51 is formed in a U shape so as to be open backwards when seen from above. Fig. 9 illustrates an extended portion of the left side of the main body frame 51, and Fig. 10 illustrates a part of the extended portion and the central coupled portion of the main body frame 51. As illustrated in Fig. 10, the oscillation support section 52 in the holding section 50 is formed in a U shape so as to be open downwards when seen in the forward-and-backward direction. The oscillation support section 52 in the holding section 50 is located at a location at which the oscillation support section overlaps the oscillation support sections 42 in the lifting and lowering sections 40 in the forward-and-backward direction and is located ahead of the oscillation support section 42 in the lifting and lowering section 40.

[0028] The guide paths 53 are rail members and are fixed to side surfaces of the right and left extended portions of the main body frame 51. The guide path 53 is formed so as to extend in the forward-and-backward direction. In the present embodiment, the guide path 53 is formed in a curved non-linear shape, particularly, an arc shape. The guide path 53 is fixed to the main body frame 51 so as to have the front end at the lowest location and have an upward arc shape as illustrated in Fig. 9. The guide path 53 is fitted into the guided member 43 in the vertical direction and holds the guided member 43. That is, the guide path 53 moves the guided member 43 in an arc shape along the guide path 53 as illustrated in Figs. 9 and 11.

[0029] When the guided members 43 move in an arc shape along the guide paths 53, the main body frame 51 in the holding section 50 moves in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40 as illustrated in Figs. 9 and 11. In detail, when a state in which the guided members 43 are located at the front ends of the guide paths 53 as illustrated in Fig. 9 transfers to a state in which the guided members 43 are located at the back ends of the guide paths 53 as illustrated in Fig. 11, the main body frame 51 in the holding section 50 moves forwards and is inclined at the front. In addition, in a case in which a state in which the locational relationship between the guided members 43 and the guide paths 53 is as illustrated in Fig. 11 transfers to a state illustrated in Fig. 9, the main body frame 51 in the holding section 50 moves backwards and falls into a horizontal state. As described above, the guide paths 53 guide the holding section 50 to move in a forward, backward, and inclined manner with respect to the lifting and

lowering sections 40 through the guided members 43.

[0030] The forward-and-backward movement actuators 90 and 100 drive the holding section 50 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40 as described above. Here, the number of the forward-and-backward movement actuators is two (the left-side forward-and-backward movement actuator 90 and the right-side forward-and-backward movement actuator 100), but the forward-and-backward movement actuators perform one kind of driving action to drive the holding section 50 with respect to the right and left lifting and lowering sections 40. That is, the two forward-and-backward movement actuators 90 and 100 act in synchronization with each other and are constituted as an actuator that performs one kind of driving action. In addition, the forward-and-backward movement actuators 90 and 100 that performs one kind of driving action drive the holding section 50 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40 with one kind of driving action.

[0031] As illustrated in Figs. 9 and 10, the forward-and-backward movement actuator 90 includes the supported member 91, the rotary driving source 92, the screw shaft 93, and the nut member 94. The supported member 91 has a through-hole formed in the center and is formed in a block shape. The supported member 91 is supported by a U-shaped opening end of the oscillation support section 52 in the holding section 50 so as to be capable of oscillating using the horizontal direction as a rotation axis line.

[0032] The rotary driving source 92 is, for example, a motor. The rotary driving source 92 is fixed to the supported member 91. That is, the rotary driving source 92 becomes capable of moving in an inclined manner with respect to the oscillation support section 52 in the holding section 50. The screw shaft 93 is coupled to the output axis of the rotary driving source 92 and is rotary-driven using the rotary driving source 92. The screw shaft 93 is supported by the supported member 91 so as to be capable of rotating around an axis line of the screw shaft 93. That is, the screw shaft 93 becomes capable of moving in an inclined manner with respect to the oscillation support section 52 together with the rotary driving source 92. The nut member 94 is supported by a U-shaped opening end of the oscillation support section 42 in the lifting and lowering section 40 so as to be capable of moving in an inclined manner using the horizontal direction as a rotation axis line. The nut member 94 is engaged with the screw shaft 93 and moves along the screw shaft 93 in accordance with the rotation of the screw shaft 93.

[0033] That is, the rotary driving source 92 rotates the screw shaft 93 by means of rotary drive and, furthermore, moves the nut member 94 in the forward-and-backward direction in accordance with the rotation of the screw shaft 93. In accordance with the rotation of the rotary driving source 92, the distance between the supported member 91 that supports one end of the screw shaft 93

and the nut member 94 changes. At this time, as described above, the posture of the holding section 50 with respect to the lifting and lowering sections 40 is determined by the movement of the guided members 43 in an arc shape along the guide paths 53. Therefore, the screw shaft 93 and the nut member 94 move in an inclined manner due to the movement of the holding section 50 with respect to the lifting and lowering sections 40 in a forward, backward, and inclined manner.

(4. Structure of attachment 60)

[0034] The attachment 60 will be described with reference to Figs. 1 to 4. The attachment 60 includes a main body section 61, a trunk pad 62, right and left grips 63a and 63b, right and left elbow rest sections 64a and 64b, armpit holding sections 65a and 65b, and an operation section 66. The main body section 61 is mounted so as to be attachable to or detachable from the main body frame 51 in the holding section 50 (illustrated in Fig. 9).

[0035] The trunk pad 62 is formed of a cushion material in an almost plate shape. The trunk pad 62 is located in the central portion in the horizontal direction and in the central portion in the forward-and-backward direction of the entire attachment 60 on the upper surface of the main body section 61. The trunk pad 62 is provided so that the upper surface thereof is slightly inclined backwards. The trunk pad 62 supports almost all of the trunk of the person in need of assistance M1, that is, chest to abdomen and the vicinity of the left armpit to the vicinity of the right armpit. Particularly, the trunk pad 62 is formed to have a narrower horizontal width in the upper half which corresponds to chest than that in the lower half which corresponds to abdomen. Therefore, the person in need of assistance M1 is able to locate both armpits without any discomfort and obtain a feeling of the vicinity of abdomen stably supported. Furthermore, the upper edge of the trunk pad 62 is formed in a concave shape so as to allow the head of the person in need of assistance M1 to move without any hindrance. The lower edge of the trunk pad 62 is formed in a concave shape so as to allow the leg section to enter the trunk pad and allow the waist portion to be stably supported.

[0036] The grips 63a and 63b are respectively fixed to the front parts of the right and left sides of the main body section 61. The elbow rest sections 64a and 64b are respectively disposed in the back of the right and left sides of the main body section 61. The operation section 66 includes buttons that the person in need of assistance M1 or a caregiver operates. The armpit holding sections 65a and 65b are formed in an arc shape and are respectively disposed on the right and left of the trunk pad 62. The armpit holding sections 65a and 65b are pinched under both arms of the person in need of assistance M1 and regulate the forward-and-backward movement of the person in need of assistance M1. The operation section 66 includes buttons for lifting and lowering operation. When the person in need of assistance M1 operates the

buttons for lifting and lowering operation in the operation section 66, the lifting and lowering sections 40 perform lifting and lowering movement, and the holding section 50 moves in a forward, backward, and inclined manner in synchronization with the lifting and lowering movement of the lifting and lowering sections 40.

[0037] Meanwhile, in the attachment 60, each of the trunk pad 62, the right and left grips 63a and 63b, the right and left elbow rest sections 64a and 64b, the armpit holding sections 65a and 65b, and the operation section 66 can be individually exchanged with new members. In addition, the attachment 60 does not need to include all of the trunk pad 62, the right and left grips 63a and 63b, the right and left elbow rest sections 64a and 64b, the armpit holding sections 65a and 65b, and the operation section 66 and may have a constitution including only appropriately-selected members.

(5. Constitution of control device 120 and operation of assistant robot 1)

[0038] The constitution of the control device 120 will be described with reference to Fig. 12. Simultaneously, the actions of the assistant robot 1 will be described with reference to Figs. 13 and 14. The control device 120 includes a calculating section 121 such as CPU and a memory section 122 such as HDD or Flash SSD. Although not illustrated, the control device 120 includes an interface for communication with the operation section 66, the lifting and lowering actuators 70 and 80, and the forward-and-backward movement actuators 90 and 100 as external devices.

[0039] The calculating section 121 acquires operation information from the operation section 66 in a case in which the person in need of assistance M1 operates the operation section 66. The operation information is about lifting actions, lowering actions, and stoppage actions with respect to the holding section 50. Furthermore, the calculating section 121 acquires the current state information of each of the actuators 70, 80, 90, and 100, for example, the rotation increment values of motors. In addition, the calculating section 121 synchronously controls the lifting and lowering actuators 70 and 80 and the forward-and-backward movement actuators 90 and 100 on the basis of the acquired operation information, the current states of the respective actuators 70, 80, 90, and 100, and information memorized in the memory section 122. Here, the memory section 122 memorizes the operation information, the current states of the respective actuators 70, 80, 90, and 100, and the relationships with command values for the respective actuators 70, 80, 90, and 100.

[0040] When the person in need of assistance M1 is in a sitting posture, immediately after the person in need of assistance M1 is held in the trunk pad 62 in the attachment 60 in the holding section 50, the calculating section 121 first drives the forward-and-backward movement actuators 90 and 100 and moves the holding section 50 in

a forward, backward, and inclined manner as illustrated in Fig. 13. After that, the calculating section 121 drives the lifting and lowering actuators 70 and 80 while driving the forward-and-backward movement actuators 90 and 100. That is, the holding section 50 lifts while moving in a forward, backward, and inclined manner as illustrated in Fig. 14. The lift height of the holding section 50 can be set in accordance with the height of the person in need of assistance M1. In addition, even in a case in which the person in need of assistance M1 transfers from a stand-up posture to a sitting posture, similarly, lifting and lowering movement using the lifting and lowering actuators 70 and 80 and forward, backward, and inclined movement using the forward-and-backward movement actuators 90 and 100 are performed in cooperation.

<Second embodiment>

[0041] Lifting and lowering sections 240, a holding section 250, and forward-and-backward movement actuators 260 in an assistant robot 200 of a second embodiment will be described with reference to Figs. 15 and 16. Figs. 15 and 16 illustrate, similar to Figs. 9 and 10 in the first embodiment, a coupled structure between the left side portion of the lifting and lowering section 240 and the left side portion of the holding section 250.

[0042] Here, in the assistant robot 200 of the present embodiment, the holding section 250 includes guide paths 253 which are rail members, the lifting and lowering sections 240 include guided members 243, screw shafts 262 of the forward-and-backward movement actuators 260 are provided in the lifting and lowering sections 240, and nut members 263 are provided in the holding section 250.

[0043] The lifting and lowering sections 240 are mounted on the upper ends of the third arm sections 23. The lifting and lowering section 240 includes a base section 241, a both-end support section 242, and a guided member 243. The base section 241 is constituted in the same manner as the base section 41 in the first embodiment. The both-end support section 242 has flange portions at both ends of a long portion. The central portion of the both-end support section 242 is supported by one side surface (the near surface in Fig. 15) of the base section 241 so that the both-end support section is capable of moving in an inclined manner around an axial line of the assistant robot 1 in the horizontal direction. The guided member 243 is fixed to the other side surface (the far surface in Fig. 15) of the base section 241.

[0044] The holding section 250 includes a main body frame 251, oscillation support sections 252, and guide paths 253. The oscillation support section 252 is formed in the main body frame 251 in a U shape so as to be open downwards in a case in which the oscillation support section is seen in the forward-and-backward direction. The guide paths 253 are rail members and are fixed to side surfaces of the right and left extended portions of the main body frame 251. The guide path 253 is formed so

as to extend in the forward-and-backward direction. The guide path 253 is formed in a curved non-linear shape, particularly, an arc shape. The guide path 253 is fitted into the guided member 243 in the vertical direction and holds the guided member 243. That is, the guide path 253 moves the guided member 243 in an arc shape along the guide path 253 as illustrated in Figs. 15 and 16.

[0045] The forward-and-backward movement actuator 260 includes a rotary driving source 261, a screw shaft 262, and a nut member 263 as illustrated in Figs. 15 and 16. The rotary driving source 261 is fixed to one flange portion of the both-end support section 242 in the lifting and lowering section 240. That is, the rotary driving source 261 becomes capable of moving in an inclined manner with respect to the base section 241 in the lifting and lowering section 240. The screw shaft 262 is coupled to the output axis of the rotary driving source 261 and is rotary-driven using the rotary driving source 261. The screw shaft 262 has both ends that are supported by the both flange portions of the both-end support section 242 in the lifting and lowering section 240 so that the screw shaft is capable of rotating around the axis line of the screw shaft 262. That is, the screw shaft 262 becomes capable of moving in an inclined manner with respect to the base section 241 in the lifting and lowering section 240 together with the rotary driving source 261. The nut member 263 is supported by a U-shaped opening end of the oscillation support section 252 in the holding section 250 so as to be capable of moving in an inclined manner using the horizontal direction as a rotation axis line. The nut member 263 is engaged with the screw shaft 262 and moves along the screw shaft 262 in accordance with the rotation of the screw shaft 262.

[0046] The holding section 250 acts with respect to the lifting and lowering sections 240 in the same manner as in the first embodiment. That is, in a state illustrated in Fig. 15 as the initial state, the rotary driving sources 261 rotary-drive the screw shafts 262 to rotate, and the nut members 263 move in a unidirectional manner along the screw shafts 262 in accordance with the rotation of the screw shafts 262. In such a case, the both-end support sections 242 in the lifting and lowering sections 240 which support the screw shafts 262 and the oscillation support sections 252 in the holding section 250 which support the nut members 263 come close to each other.

[0047] At this time, the guided members 243 move in an arc shape along the guide paths 253. Therefore, the holding section 250 moves forwards and is inclined at the front with respect to the lifting and lowering sections 240 as illustrated in Fig. 16. On the other hand, in a case in which the rotary driving sources 261 rotary-drive the screw shafts in the reverse direction, the holding section 250 acts with respect to the lifting and lowering sections 240 in a reverse manner.

<Third embodiment>

[0048] Lifting and lowering sections 340, a holding sec-

tion 350, and forward-and-backward movement actuators 360 in an assistant robot 300 of a third embodiment will be described with reference to Figs. 17 and 18. Figs. 17 and 18 illustrate, similar to Figs. 9 and 10 in the first embodiment, a coupled structure between the left side portion of the lifting and lowering section 340 and the left side portion of the holding section 350.

[0049] Here, in the assistant robot 300 of the present embodiment, the lifting and lowering sections 340 include guide paths 342 and 343 which are rail members, the holding section 350 includes guided members 352 and 353, screw shafts 262 of the forward-and-backward movement actuators 360 are provided in the lifting and lowering sections 340, and nut members 363 are provided in the holding section 250.

[0050] The lifting and lowering sections 340 are mounted on the upper ends of the third arm sections 23. The lifting and lowering section 340 includes a base section 341, a first guide path 342, and a second guide path 343. Unlike the base section 41 in the first embodiment, the base section 341 is formed to be long in the forward-and-backward direction enough to fix the guide paths 342 and 343 which are rail members. The first guide path 342 is formed to be linear and is horizontally disposed in the back part of a side surface of the base section 341 so as to extend in the forward-and-backward direction. The second guide path 343 is formed to be linear and is disposed in the front part of the side surface of the base section 341 an angle inclined with respect to the horizontal surface so as to extend in the forward-and-backward direction. In detail, the second guide path 343 is provided so that the front end is located below the back end.

[0051] The holding section 350 includes a main body frame 351, a first guided member 352, and a second guided member 353. The first guided member 352 is supported by the back part of the main body frame 351 so as to be capable of moving in an inclined manner using the horizontal direction of the assistant robot 300 as a rotation axis line. The first guided member 352 is held in the first guide path 342 so as to pinch the first guide path 342 in the lifting and lowering section 340 in the vertical direction. The first guided member 352 moves linearly (in the forward-and-backward direction and horizontally) along the first guide path 342.

[0052] The second guided member 353 is supported by the front part of the main body frame 351 so as to be capable of moving in an inclined manner using the horizontal direction as a rotation axis line. The second guided member 353 is held in the second guide path 343 so as to pinch the second guide path 343 in the lifting and lowering section 340 in the vertical direction. The second guided member 353 moves linearly (in the forward-and-backward direction so as to be inclined at the front) along the second guide path 343.

[0053] The forward-and-backward movement actuator 360 includes a rotary driving source 361, a screw shaft 362, and a nut member 363. The rotary driving source 361 is fixed to the base section 341 in the lifting and

lowering section 340. The screw shaft 362 is coupled to the output axis of the rotary driving source 361 and is rotary-driven using the rotary driving source 361. That is, the rotary driving source 361 and the screw shaft 362 are supported so as to be incapable of moving in an inclined manner with respect to the lifting and lowering section 340. Here, the axis line of the screw shaft 362 is horizontally disposed so as to extend in the forward-and-backward direction.

[0054] The nut member 363 is engaged with the screw shaft 362 and moves along the screw shaft 362 in accordance with the rotation of the screw shaft 362. The nut member 363 is fixed to the first guided member 352 in the holding section 350. That is, the first guided member 352 in the holding section 350 moves in accordance with the movement of the nut member 363.

[0055] The holding section 350 acts with respect to the lifting and lowering sections 340 in the same manner as in the first embodiment. That is, in a state illustrated in Fig. 17 as the initial state, the rotary driving sources 361 rotary-drive the screw shafts 362 to rotate, and the nut members 363 move forwards along the screw shafts 362 in accordance with the rotation of the screw shafts 362.

[0056] At this time, the first guided members 352 move linearly and horizontally along the first guide paths 342. On the other hand, the second guided members 353 move linearly along the second guide paths 343 so as to be inclined at the front. Therefore, the holding section 350 moves forwards and is inclined at the front with respect to the lifting and lowering sections 340 as illustrated in Fig. 18. On the other hand, in a case in which the rotary driving sources 361 rotary-drive the screw shafts in the reverse direction, the holding section 350 acts with respect to the lifting and lowering sections 340 in a reverse manner.

<Fourth embodiment>

[0057] Lifting and lowering sections 440, a holding section 450, and forward-and-backward movement actuators 460 in an assistant robot 400 of a fourth embodiment will be described with reference to Figs. 19 and 20. Figs. 19 and 20 illustrate, similar to Figs. 9 and 10 in the first embodiment, a coupled structure between the left side portion of the lifting and lowering section 440 and the left side portion of the holding section 450.

[0058] Here, in the assistant robot 400 of the present embodiment, the holding section 450 includes guide paths 451a which are grooves, the lifting and lowering sections 440 include guided members 443 and 444, main body sections 461 of the forward-and-backward movement actuators 460 are provided in the lifting and lowering sections 440, and rod sections 462 of the forward-and-backward movement actuators 460 are provided in the holding section 450.

[0059] The lifting and lowering sections 440 are mounted on the upper ends of the third arm sections 23. The lifting and lowering section 440 includes a base section

441, an oscillation support section 442, a first guided member 443, and a second guided member 444. The oscillation support section 442 is provided in the front part of a side surface of the base section 441. The first guided member 443 and the second guided member 444 are protruding members that are provided in the back parts of the side surfaces of the base section 441 so as to protrude toward the side parts. The first guided member 443 and the second guided member 444 are provided so as to be arranged almost in the forward-and-backward direction.

[0060] The holding section 450 includes a main body frame 451 and oscillation support sections 452. The guide paths 451a which are grooves that are open toward the side parts are formed on the side surfaces of the main body frame 451. The guide path 451a is formed in a non-linear shape extending in the forward-and-backward direction. The front part of the guide path 451a is formed in a linear shape extending in the forward-and-backward direction, and the back part of the guide path 451a is formed in a continuously curved shape in the linear portion. The back end of the guide path 451a is located below the front end. That is, the guide path 451a forms a cam groove. The first guided member 443 and the second guided member 444 are inserted into the guide path 451a so as to be capable of moving along the guide path 451a. When the first guided member 443 and the second guided member 444 are inserted into the guide path 451a, the posture of the holding section 450 is stabilized with respect to the lifting and lowering section 440. The oscillation support section 452 is provided at the back end of the main body frame 451.

[0061] The forward-and-backward movement actuator 460 is a cylinder mechanism. The forward-and-backward movement actuator 460 includes a main body section 461 and a rod section 462. The main body section 461 is supported by the oscillation support section 442 in the lifting and lowering section 440 so as to be capable of moving in an inclined manner using the horizontal direction of the assistant robot 400 as a rotation axis line. The rod section 462 acts so that the protruding amount changes with respect to the main body section 461. The front end of the rod section 462 is supported by the oscillation support section 452 in the holding section 450 so as to be capable of moving in an inclined manner using the horizontal direction of the assistant robot 400 as a rotation axis line.

[0062] In the present embodiment, the holding section 450 acts with respect to the lifting and lowering sections 440 in the same manner as in the first embodiment. That is, in a state illustrated in Fig. 19 as the initial state, the rod section 462 transfers from a state of being extended with respect to the main body section 461 to a state of being contracted with respect to the main body section, the oscillation support section 452 in the holding section 450 comes close to the oscillation support section 442 in the lifting and lowering section 440. At this time, the first guided member 443 and the second guided member

444 relatively move along the guide path 451a which is a groove. In such a case, as illustrated in Fig. 20, the holding section 450 is inclined forwards while moving forwards with respect to the lifting and lowering section 440. On the other hand, when the forward-and-backward movement actuators 460 are caused to act in a reverse manner, the holding section 450 acts with respect to the lifting and lowering sections 440 in a reverse manner.

[0063] Meanwhile, in the fourth embodiment, the guide path 451a is formed in the holding section 450, and the guided members 443 and 444 are provided in the lifting and lowering section 440, but the guide path 451a may be formed in the lifting and lowering section 440, and the guided members 443 and 444 may be provided in the holding section 450.

<Summary>

[0064] The assistant robots 1, 200, 300, and 400 of the first, second, third, and fourth embodiments include the base 10, the lifting and lowering sections 40, 240, 340, and 440 which lift and lower with respect to the base 10, the holding sections 50, 250, 350, and 450 which hold a part of the body of the person in need of assistance M1 and move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440, the lifting and lowering actuators 70 and 80 which drive the lifting and lowering sections 40, 240, 340, and 440 to lift and lower with respect to the base 10, and the forward-and-backward movement actuators 90, 100, 260, 360, and 460 which drive the holding sections 50, 250, 350, and 450 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440.

[0065] One of the lifting and lowering sections 40, 240, 340, and 440 and the holding sections 50, 250, 350, and 450 are formed to extend in the forward-and-backward direction and include the guide paths 53, 253, 342, 343, and 451a which guide the holding sections 50, 250, 350, and 450 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440. The other one of the lifting and lowering sections 40, 240, 340, and 440 and the holding sections 50, 250, 350, and 450 include the guided members 43, 243, 352, 353, 443, and 444 which move along the guide paths 53, 253, 342, 343, and 451a.

[0066] The holding sections 50, 250, 350, and 450 move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440. In addition, the forward-and-backward movement actuators 90, 100, 260, 360, and 460 drive the holding sections 50, 250, 350, and 450 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440. Therefore, the person in need of assistance M1 is moved in a forward, backward, and inclined manner by the driving of the forward-and-backward movement actuators 90, 100, 260, 360, and 460. As described above, the forward-and-

backward movement actuators 90, 100, 260, 360, and 460 drive the holding sections 50, 250, 350, and 450 with respect to the lifting and lowering sections 40, 240, 340, and 440. That is, compared with actuators in the related art which moment-drive the lifting and lowering sections 50, 250, 350, and 450 with respect to the base 10, the forward-and-backward movement actuators 90, 100, 260, 360, and 460 in the present embodiments have small sizes.

[0067] Furthermore, the forward-and-backward movement actuators 90, 100, 260, 360, and 460 move the holding sections 50, 250, 350, and 450 in an inclined manner and, furthermore, move the holding sections in a forward and backward manner. That is, in the assistant robots 1, 200, 300, and 400, it is not necessary to separately provide actuators for driving the holding sections 50, 250, 350, and 450 to move in an inclined manner and actuators for driving the holding sections in a forward-and-backward manner. Therefore, the number of actuators decreases. As a result, the assistant robots 1, 200, 300, and 400 have small sizes.

[0068] In addition, in the assistant robots 1, 200, and 300 of the first, second, and third embodiments, the guide paths 53, 253, 342, and 343 are rail members, and the guided members 43, 243, 352, and 353 are members which are held so as to be capable of relatively moving with respect to the guide paths 53, 253, 342, and 343. When the rails members are used, the holding sections 50, 250, and 350 are stably guided with respect to the lifting and lowering sections 40, 240, and 340. Furthermore, the sliding resistance between the guide paths 53, 253, 342, and 343 as rail members and the guided members 43, 243, 352, and 353 is small, and thus the power of the forward-and-backward movement actuators 90, 100, 260, and 360 becomes small.

[0069] In the assistant robot 400 of the fourth embodiment, the guide path 451a is a groove which is formed in one of the lifting and lowering section 440 and the holding section 450, and the guided members 443 and 444 are protruding members which are inserted into the guide path 451a so as to be capable of relatively moving in the guide path 451a. In this case, the guide path 451a is not an exclusive member and is formed in one of the lifting and lowering section 440 and the holding section 450, and thus the number of components decreases. Furthermore, since the degree of freedom in designing the shape of the groove is high, the degree of freedom of the holding section 450 acting with respect to the lifting and lowering section 440 is high.

[0070] In the assistant robots 1, 200, and 400 of the first, second, and fourth embodiments, the holding sections 50, 250, and 450 include the guide paths 53, 253, and 451a, and the lifting and lowering sections 40, 240, and 440 include the guided members 43, 243, 443, and 444. Since the guide paths 53, 253, and 451a have lengths in the forward-and-backward direction, members having the guide paths 53, 253, and 451a have lengths. On the other hand, the guided members 43, 243, 443,

and 444 are members that move along the guide paths 53, 253, and 451a and are thus relatively short.

[0071] In addition, the holding sections 50, 250, and 450 hold a part of the body of a person in need of assistance M1 and thus have a length to a certain extent. Therefore, when the holding sections 50, 250, and 450 having original lengths include the guide paths 53, 253, and 451a, it is possible to shorten the full lengths of the lifting and lowering sections 40, 240, and 440 in the forward-and-backward direction. As a result, the full lengths of the assistant robots 1, 200, and 400 in the forward-and-backward direction become short.

[0072] In the assistant robot 1 of the first embodiment, the forward-and-backward movement actuators 90 and 100 include the rotary driving sources 92 which are provided in the holding section 50, the screw shafts 93 which are coupled to the output axes of the rotary driving sources 92 and are rotary-driven using the rotary driving sources 92, and the nut members 94 which are provided in the lifting and lowering sections 40, are engaged with the screw shafts 93, and move to the screw shafts 93 in accordance with the rotation of the screw shafts 93. In this case, the screw shafts 93 in the forward-and-backward movement actuators 90 and 100 move together with the holding section 50. The screw shafts 93 have lengths. The holding section 50 holds a part of the body of the person in need of assistance M1 and thus has a length to a certain extent. Therefore, when the screw shafts 93 are held in the holding section 50 having an original length, it is possible to shorten the lengths in the forward-and-backward direction of members which are provided in the lifting and lowering sections 40. As a result, the full length of the assistant robot 1 in the forward-and-backward direction becomes short.

[0073] Furthermore, in the assistant robot 1 of the first embodiment, the rotary driving sources 92 and the screw shafts 93 are supported by the holding section 50 so as to be capable of moving in an inclined manner, and the nut members 94 are supported by the lifting and lowering sections 40 so as to be capable of moving in an inclined manner. In this case, in a case in which the holding section 50 moves in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, the screw shafts 93 move in an inclined manner in accordance with the inclination angle of the holding section 50. Therefore, the sizes of the forward-and-backward movement actuators 90 and 100 in the vertical direction are reduced.

[0074] In the assistant robots 200 and 300 of the second and third embodiments, the forward-and-backward movement actuators 260 and 360 include the rotary driving sources 261 and 361 which are provided in the lifting and lowering sections 240 and 340, the screw shafts 262 and 362 which are coupled to the output axes of the rotary driving sources 261 and 361 and are rotary-driven using the rotary driving sources 261 and 361, and the nut members 263 and 363 which are provided in the holding sections 250 and 350, are engaged with the screw shafts

262 and 362, and move to the screw shafts 262 and 362 in accordance with the rotation of the screw shafts 262 and 362. In this case, the rotary driving sources 261 and 361 rarely move in a forward and backward manner with respect to the lifting and lowering sections 240 and 340. Therefore, handling of wires for the rotary driving sources 261 and 361 is extremely favorable.

[0075] In addition, in the assistant robot 200 of the second embodiment, the rotary driving sources 261 and the screw shafts 262 are supported by the lifting and lowering sections 240 so as to be capable of moving in an inclined manner, and the nut members 263 are supported by the holding sections 250 so as to be capable of moving in an inclined manner. In this case, in a case in which the holding section 250 moves in a forward, backward, and inclined manner with respect to the lifting and lowering sections 240, the screw shafts 262 move in an inclined manner in accordance with the inclination angle of the holding section 250. Therefore, the sizes of the forward-and-backward movement actuators 260 in the vertical direction are reduced.

[0076] In addition, in the assistant robot 300 of the third embodiment, the rotary driving sources 361 and the screw shafts 362 are supported by the lifting and lowering sections 340 so as to be incapable of moving in an inclined manner, and the nut members 363 are supported by the holding sections 350 so as to be capable of moving in an inclined manner. The rotary driving sources 361 and the screw shafts 362 move in accordance with the lifting and lowering action of the lifting and lowering section 340, but do not follow the forward, backward, and inclined movement of the holding section 350. Therefore, there is a little opportunity that the rotary driving sources 361 and the screw shafts 362 are imparted with vibrations from the outside. Therefore, the service lives of the rotary driving sources 361 and the screw shafts 362 extend.

[0077] In addition, in the assistant robot 200 of the second embodiment, both ends of the screw shafts 262 are supported by the lifting and lowering sections 240. Since the screw shafts 262 are stably held, even in a case in which the assistant robot 200 acts, the engagement state between the screw shafts 262 and the nut members 263 is favorably maintained. Therefore, the service lives of the screw shafts 262 and the nut members 263 extend.

[0078] In addition, in the assistant robots 1, 200, 300, and 400 of the first, second, third, and fourth embodiments, the lifting and lowering sections 40, 240, 340, and 440 linearly move forwards as the lifting and lowering sections lift with respect to the base 10. Here, in a case in which the person in need of assistance M1 transfers from a seating posture to a standing posture, the holding sections 50, 250, 350, and 450 need to move forwards with respect to the lifting and lowering sections 40, 240, 340, and 440 to a predetermined extent. When the lifting and lowering sections 40, 240, 340, and 440 lift, the lifting and lowering sections 40, 240, 340, and 440 are capable of moving forwards. As a result, it is possible to shorten the stroke of the forward-and-backward movement of the

holding sections 50, 250, 350, and 450 with respect to the lifting and lowering sections 40, 240, 340, and 440. Therefore, the lengths of the guide paths 53, 253, 342, 343, and 451a become short, and the full lengths of the assistant robots 1, 200, 300, and 400 in the forward-and-backward direction become short.

[0079] In the assistant robots 1, 200, 300, and 400 of the first, second, third, and fourth embodiments, the guide paths 53, 253, and 451a are formed in a non-linear shape. The guide paths 53, 253, and 451a enable the holding sections 50, 250, and 450 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, and 440. The structure can be easily formed. In the assistant robot 300 of the third embodiment, the guide path 343 is linearly formed in an inclined manner. The formation of the guide path 343 becomes easy.

[0080] In addition, in the assistant robots 1, 200, 300, and 400 of the first, second, third, and fourth embodiments, the forward-and-backward movement actuators 90, 100, 260, 360, and 460 are constituted of actuators that perform one kind of driving action and drive the holding sections 50, 250, 350, and 450 to move in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440. Here, the actuators that perform one kind of driving action may be multiple actuators which are intended to perform the same kind of action in synchronization with each other.

[0081] That is, in the assistant robots 1, 200, 300, and 400, it is not necessary to separately provide actuators for driving the holding sections 50, 250, 350, and 450 to move only in an inclined manner and actuators for driving the holding sections only in a forward-and-backward manner. As described above, in the assistant robots 1, 200, 300, and 400, it is not necessary to provide actuators that perform two kinds of driving action in order to move the holding sections 50, 250, 350, and 450 in a forward, backward, and inclined manner with respect to the lifting and lowering sections 40, 240, 340, and 440. Therefore, the assistant robots 1, 200, 300, and 400 may include a small number of actuators. As a result, the assistant robots 1, 200, 300, and 400 have small sizes.

Reference Signs List

[0082]

1, 200, 300, 400: assistant robot, 10: base, 20, 30: lifting and lowering arm, 23, 33: third arm section, 40, 240, 340, 440: lifting and lowering section, 41, 241, 341, 441: base section, 43, 243, 352, 353, 443, 444: guided member, 50, 250, 350, and 450: holding section, 51, 251, 351, 451: main body frame, 53, 253, 342, 343, 451a: guide path, 60: attachment, 70, 80: lifting and lowering actuator, 90, 100, 260, 360, 460: forward-and-backward movement actuator, 92, 261, 361: rotary driving source, 93, 262, 362: screw shaft, 94, 263, 363: nut member, 120: control device,

M1: person in need of assistance

Claims

1. An assistant robot comprising:

a base;
a lifting and lowering section which lifts and lowers with respect to the base;
a holding section which holds a part of a body of a person in need of assistance and moves in a forward, backward, and inclined manner with respect to the lifting and lowering section;
a lifting and lowering actuator which drives the lifting and lowering section to lift and lower with respect to the base; and
a forward-and-backward movement actuator which drives the holding section to move in a forward, backward, and inclined manner with respect to the lifting and lowering section,

wherein one of the lifting and lowering section and the holding section includes a guide path which is formed to extend in a forward-and-backward direction and guides the holding section to move in a forward, backward, and inclined manner with respect to the lifting and lowering section, and
the other of the lifting and lowering section and the holding section includes a guided member which moves along the guide path.

2. The assistant robot according to Claim 1, wherein the guide path is a rail member, and the guided member is a member which is held in the guide path so as to be capable of relatively moving.

3. The assistant robot according to Claim 1, wherein the guide path is a groove which is formed in one of the lifting and lowering section and the holding section, and
the guided member is a protruding member which is inserted into the guide path so as to be capable of relatively moving in the guide path.

4. The assistant robot according to any one of Claims 1 to 3, wherein the holding section includes the guide path, and
the lifting and lowering section includes the guided member.

5. The assistant robot according to any one of Claims 1 to 4, wherein the forward-and-backward movement actuator includes a rotary driving source which is provided in the holding section,
a screw shaft which is coupled to an output axis of

the rotary driving source and is rotary-driven by the rotary driving source, and
a nut member which is provided in the lifting and lowering section, is engaged with the screw shaft, and moves along the screw shaft in accordance with rotation of the screw shaft.

6. The assistant robot according to Claim 5,
wherein the rotary driving source and the screw shaft are supported by the holding section so as to be capable of moving in an inclined manner, and the nut member is supported by the lifting and lowering section so as to be capable of moving in an inclined manner. 10
7. The assistant robot according to any one of Claims 1 to 4,
wherein the forward-and-backward movement actuator includes a rotary driving source which is provided in the lifting and lowering section, 20
a screw shaft which is coupled to an output axis of the rotary driving source and is rotary-driven by the rotary driving source, and
a nut member which is provided in the holding section, is engaged with the screw shaft, and moves along the screw shaft in accordance with rotation of the screw shaft. 25
8. The assistant robot according to Claim 7,
wherein the rotary driving source and the screw shaft are supported by the lifting and lowering section so as to be capable of moving in an inclined manner, and 30
the nut member is supported by the holding section so as to be capable of moving in an inclined manner. 35
9. The assistant robot according to Claim 7,
wherein the rotary driving source and the screw shaft are supported by the lifting and lowering section so as to be incapable of moving in an inclined manner, and 40
the nut member is supported by the holding section so as to be capable of moving in an inclined manner.
10. The assistant robot according to any one of Claims 7 to 9, 45
wherein both ends of the screw shaft are supported by the lifting and lowering section.
11. The assistant robot according to any one of Claims 1 to 10, 50
wherein the lifting and lowering section linearly moves forwards as the lifting and lowering section lifts with respect to the base. 55
12. The assistant robot according to Claim 6 or 8,
wherein the guide path is formed in a curved non-linear shape.

13. The assistant robot according to Claim 9,
wherein the guide path is linearly formed in an inclined manner.

Fig. 1

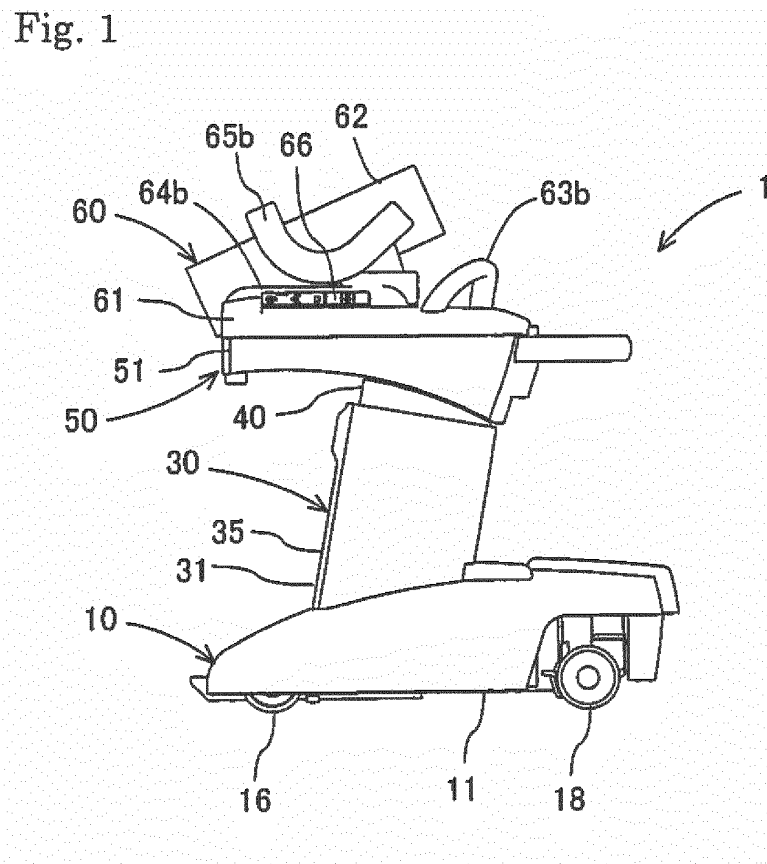


Fig. 2

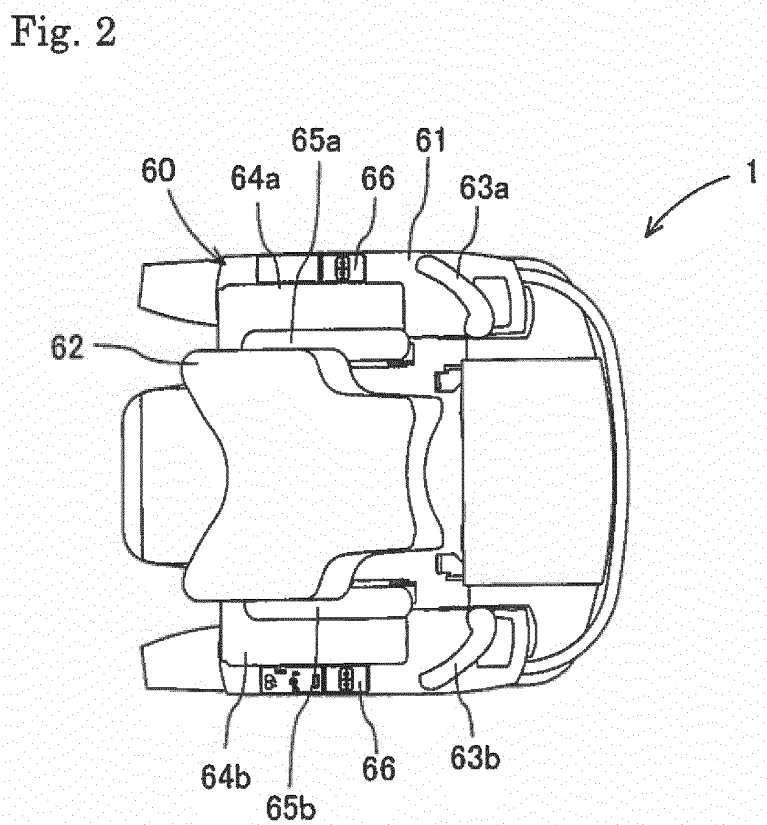


Fig. 3

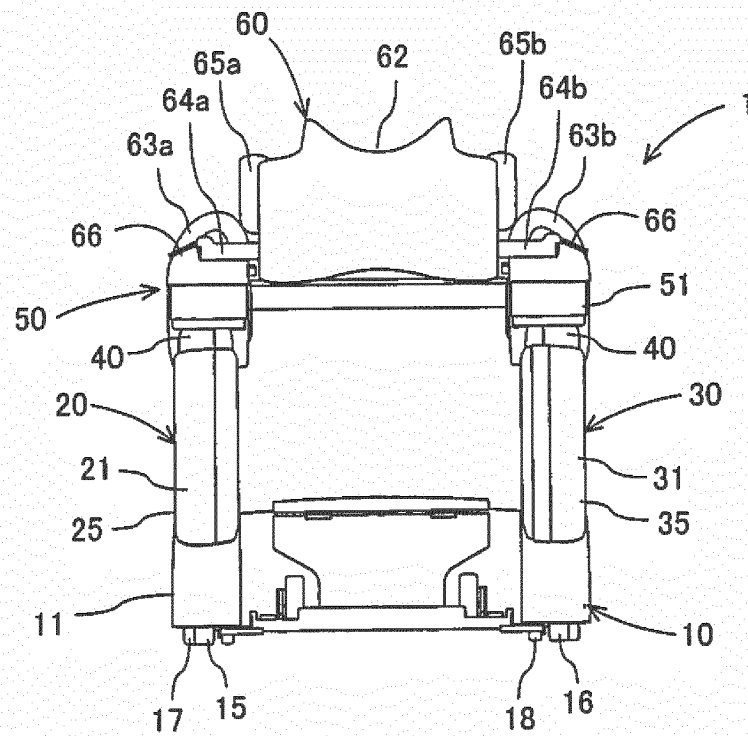


Fig. 4

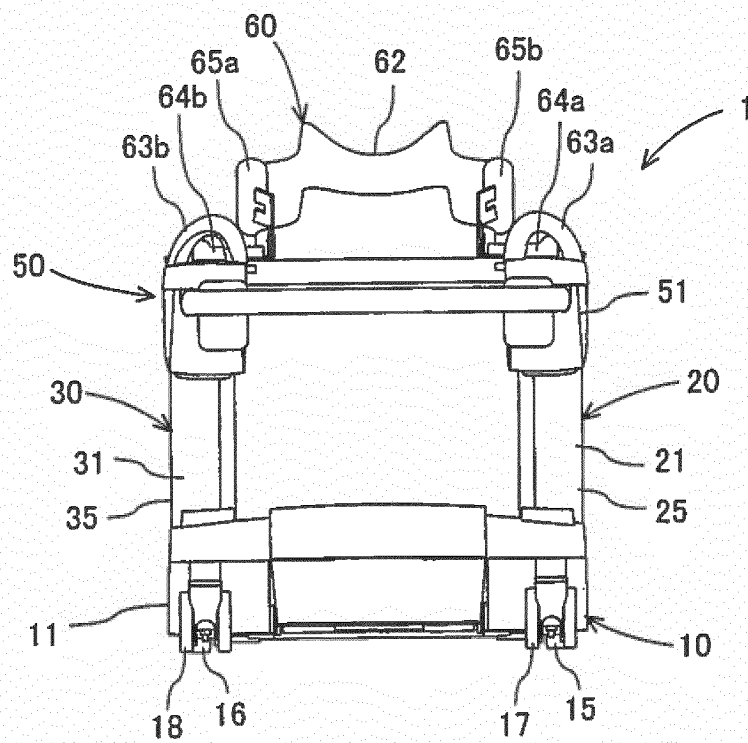


Fig. 5

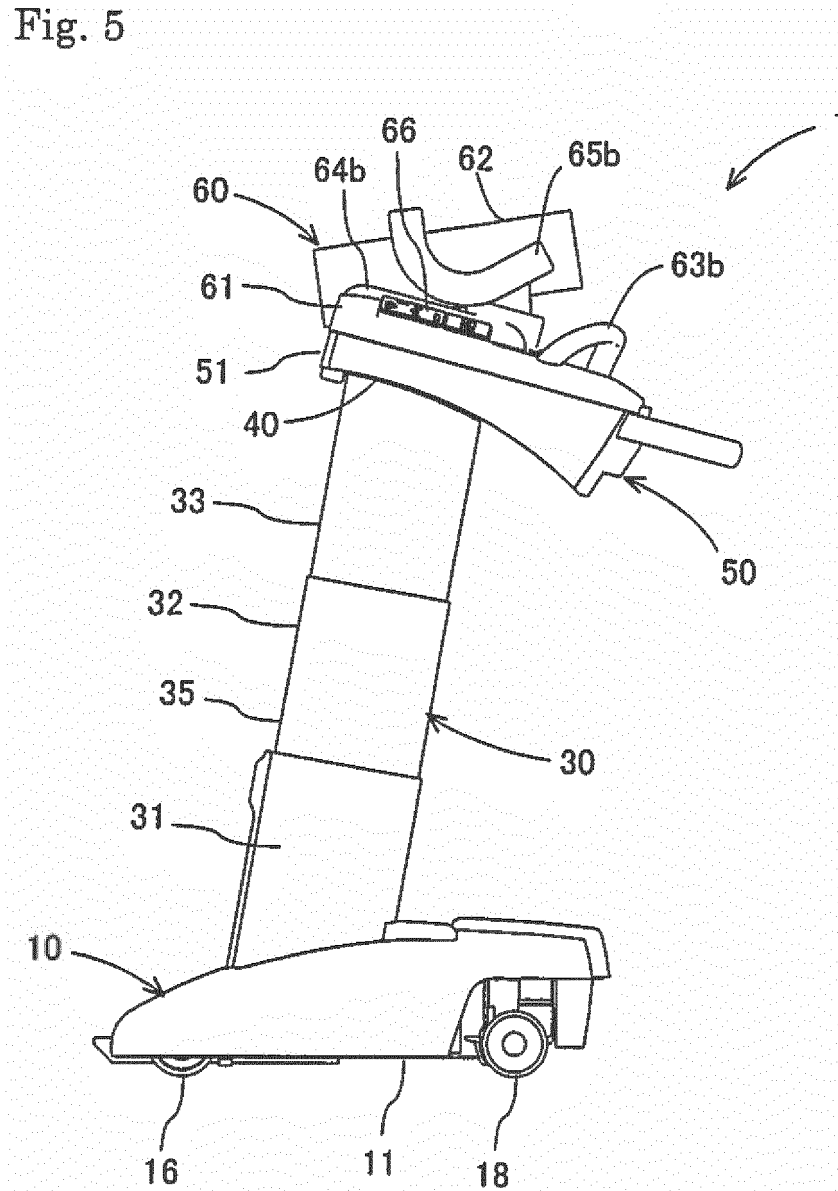


Fig. 6

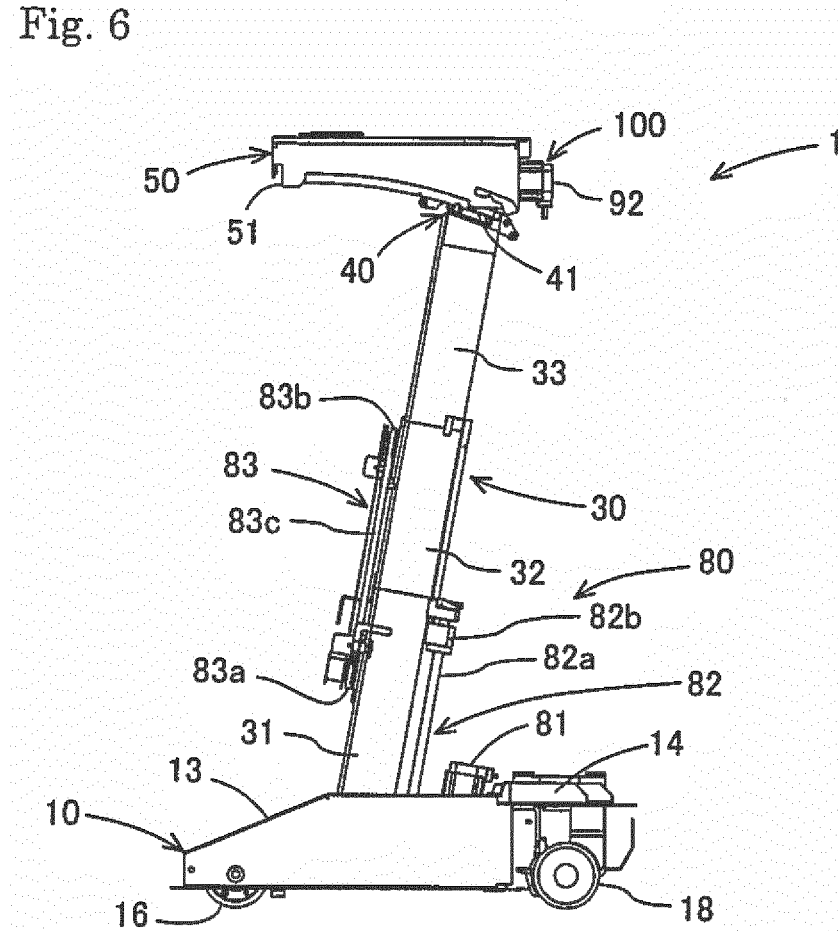


Fig. 7

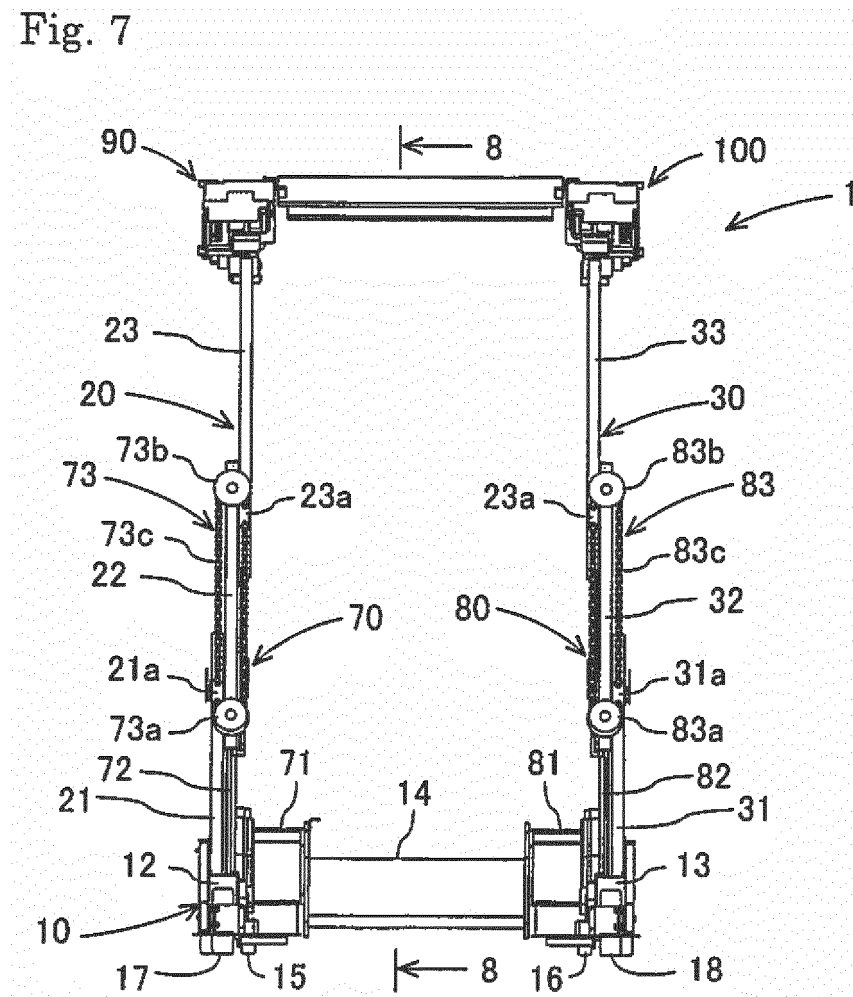


Fig. 8

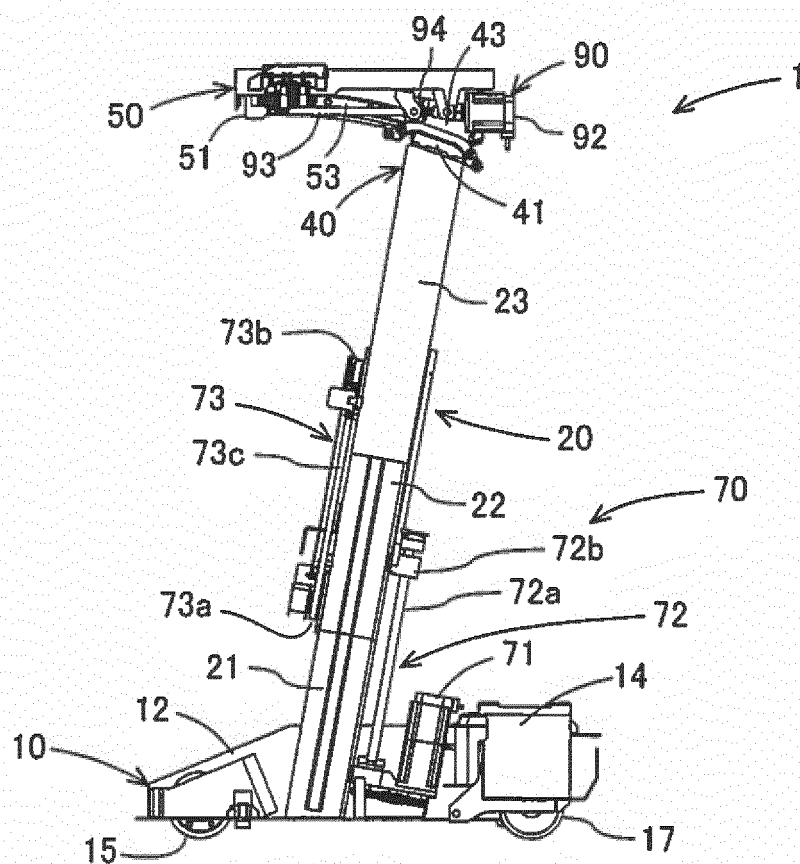


Fig. 9

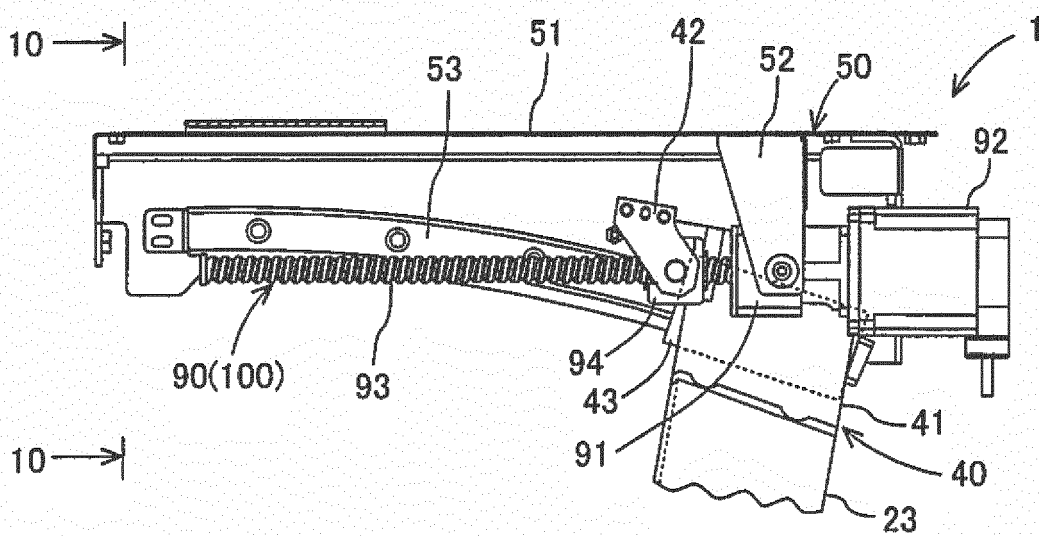


Fig. 10

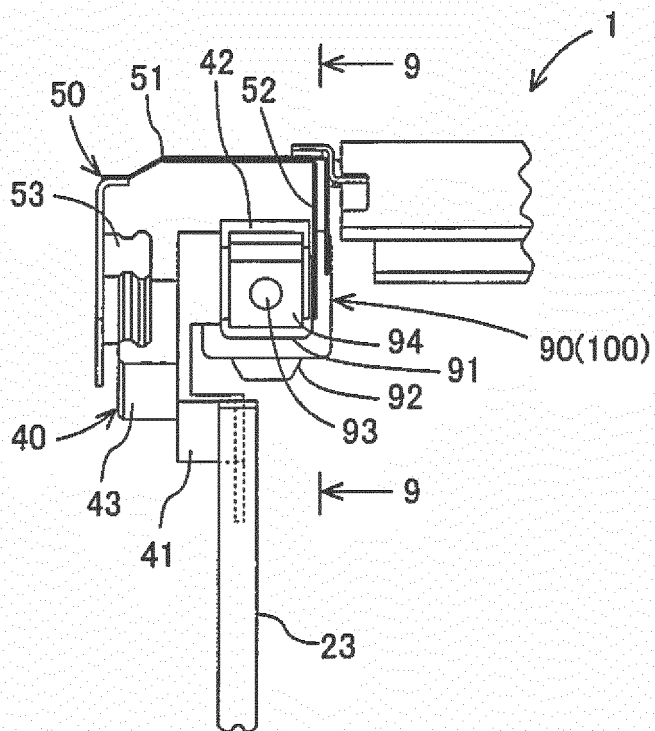


Fig. 11

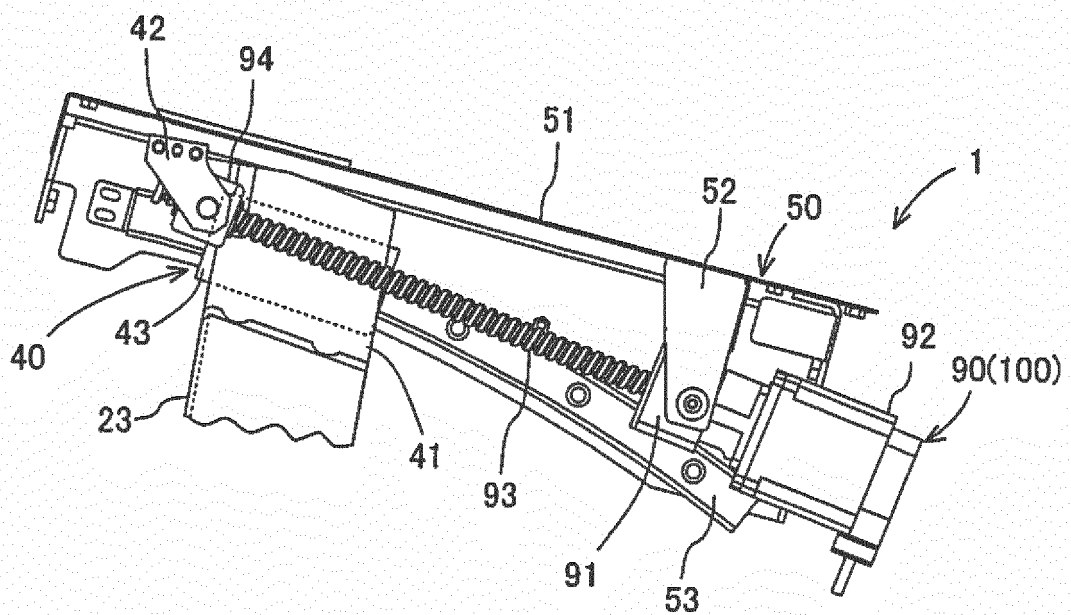


Fig. 12

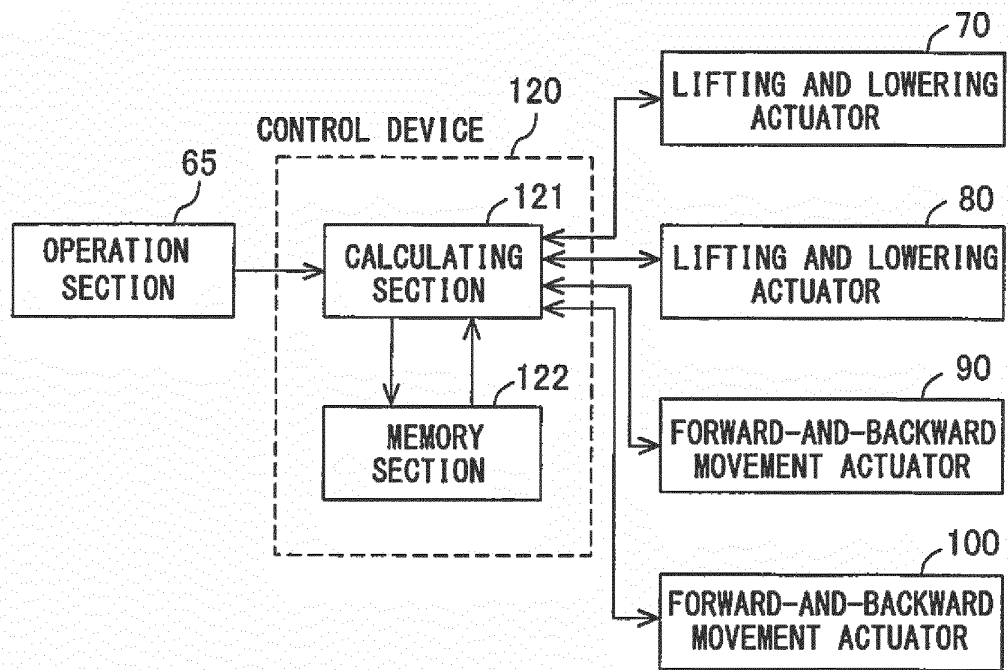


Fig. 13

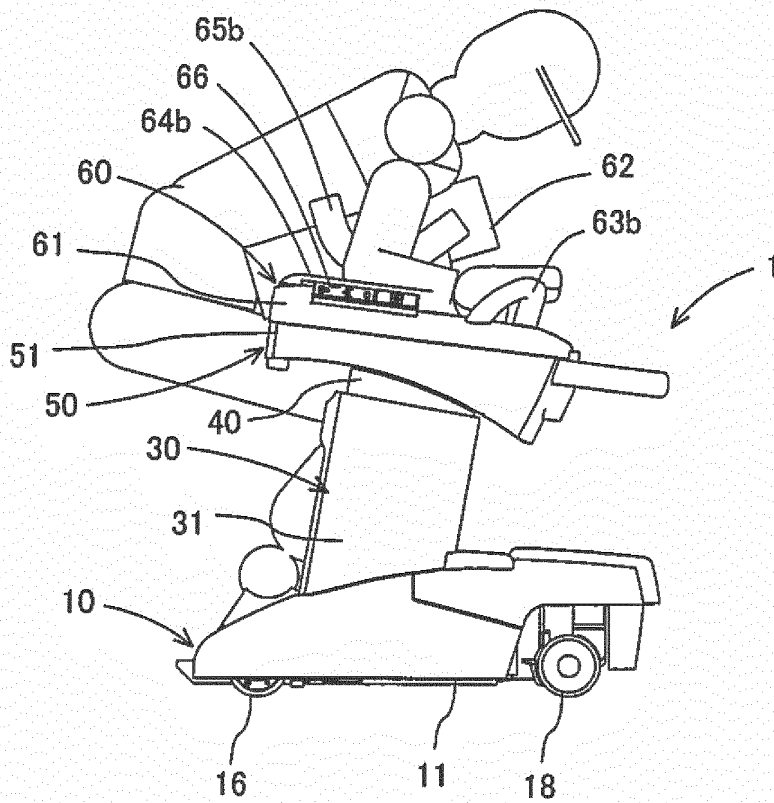


Fig. 14

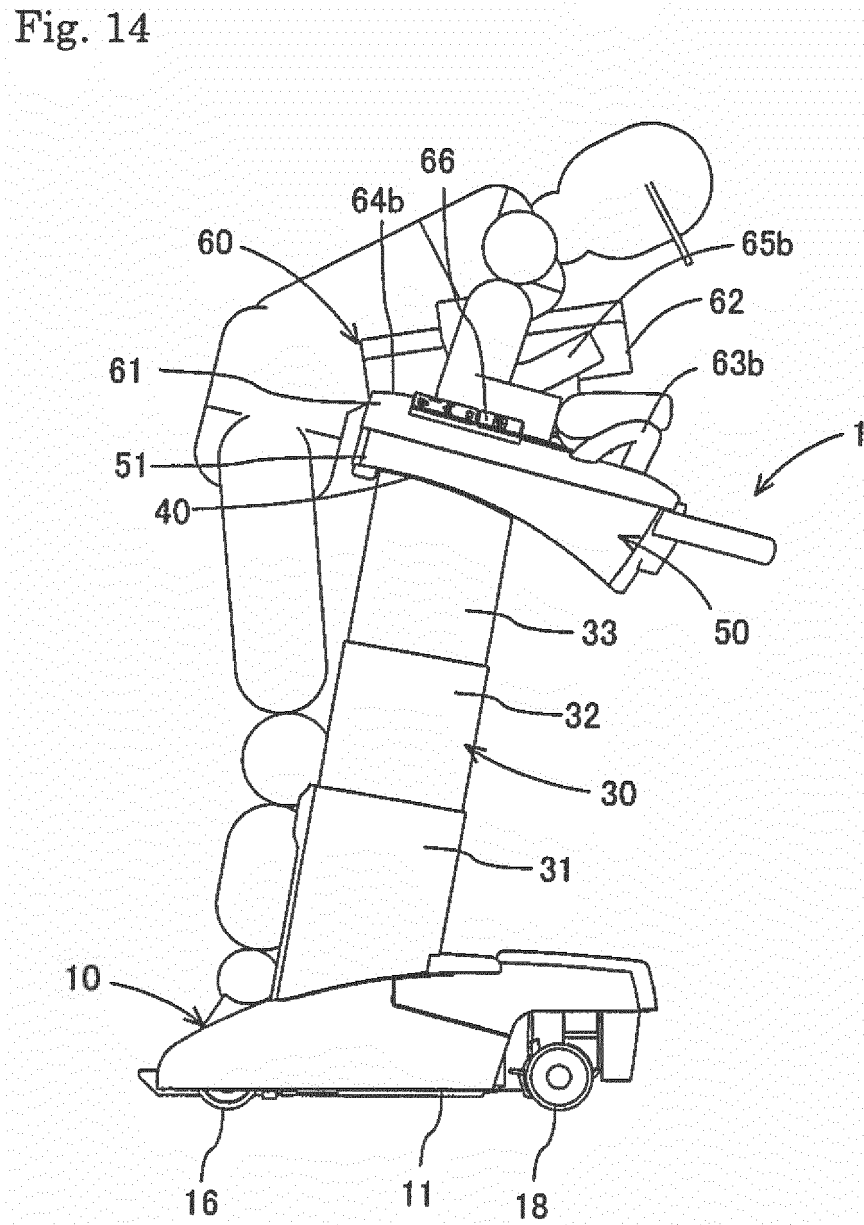


Fig. 15

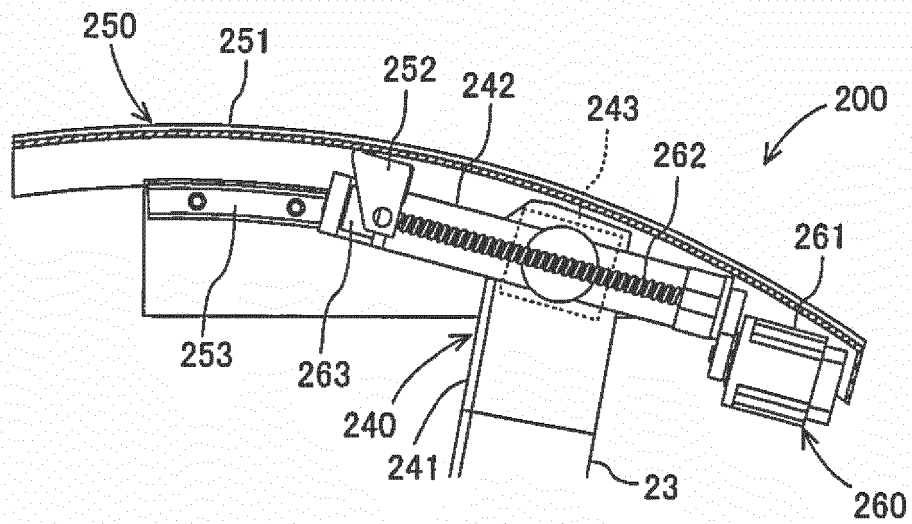


Fig. 16

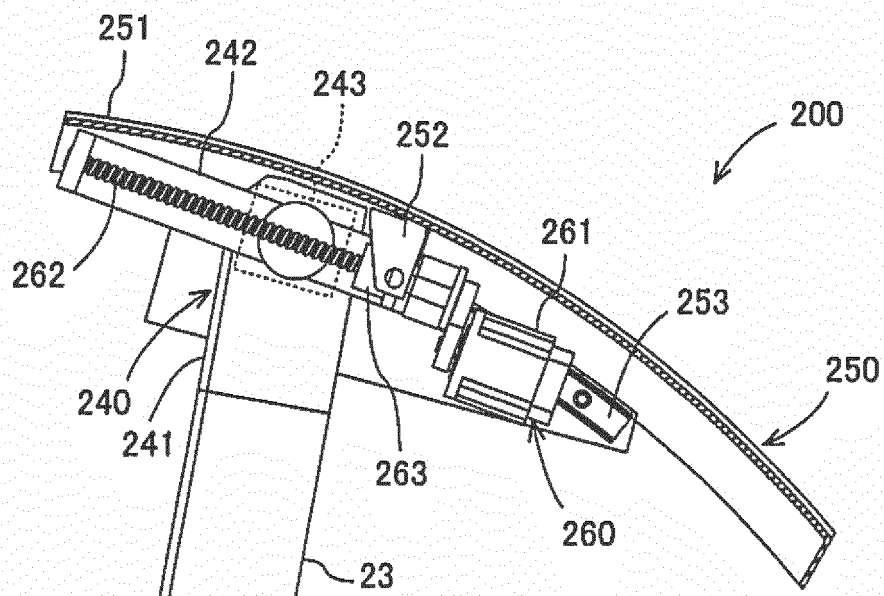


Fig. 17

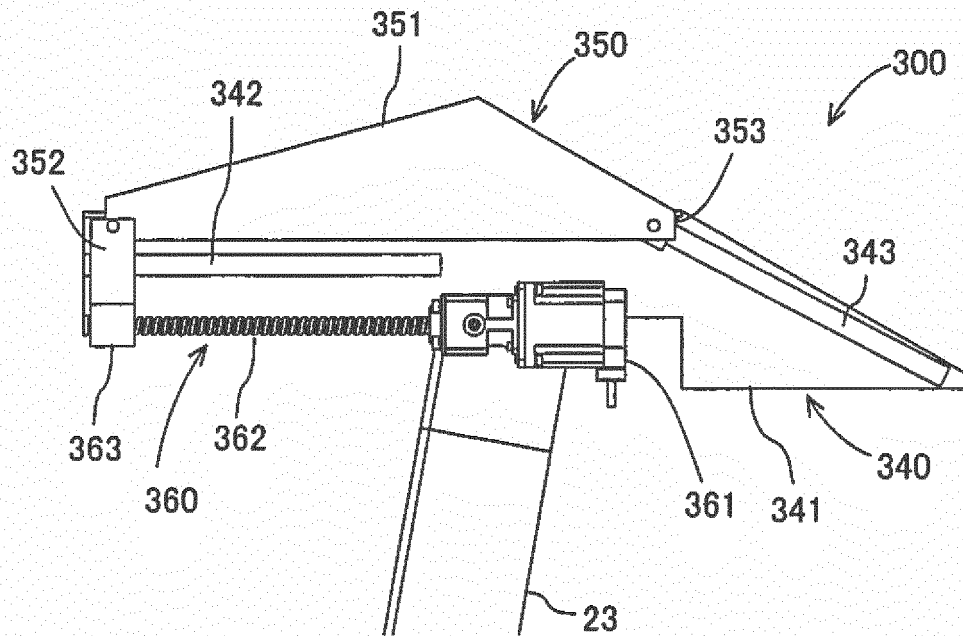


Fig. 18

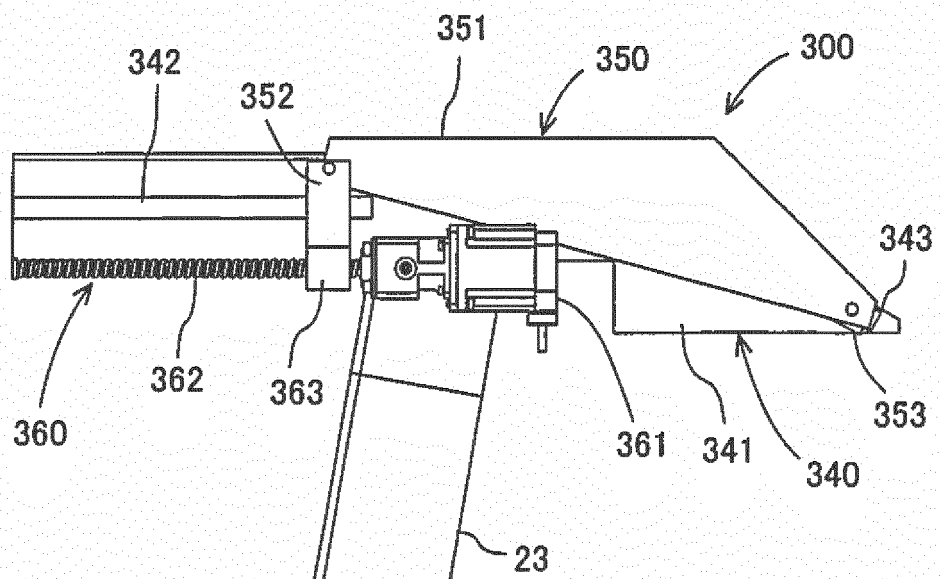


Fig. 19

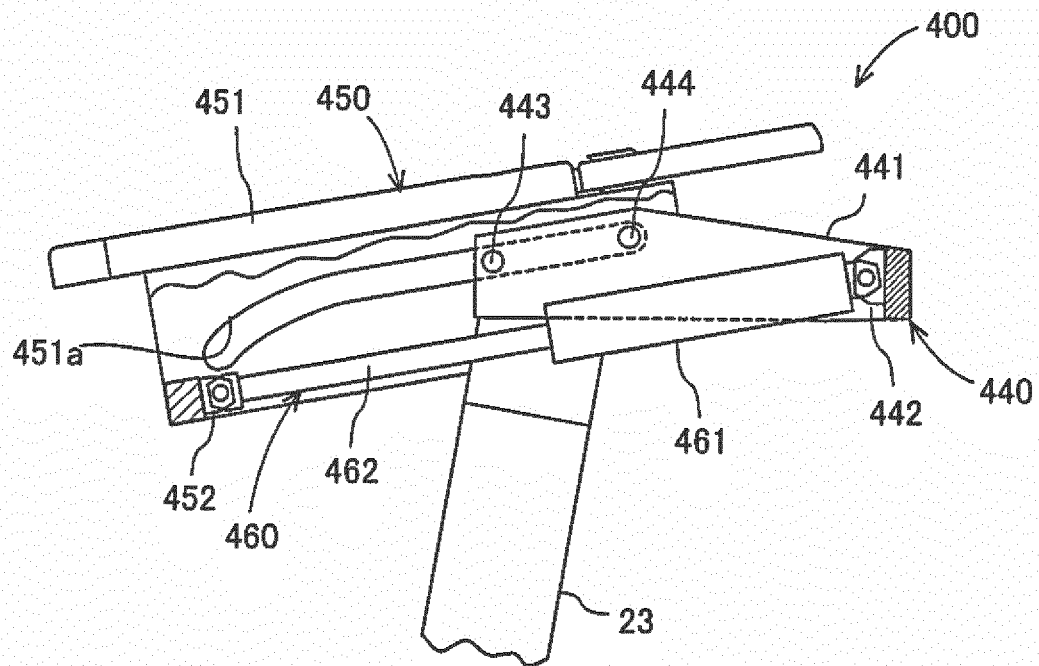
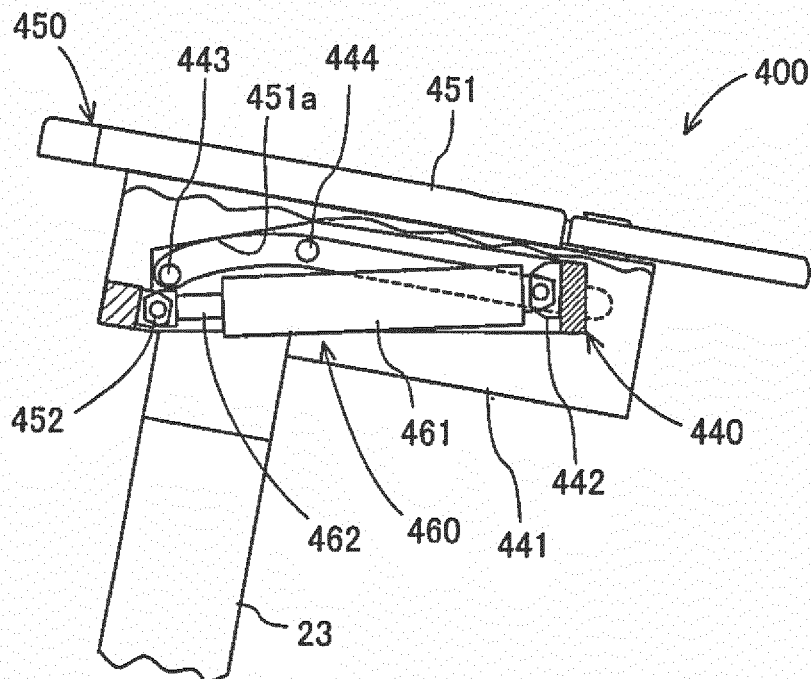


Fig. 20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/084660

A. CLASSIFICATION OF SUBJECT MATTER

A61H3/04(2006.01)i, A61G5/00(2006.01)i, A61G7/10(2006.01)i, B25J11/00(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)

A61H3/04, A61G5/00, A61G7/10, B25J11/00

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 1996-2015

Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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.
X A	JP 2010-110435 A (Honda Motor Co., Ltd.), 20 May 2010 (20.05.2010), paragraphs [0001] to [0096]; fig. 1 to 9 & US 2010/0113989 A1	1-2, 4 3, 5-13
A	WO 2011/93054 A1 (Fucom Co., Ltd.), 04 August 2011 (04.08.2011), paragraphs [0001] to [0143]; fig. 1 to 11 & WO 2011/093054 A1	1-13
A	WO 2010/140560 A1 (Tmsuk Co., Ltd.), 09 December 2010 (09.12.2010), paragraphs [0001] to [0065]; fig. 1 to 12 & US 2012/0133113 A1 & EP 2438894 A1 & WO 2010/140560 A1 & CN 102802583 A	1-13

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Date of the actual completion of the international search
04 February 2015 (04.02.15)Date of mailing of the international search report
24 February 2015 (24.02.15)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

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Patent documents cited in the description

- WO 2014122751 A [0003]