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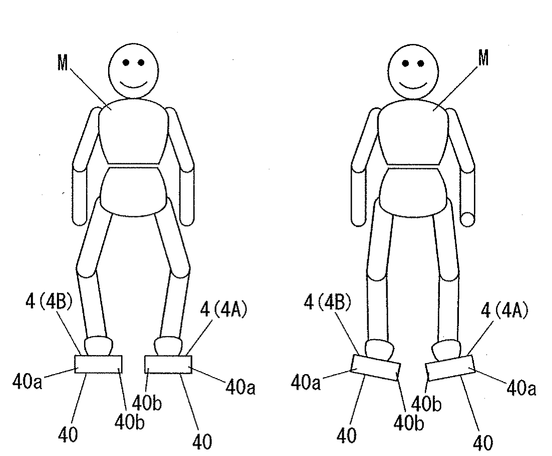
(54) EXERCISE ASSISTING SYSTEM

(57) The exercise assisting device includes a support unit (1) configured to bear a user's body and a drive device (2). The support unit (1) includes a pair of foot supports (4) having a bearing member (40) configured to bear the user's left foot and right foot respectively. The drive device (2) is configured to drive the support unit (1) to move the user's body so as to vary a load applied to user's lower limb. The exercise assisting device further includes a tilting device (A). The tilting device (A) includes a load detection unit (5), a tilting mechanism unit (6), and a control unit (8). The load detection unit (5) includes two load sensors (50) provided to an outer portion (40a) and an inner portion (40b) of the bearing member (40) respectively. The tilting mechanism unit (6) is configured to tilt the bearing member (40) inward or outward with regard to the user's foot. The control unit (8) is configured to control the tilting mechanism unit (6) so as to reduce a difference between loads detected by two load sensors (50) respectively.

FIG. 3A FIG. 3B



Description

Technical Field

[0001] The present invention relates to an exercise assisting device which gives an exercise effect to a user without the user's voluntary (active) exercise.

Background Art

[0002] In the past, there have been proposed various types of exercise assisting devices which have a user make a passive exercise so as to give an exerciser effect to the user. The passive exercise is an exercise where the user's muscles are stretched without effort but with an aid of external forces being applied to the user. Therefore, these exercise assisting devices can give the exercise effect to the user in a like fashion as the user exercises voluntarily.

[0003] The exercise assisting devices are known to be classified into two types, one being configured to apply a force of bending joints of the user for stretching the muscles associated with the joints, and the other configured to apply a stimulus to a user's body to cause a nervous reflex by which associated muscles are forced to stretch.

[0004] Further, the exercise assisting devices are designed to require the user to take different postures depending upon the muscles to be stretched. One example of the exercise assisting devices is to simulate a walking by the user at a standing posture, as proposed in JP 2003-290386 A and JP10-55131 A.

[0005] JP 2003-290386 A discloses a training device which includes a pair of steps bearing thereon left and right feet of the user, and is configured to interlock the reciprocating movements of the left and right steps for providing a skating simulation exercise to the user. The device is arranged to shift the user's weight along forward/rearward direction and also along lateral direction such that the user makes the use of one's nervous reflex to keep a balance with an effect of stretching the muscles. The steps are driven by a driving mechanism to move so that the user can enjoy the passive exercise simply by placing one's feet on the steps and without making an effort or active movement. JP 10-55131 A discloses a walk experience device is designed for walking training or virtual-reality exercise, and includes a pair of left and right foot plates driven by a horizontal driving unit.

[0006] The device of JP 2003-290386 A or JP 10-55131 A is widely utilized by a user suffering from such as knee pains when training one's lower limb. By the way, knee osteoarthritis is known to be a main cause of the knee pains. The knee osteoarthritis may develop as a consequence of that distorted skeleton of user's lower limbs such as bow-legs and knock-knees is kept over a prolonged period, i.e., a load axis (passing through the hip joint and ankle joint) is being long kept out of a knee center. Therefore, it is important to correct skeletal deformity of the lower limbs for the purpose of preventing the knee pains. However, the device of JP 2003-290386 A or JP 10-55131 A is not intended to correct the skeletal deformity of the lower limbs.

Disclosure of Invention

[0007] In view of above insufficiency, the purpose of the present invention has been accomplished to provide an exercise assisting device capable of correcting a skeletal deformity of a lower limb.

[0008] The exercise assisting device in accordance with the present invention includes a support unit configured to bear a user's body and a drive device. The support unit includes a pair of foot supports having a bearing member configured to bear the user's left foot and right foot respectively. The drive device is configured to drive the support unit to move the user's body so as to vary a load applied to user's lower limb. The exercise assisting device further includes a tilting device. The tilting device is configured to tilt at least one part of the bearing member so as to reduce a difference between a load applied to an outer portion of the bearing member corresponding to an outer part of user's foot and a load applied to an inner portion of the bearing member corresponding to an inner part of the user's foot.

[0009] According to this invention, at least one part of the bearing member is tilted so as to reduce the difference between the load applied to the outer portion of the bearing member and the load applied to the inner portion of the bearing member. Therefore, while the load applied to the outer portion of the bearing member exceeds the load applied to the inner portion of the bearing member (that is, the user has bow legs), the load applied to the inner part of the lower limb is increased to a greater extent than in a condition where the user's foot has its width direction kept parallel to a horizontal plane. Accordingly, it is possible to intensively train the inner part of muscles of the lower limb. Meanwhile, while the load applied to the inner portion of the bearing member exceeds the load applied to the outer portion of the bearing member (that is, the user has knock knees), the load applied to the outer part of the lower limb is increased to a greater extent than in a condition where the user's foot has its width direction kept parallel to the horizontal plane. Accordingly, it is possible to intensively train the outer part of the muscles of the lower limb. Thus, it is possible to improve a balance (capacity imbalance) between the outer part and the inner part of the muscles of the lower limb, even if the user has bow legs or knock knees. As a result, it is possible to remedy deformed bones of the lower limb (that is, it is possible to recover a skeletal alignment of the lower limb). Further, the user can have the exercise while balancing the load applied to the lower limb (i.e., equalizing the loads applied to the outer and inner parts of the lower limb), thereby reducing the load acting on the knee joint. Accordingly, the user can enjoy a comfortable passive exercise (training) while being alleviated of the knee pain, which means that even the user suffering from knee pains during one's walking can make the passive exercise.

[0010] In a preferable embodiment, the tilting device includes a load detection unit provided to the foot support so as to detect a load applied to the bearing member, and a tilting mechanism unit configured to tilt at least one part of the bearing member inward or outward with regard to the user's foot. The tilting device further includes a control unit configured to control the tilting mechanism unit based on the load detected by the load detection unit.

[0011] According to this embodiment, at least one part of the bearing member is tilted inward or outward with regard to the user's foot based on the load detected by the load detection unit. Therefore, it is possible to adjust a tilt of the bearing member to be a tilt suitable for the user.

[0012] In a more preferable embodiment, the load detection unit includes two load sensors provided to the outer portion and the inner portion of the bearing member respectively. The control unit is configured to control the tilting mechanism unit so as to reduce a difference between loads respectively detected by the two load sensors.

[0013] According to this embodiment, since the load applied to the outer portion of the bearing member and load applied to the inner portion of the bearing member are detected, it is possible to estimate a deformation of the user's lower limb precisely. Therefore, it is possible to adjust a tilt of the bearing member to be a tilt suitable for the user.

[0014] In a more preferable embodiment, the load detection unit includes a load sensor provided to either the outer portion or the inner portion of the bearing member. The control unit is configured to make a comparison of a load detected by the load sensor with a predetermined threshold, and determine the difference between the load applied to the outer portion of the bearing member and the load applied to the inner portion of the bearing member based on the resultant comparison.

[0015] According to this embodiment, the number of the load sensor of the load detection unit can be reduced to one. Therefore, it is possible to reduce a production cost.

Brief Description of Drawings

[0016]

FIG. 1A is a block diagram illustrating a principle part of an exercise assisting device in accordance with a first embodiment of the present invention;
FIG. 1B is a cross-sectional view showing the principle part of the above exercise assisting device;
FIG. 2 is a plan view showing the above exercise assisting device;
FIG. 3 is an explanatory view of the above exercise assisting device;
FIG. 4 is an explanatory view of an exercise assisting device in accordance with a second embodiment of the present invention;
FIG. 5 is an explanatory view showing a principle part of the above exercise assisting device of another configuration;
FIG. 6 is an explanatory view showing a principle part of the above exercise assisting device of another configuration;
FIG. 7A is a side view showing the above exercise assisting device of another configuration; and
FIG. 7B is a top view showing the same.

Best Mode for Carrying Out the Invention

(first embodiment)

[0017] There is an exercise assisting device in accordance with the first embodiment adapted in use to be placed on a floor. As shown in FIGS. 1 and 2, the exercise assisting device includes a support unit **1** configured to bear a body of a user **M** (see FIG. 3), a drive device **2,** and a housing **3.** The support unit **1** includes a pair of foot supports **4** respectively configured to bear the left foot and right foot of the user **M.** The drive device **2** is configured to move the foot supports **4** to move the body of the user **M** with one's feet resting on the foot supports **4** respectively so as to vary a load applied to a lower limb of the user **M.** The support unit 1 and drive device **2** are housed in the housing 3.

[0018] The housing **3** includes a base plate **30** used as a carrier to be placed on a floor, and designed to have a rectangular parallelepiped shape. The pair of the foot supports **4** and drive device **2** are disposed on the base plate **30.** The base plate **30** in the present embodiment is configured to have the rectangular parallelepiped shape, although not limited to a peripheral shape. For a simplified explanation made hereinafter, the base plate **30** is illustrated to have a top surface parallel to the floor when it is placed on the floor. Accordingly, a vertical dimension in FIG. 1B is equal to a vertical dimension of the exercise assisting device to be in use.

[0019] An upper plate **31** is disposed above the base plate **30,** and is coupled thereto to constitute a housing **3,** It is noted that an arrow X in FIG. 2 denotes a forward direction of the housing **3.** The upper plate **31** is not shown in FIG. 2.

[0020] The upper plate **31** is formed with two openings **31** a extending in a thickness direction of the upper plate **31** to expose the foot supports **4,** respectively. The openings **31 a** are each formed into a rectangular shape. The openings **31a** have their longitudinal center lines extending in a crossing relation with respect to the back-and-forth direction of the housing **3** such that the distance between the center lines is greater at the front ends of the openings **31a** than at the rear ends thereof.

[0021] Each of the foot supports **4** has a bearing member **40** that is a footrest where the user **M** rests one's foot. In order to distinguish the foot supports **4,** as necessary, the foot support **4** for bearing the left foot of the user **M** is represented as the left foot support **4A,** and the foot support **4** for bearing the right foot of the user **M** is represented as the right foot support **4B**. The foot supports **4** are designed in a similar manner. Therefore, an explanation is made to the left foot support **4A** with reference to FIG. 1B, and an explanation concerning the right foot support **4B** is omitted.

[0022] The left foot support **4A** has the bearing member **40** where the user **M** rests one's left foot. The bearing member **40** is formed into a rectangular plate to have such dimensions as to bear the entire foot of the user **M.** The bearing member **40** has a bearing surface (upper surface in FIG. 1B) where the user **M** rests ones' foot and is made of a material or shaped to have a large coefficient of friction.

[0023] There is a load detection unit **5** provided to the bearing member **40.** The load detection unit **5** is configured to detect a load applied to the bearing member **40** and has two load sensors **50.** One load sensor **50** (represented by a reference number **50A,** as necessary) is provided to an outer portion (left portion in FIG. 1B) **40a** of the bearing member **40** corresponding to an outer part of user's foot. The other load sensor **50** (represented by a reference number **50B,** as necessary) is provided to an inner portion (right portion in FIG. 1B) **40b** of the bearing member **40** corresponding to an inner part of the user's foot. That is, the load detection unit 5 includes the load sensor **50A** configured to detect a load applied to the outer portion **40a** and load sensor **50B** configured to detect a load applied to the inner portion **40b.** It is noted that a sensor made of semiconductors is adopted as the load sensor **50.** Further, a load cell utilizing a strain gauge can be adopted as the load sensor **50.**

[0024] There is a basement **41** disposed below the bearing member **40** (between the base plate **30** and the bearing member **40)** and rotatively coupled to the bearing member **40.** The basement **41** has an opposite surface (upper surface, in FIG. 1B) opposite to the inner portion **40b** of the bearing member **40,** and the opposite surface is provided with a side wall portion **42.** The side wall portion **42** is provided at its apex with a tilting axle **43** to be rotatively connected to the bearing member **40.** The inner portion **40b** of the bearing member **40** is provided at its lower surface (back surface) with a tilting bearing **44** having an axle hole **44a** for the tilting axle **43.** The tilting axle **43** is formed such that its central axis extends along a forward/rearward direction of the foot of the user **M.** To rotate the bearing member **40** around the tilting axle **43** can tilt the bearing member outward (leftward, in FIG. 1B) or inward (rightward, in FIG. 1B) with regard to the foot of the user **M.** The bearing surface of the bearing member **40** where the user **M** rests one's left foot can be tilted as the bearing member **40** is tilted.

[0025] By the way, there is a tilt adjusting unit **45** provided to the foot support **4.** The tilt adjusting unit **45** is configured to adjust a tilt of the bearing member **40.** The tilt adjusting unit **45** includes a rack **45a** provided to a lower surface of the outer portion **40a** of the bearing member **40,** and further includes a gear **45b** provided to the basement **41.** The gear **45b** meshes with the rack **45a.** The tilt adjusting unit **45** further includes an adjusting motor **45c** being a stepping motor (pulse motor) configured to rotate the gear **45b** clockwise or counterclockwise. The basement **41** has a through hole for the rack **45a** extending in a thickness direction thereof.

[0026] The tilt adjusting unit **45** drives the adjusting motor 45c to rotate the gear **45b** clockwise or counterclockwise. The rack **45a** moves upward or downward in relative to the gear **45b** as the gear **45b** rotates or counterrotates. A movement of the rack **45a** varies a distance between the bearing member **40** and the basement **41** is varied in an opposite end (the outer portion **40a** of the bearing member **40)** in a width direction of the foot support **4.** Therefore, the tilt of the bearing member **40** varies. It is noted that the basement **41,** side wall portion **42,** tilting axle **43,** tilting bearing **44,** and tilt adjusting unit **45** are not shown in FIG. 2.

[0027] As described in the above, the left foot support **4A** is provided with the load detection unit **5** configured to detect the load applied to the bearing member **40** (that is, the load applied by the left foot of the user **M)** and the tilting mechanism unit **6** configured to tilt the bearing member **40** inward or outward with regard to the foot (left foot). Likewise, the right foot support **4B** is provided with the load detection unit **5** configured to detect the load applied to the bearing member **40** (that is, the load applied by the user **M** 's right foot) and the tilting mechanism unit **6** configured to tilt the bearing member **40** inward or outward with regard to the foot (right foot). In the following explanation, in order to distinguish the load detection unit **5** and tilting mechanism unit **6** of the left foot support **4A** from the load detection unit **5** and tilting mechanism unit **6** of the right foot support **4B** respectively, a suffix **"A"** is attached to the reference number of each of the load detection unit **5** and tilting mechanism unit **6** of the left foot support **4A,** and a suffix "**B**" is attached to the reference number of each of the load detection unit **5** and tilting mechanism unit 6 of the right foot support **4B**, as necessary.

[0028] Further, there is a pair of bearings **46** integrally formed on the lower surface of the basement **41.** The bearings **46** are apart from each other in the width direction of the bearing member **40.** There is a bearing plate **47** of U-shaped cross section rotatively coupled to the basement **41** to have its open end oriented upwardly. An axle **48** penetrating through the legs **47a** of the bearing plate **47** and the bearings **46** is used for a rotative coupling of the bearing member **47.** In this manner, the axle **46** is located along a width direction of the bearing member **40.** The bearing member **40** can rotate around the axle **48** such that both ends thereof in its longitudinal direction move upwardly or downwardly relative to the bearing plate **47.** It is noted that the bearing **46,** bearing plate **47,** and axle **48** are not shown in FIG. 1B.

[0029] By the way, the bearing plate **47** is attached to an upper surface of a footrest cover (not shown). The footrest cover is slidably attached to the base plate **30.** A truck **70** of U-shaped cross section is fixed to a bottom of the footrest cover to have its open end oriented downwardly.

[0030] The truck **70** is provided on each exterior face with two wheels **71**. The base plate **30** is formed with two fixed rails **72** for each of the left and right foot supports **4A** and **4B**. The truck **70** is placed on the rails **72** with the wheels **71** roll in rail grooves **72a** in an upper surface of the rails **72.** A derailment prevention plate (not shown) is provided on the upper surface of the rail **72** for preventing the wheels **71** from running off the rail grooves **72a**.

[0031] By the way, the rails **72** extend in a direction different from a lengthwise direction of the openings **31a** in the housing **3.** As described in the above, the openings 31 **a** have their individual longitudinal center lines crossed with each other so as to be spaced by a larger distance at the forward ends than at the rearward ends. Also, the rails **72** have their individual longitudinal directions crossed with each other in the like manner.

[0032] However, the rails **72** are inclined in relation to the forward/rearward direction of the housing **3** at a large angle than the openings **31a.** For example, when the openings **31a** have their lengths inclined relative to the forward/rearward direction of the housing **3** at an angle of **15°,** the rails **72** have its length inclined at an angle of 45°. In short, the rails **72** are oriented to such a direction as to prevent an increase of shearing force acting on the knee joints while the left and right foot supports **4A** and **4B** are moved along the rails **72** in a condition that the user's feet are placed thereon with each center line of the feet aligned with each of the length of the openings **31a.** Further, each of the left and right foot supports **4A** and **4B** is located such that the longitudinal direction of each of the left and right foot supports **4A** and **4B** is inclined, for example, at an angle of 9° relative to the forward/rearward direction (the direction indicated by the arrow X). Therefore, the user can take a natural posture without suffering from twisted feet when standing on the left and right foot supports **4A** and **4B.** Although the present embodiment illustrates a preferred mode that the left and right foot supports **4A** and **4B** are moved along the individual travel paths of shifting their positions both in the forward/rearward direction and the lateral direction, it is possible to determine the orientation of the rails **72** such that the left and right foot supports **4A** and **4B** are moved either in the forward/rearward direction or the lateral direction.

[0033] With the above arrangement, the left and right foot supports **4A** and **4B** are allowed to reciprocate respectively along the length of the rails **72.** Because of that the rails **72** have their length crossed respectively with the lengthwise center lines of the openings **31a,** the bearing member **40** is allowed to move within the openings **31a** along the direction crossing with the lengthwise direction of the openings **31 a.** In short, the truck **70,** wheels **71,** and rails **72** constitute a guide **7** restricting the travel path of each of the left and right foot supports **4A** and **4B.** It is noted that FIG. 1B shows the simplified guide **7.**

[0034] The drive device **2** is provided in order to move the pair of foot supports **4** respectively. The drive device **2** includes a drive motor **20,** which is a rotary motor, as a driving source generating a rotary driving force to move the pair of foot supports **4.** The drive device **2** further includes a router **21** and reciprocators **22.** The router **21** is configured to transmit the rotary driving force of the motor **20** to the left and right foot supports **4A** and **4B.** The reciprocators **22** in configured to use the driving force to reciprocate the trucks **70** respectively along the rails **72.** Although the present embodiment is configured to divide the driving force at the router **21** and transmit the divided driving force to the reciprocators **22,** it is equally possible to generate the reciprocating driving force at the reciprocator **22** and divide the same at the router **21.**

[0035] The router **21** includes a worm (first gear) **21a** and a pair of worm wheels (second gears) 21 **b.** The worm **21a** is coupled to an output shaft **20a** of the driving motor **20.** Each of the worm wheels 21 **b** meshes with the worm **21** a. The worm **21a** and the two worm wheels 21 **b** are held within a gearbox (not shown) fixed to the base plate **30.** A pair of bearings (not shown) is provided inside the gear box. The pair of bearings is configured to bear the opposite longitudinal ends of the worm **21** a.

[0036] Extending through the worm wheel 21 **b** is a rotary shaft 21c which is housed in the gear box. The rotary shaft 21 c is coupled to the worm wheel **21** b to be driven thereby to rotate. The rotary shaft 21 c is formed at its upper end with a coupling section **21d** with non-circular cross-section (rectangular one in the illustrated instance),

[0037] The reciprocator **22** includes a crank plate **22a,** a crank shaft **22b,** and a crank rod **22c.** The crank plate **22a** is coupled at its one end to the coupling section 21 d of the rotary shaft **21c.** The crank rod **22c** is coupled to the crank plate **22a** by means of the crank shaft **22b.** The crank shaft **22b** has its one end fixed to the crank plate **22a** and has the other end received in a bearing **22d** carried on one end of the crank rod **22c.** That is, the crank rod **22c** has its one end rotatively coupled to the crank plate **22b,** while the other end of the crank rod **22c** is coupled to the truck 70 by means of an axle **22e** so as to be rotatively coupled thereto.

[0038] As is apparent from the above, the crank rod **22c** functions as a motion converter to translate the rotary motion of the worm wheel **21** b into a reciprocatory motion of the truck **70.** The crank rod **22c** is provided for each of the worm wheels 21 **b.** The trucks **70** are provided respectively to the left and right foot supports **4A** and **4B.** Therefore, the crank rods **22c** function as the individual motion converters for translating the rotary motion of the worm wheels **21** b into the reciprocating motions of the left and right foot supports **4A** and **4B.**

[0039] As described in the above, the truck **70** has its travel path restricted by the wheels **71** and the rails **72.** Thus, the truck **70** reciprocates along the length of the rails **72** as the worm wheel **21** b rotates. That is, the rotation of the motor **20** is transmitted to the crank plate **22b** by way of the worm **21a** and the worm wheel **21b,** so that the crank rod **22c** coupled to the crank plate **22b** causes the truck 70 to reciprocate linearly along the rails **72.** Whereby, the left and right foot supports **4A** and **4B** are driven to reciprocate respectively along the length of the rails **72.**

[0040] In the present embodiment, the worm **21 a** and the two worm wheels **21** b are responsible for routing the driving force into two channels respectively for driving the left and right foot supports **4A** and **4B** so that the drive unit **2** drives the left and right foot supports **4A** and **4B** in a manner linked to each other. The worm wheels **21 b** are engaged with the worm **21a** at different portions spaced apart by 180° such that the right foot support **4B** comes to the forward end of its movable range when the left foot support **4A** comes to the rear end of its movable range. As the left foot support **4a** comes to the right end of its movable range when it comes to the rear end of the movable range, and the right foot support **4B** comes to the right end of its movable range when it comes to the forward end of the movable range, the left and right foot supports **4A** and **4B** shift in the same direction along the lateral direction.

[0041] As apparent from the above, it is possible to give a desired phase difference of the movement between the left and right foot supports **4A** and **4B** by varying positions of engaging the worm wheels **21** b with the worm 21 **a.** When the device is used by the user at the standing posture with one's feet placed on the left and right foot supports **4A** and **4B**, the phase difference of 180° is effective to minimize the shifting of the user's weight in the forward/rearward direction, enabling the exercise even by the user suffering from lowered balancing capability. Alternatively, when no phase difference is given, the device necessitates the shifting movement of the user's weight in the forward/rearward direction, thereby developing an exercise not only for the leg muscles but also for lower back muscles of the user maintaining the balancing capability.

[0042] By the way, each of the foot supports **4** is allowed to rotate around the axle **48.** Therefore, it is possible to vary the height positions of the forward end as well as the rearward end of the bearing member **40.** Thus, the height positions of the toe and the heel of the foot placed on the bearing member **40** can be varied for enabling the plantarflexion and dorsiflexion of the ankle joint. The present embodiment adopts the following structure in order to link the swinging movement of the bearing member **40** about the axle **48** with the reciprocating movement thereof along the rail **72.** That is, the base plate **30** is provided at a portion along the travel path of the bearing member 40 with a guide surface (not shown) including an inclination. In this connection, the basement **41** is provided on its bottom with a follower projection (not shown) which comes into engagement with the guide surface. The follower projection has at its top a roller which comes into rolling contact with the guide surface. Although the follower projection has the roller, it is suffice that the follower projection is formed from a material and/or shaped into a configuration to have a tip of small coefficient of friction.

[0043] In this case, the follower projection, which is arranged to come into rolling contact with the guide surface, rides up and down the inclination of the guide surface while each of the foot supports **4** is driven by the drive motor **20** to reciprocates, thereby swinging the basement **41** about the axle **48** to vary tilt angles of the bearing member **40** and basement **41** relative to the base plate **30,** and therefore enabling the plantarflexion and dorsifilexion at the ankle joint.

[0044] In the exercise assisting device of the present embodiment, the control unit 8 is configured to perform a control of the drive device **2** (an operation control of the drive motor **20** of the drive device **2)** as well as a control of the tilting mechanism unit 6 (an operation control of the adjusting motor **45c** of the tilting mechanism unit **6)**.

[0045] The control unit 8 is, for example, a micro computer. The control unit **8** controls an electrical power supplied to the drive motor 20 or adjusting motor **45c** from a power source not shown, thereby activating the drive motor **20,** deactivating the drive motor **20,** or adjusting the number of rotations of the drive motor 20. Further, the control unit **8** is configured to activate the drive motor **20** when a switch (not shown) provided on the housing **3** is turned on, and to deactivate the drive motor **20** when the switch is turned off.

[0046] The control unit **8** further is configured to supply pulse power to the adjusting motor **45c** of the tilting mechanism unit **6** from the power source to adjust the tilt of the bearing member **40.**

[0047] The control unit **8** adjusts the tilt of the bearing member **40** with reference to detection result of the respective load detection units **5.** The control unit **8** controls the tilting mechanism unit **6,** that is, tilts the bearing member **40** so as to reduce a difference between loads detected by two load sensors **50A** and **50B** of the load detection unit **5** respectively. Particularly, in the present embodiment, the control unit **8** controls the tilting mechanism unit **6** such that the difference between the loads detected by two load sensors **50A** and **50B** respectively becomes around 0 (that is, the load detected by the load sensor **50A** becomes equal to the load detected by the load sensor **50B).**

[0048] Therefore, in the exercise assisting device of the present embodiment, the load detection unit 5 including the two load sensors **50,** tilting mechanism unit **6,** and control unit **8** constitute a tilting device **A** configured to tilt the bearing member **40** so as to reduce a difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40.**

[0049] Next, an explanation is made to an operation of the exercise assisting device of the present embodiment. It is assumed that, in an initial condition, the switch is kept turned off and the left and right foot supports **4A** and **4B** are located at predetermined initial positions respectively. At the initial positions, the left and right foot supports **4A** and **4B** are located at the same level along the forward/rearward direction. That is, the left and right foot supports **4a** and **4B** lie on a line extending along the lateral direction when they are at the initial positions. Accordingly, when the user stands on the left and right foot supports **4A** and **4B** of the initial positions, a vertical line depending from the weight center of the user passes through a center between the left and right foot supports **4A** and **4B.**

[0050] As described in the above, the tilt of the bearing member **40** is adjusted such that the load detected by the load sensor **50A** becomes equal to the load detected by the load sensor **50B.** Therefore, at the initial condition, the bearing surface of the bearing member **40** is almost kept parallel to a horizontal plane unless the user **M** rests one's foot on the foot support **4.**

[0051] When the user **M** rests one's foot on the foot support **4,** a following operation is performed.

[0052] For example, when the load applied to the outer portion **40a** of the bearing member **40** exceeds the load applied to the inner portion **40b** of the bearing member **40** (that is, the user **M** has bow legs as shown in FIG. 3B), the bearing member **40** is tilted so as to raise the outer portion **40a** relative to the inner portion **40b** (that is, the bearing member **40** is tilted inward) by the tilting device **A** (see FIG. 3B). Further, as described in the above, the bearing member **40** is caused to tilt continuously until the difference between the loads respectively detected by two load sensors **50A** and **50B** becomes zero While the outer portion **40a** of the bearing member **40** is raised to a higher position than the inner portion **40b,** the load applied to the inner part of the lower limb is increased to a greater extent than in a condition where the user's foot has its width direction kept parallel to the horizontal plane (i.e., the bearing surface of the bearing member **40** lies in the horizontal plane). Accordingly, it is possible to intensively train the inner part of the muscles of the lower limb. It is not required that the difference between the loads is kept 0 in a strict sense. It is sufficient that the difference between the loads is kept around 0.

[0053] Meanwhile, when the load applied to the inner portion **40b** of the bearing member **40** exceeds the load applied to the outer portion **40a** of the bearing member **40** (that is, the user **M** has knock knees), the bearing member **40** is tilted so as to raise the inner portion **40b** relative to the outer portion **40a** (that is, the bearing member **40** is tilted outward) by the tilting device **A.** Further, as described in the above, the bearing member **40** is kept being tilted until the difference between the loads detected by two load sensors **50A** and **50B** respectively becomes zero. While the inner portion **40b** of the bearing member **40** is raised relative to the outer portion **40a,** the load applied to the inner part of the lower limb is increased by comparison with the condition where the foot breadth direction is kept parallel to the horizontal direction (the bearing surface of the bearing member **40** is kept parallel to the horizontal plane). Accordingly, it is possible to intensively train the inner part of the muscles of the lower limb. It is not required that the difference between the loads is kept 0 in a strict sense. It is sufficient that the difference between the loads is kept around 0.

[0054] When the load applied to the inner portion **40b** of the bearing member **40** is equal to the load applied to the outer portion **40a** of the bearing member **40** (that is, the user **M** has neither bow legs nor knock knees), the tilting device **A** does not tilt the bearing member **40.**

[0055] It is sufficient that the switch is turned on in order to operate the exercise assisting device from the initial condition. When the switch is turned on, the control unit **8** supplies an electrical power to the drive motor **20** to activate the drive motor **20.** While the drive motor **20** is activated, the drive motor **20** can drive the left and right foot supports **4A** and **4B** to move in the forward/rearward direction and at the same time to move in the lateral direction in the linked manner to each other. The left and right foot supports **4A** and **4B** are driven to reciprocate linearly along the rails **72,** respectively, so as to move in directions different from the lengthwise directions of the feet. For example, the left and right foot supports **4A** and **4B** move in the directions inclined at an angle of 45° relative to the forward/rearward direction of the housing **3,** over the travel distance of 20 mm, for example.

[0056] Further, the bearing member **40** and basement **41** is driven to swing about the axle **48** as each of the left and right foot supports **4A** and **4B** reciprocates along the rail **72.** While the bearing member **40** is moving, the follower projection rides up and down the inclination of the guide surface to cause the dorsiflexion of the ankle joint when each of the left and right foot supports **4A** and **4B** comes to its forward end position, and the plantarflexion when it comes to its rearward end position. The axle **48** is positioned nearer to the heel within the length of the foot bottom. Each of the dorsiflexion and plantarflexion is realized at the tilt angle of about 10° relative to a reference plane defined by the upper surface of the base plate **30.** The dorsiflexion and the plantarflexion can be made respectively at the rearward end position and the forward end position of each of the left and right foot supports **4A** and **4B** in opposite relation to the above. Also, the tilt angle relative to the reference plane can be selected differently from the above mentioned angle. Such modified operation can be easily realized by an appropriate shaped guide surface.

[0057] The exercise assisting device of the present embodiment has the user **M** make the passive exercise by means of moving the left and right foot supports **4A** and **4B** as described in the above.

[0058] As described in the above, according to the exercise assisting device of the present embodiment, the bearing member **40** is tilted so as to reduce the difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40.** Therefore, while the load applied to the outer portion **40a** of the bearing member **40** exceeds the load applied to the inner portion **40b** of the bearing member **40** (that is, the user has bow legs), the load applied to the inner part of the lower limb is increased to a greater extent than in a condition where the user's foot has its width direction kept parallel to a horizontal plane. Accordingly, it is possible to intensively train the inner part of muscles of the lower limb. Meanwhile, while the load applied to the inner portion **40b** of the bearing member **40** exceeds the load applied to the outer portion **40a** of the bearing member **40** (that is, the user has knock knees), the load applied to the outer part of the lower limb is increased to a greater extent than in a condition where the user's foot has its width direction kept parallel to the horizontal plane. Accordingly, it is possible to intensively train the outer part of the muscles of the lower limb. Thus, it is possible to improve a balance (capacity imbalance) between the outer part and the inner part of the muscles of the lower limb, even if the user has bow legs or knock knees. As a result, it is possible to remedy deformed bones of the lower limb (that is, it is possible to recover a skeletal alignment of the lower limb). Further, the user can enjoy a comfortable passive exercise (training) while being alleviated of the knee pain, which means that even the user suffering from knee pains during one's walking can make the passive exercise.

[0059] Further, since the load applied to the outer portion **40a** of the bearing member **40** and load applied to the inner portion **40b** of the bearing member **40** are detected, it is possible to estimate a deformation of the user's lower limb precisely. The control unit is configured to control the tilting mechanism unit **6** so as to reduce the difference between loads detected by the two load sensors **50A** and **50B** respectively, thereby tilting the bearing member **40** inward or outward. Therefore, it is possible to adjust the tilt of the bearing member **40** to be a tilt suitable for the user **M.**

[0060] It is noted that a configuration of the tilting mechanism unit 6 is not limited to the above instance. For example, a conventional configuration such as a set of a rotary motor and feed screw, a set of a rotary motor and belt, a set of a rotary motor and pantograph mechanism, a linear movement mechanism utilizing a solenoid coil, and a liner movement mechanism utilizing an airbag can be adopted as the configuration of the tilting mechanism unit **6.**

[0061] In the above embodiment, the router **21** is configured to have the worm 21 **a** and the worm wheels **21** b for realizing the power transmission from the output shaft **20a** of the drive motor **20** to the rotary shaft **21c** of the worm wheel **21 b** with speed reduction. However, a belt can be utilized to transmit the power from the output shaft **20a** of the drive motor **20** to the rotary shaft **21c** perpendicular to the output shaft **20a.** In this instance, instead of the worm wheel **21b,** a pulley is utilized to receive the belt while dispensing with the worm **21 a.**

[0062] In the above embodiment, the drive motor **20** has its output shaft **20a** extending along the upper surface of the base plate **30.** However, when the output shaft **20a** is required to extend perpendicular to the upper surface of the base plate **30,** spur gearing is adopted to achieve the transmission and routing of the rotary power, instead the combination of the worm **21a** and the worm wheels **21 b. In this** instance, pulleys and a belt may be used in place of the spur gearing for transmission of the rotary power between the pulleys.

[0063] Instead of using the crank plate **22a** and the crank rod **22c,** the reciprocator **22** may be composed of a grooved cam driven to rotate by the drive motor 20 and a cam follower engaged in a groove of the cam. In this instance, the grooved cam can be used instead of the worm wheel **21b** and be arranged to have its rotation axis parallel to the output shaft **20a** of the drive motor **20** for power transmission from the output shaft **20a** to the grooved cam through a pinion.

[0064] Further, when using only one grooved cam for power transmission from the output shaft **20a** of the drive motor **20** to the groove cam, two cam followers can be used for engagement respectively with the cam grooves of the cams such that the grooved cam and the cam followers are cooperative to function as the router **21** as well as the reciprocators **22.**

[0065] Although the illustrated embodiment has the base plate **30** formed with the guide surface and the basement **41** formed with the follower projection, the same operation can be achieved with a configuration in which the basement **41** is provided with the guide surface and the base plate **30** is provided with the follower projection.

[0066] Since the exercise assisting device of the present embodiment includes the load detection unit 5, the exercise assisting device sets automatically the tilt of the bearing member **40.** However, the load detection unit **5** is optional. That is, the exercise assisting device may be configured to enable the user to adjust manually the tilt of the bearing member **40** based on one's foot condition (e.g. bow legs or knock knees). In this instance, it is sufficient that an operation unit (not shown) for operating the tilting mechanism unit **6** is provided to the housing **3.**

[0067] Although the exercise assisting device of the present embodiment is configured to be adapted in use to be placed on a floor, the exercise assisting device can be used with its portion embedded in the floor. A selection is made as to whether the exercise assisting device is placed at a fixed position or movably supported. These respects can be applied to the exercise assisting device of a below mentioned second embodiment.

(second embodiment)

[0068] The exercise assisting device of the present embodiment is different in the configuration of the tilting device **A** from the exercise assisting device of the first embodiment. Other components of the exercise assisting device of the present embodiment are the same as those of the first embodiment. Therefore the other components are designated by like reference numerals and dispensed with duplicate explanations.

[0069] In the tilting device A of the present embodiment, as shown in FIGS 4A to 4C, the load detection unit 5 includes the load sensor **50** configured to detect the load applied to the inner portion **40b** of the bearing member **40.** In short, unlike the load detection unit **5** of the first embodiment, the load detection unit 5 of the present embodiment includes only one load sensor **50.**

[0070] The control unit **8** of the present embodiment is configured to control the tilting mechanism unit **6** based on the load detected by the one load sensor **50.** The control unit **8** is configured to make a comparison of the load detected by the load sensor **50** with a predetermined threshold, and determine the difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40** based on the resultant comparison. The predetermined threshold is, for example, the load applied to the inner portion **40b** in a condition where the user **M** applies the same load to the outer portion **40a** and inner portion **40b** of the bearing member **40.** In this instance, the difference between the load applied to the outer portion **40a** and the load applied to the inner portion **40b** is determined by a difference between the predetermined threshold and the load detected by the load sensor **50.** It is noted that the predetermined threshold can be estimated from body weight of the user **M.** It is sufficient that the user **M** inputs own body weight to the exercise assisting device in preparation to use the exercise assisting device. Moreover, the predetermined threshold can be estimated from the loads detected by the load sensors of the load detection unit **5** of the respective foot supports **4.**

[0071] The control unit **8** has not only the predetermined threshold but also a judgment value as a value to be compared with the load detected by the load sensor **50.** The judgment value is a value used for judging whether or not the user **M** rests one's foot on the foot support **4.** The control unit **8** is configured to judge that the user **M** does not rest one's foot on the foot support **4** when the load detected by the load sensor **50** is less than the judgment value. In this case, the control unit **8** controls the tilting mechanism unit **6** such that the bearing surface of the bearing member **40** of each of the foot supports **4** is kept parallel to the horizontal plane.

[0072] The control unit **8** of the present embodiment supplies the pulse power to the adjusting motor **45c** of the tilting mechanism unit **6** from the power source to adjust the tilt of the bearing member **40,** thereby reducing the difference between the load applied to the outer portion **40a** and the load applied to the inner portion **40b.** As described in the above, in the case where the threshold is the load applied to the inner portion **40b** in a condition where the user **M** applies the same load to the outer portion **40a** and inner portion **40b** of the bearing member **40,** the control unit **8** inclines the bearing member **40** such that the load detected by the load sensor **50** becomes equal to the threshold.

[0073] In the exercise assisting device of the present embodiment, the load detection unit **5,** tilting mechanism unit **6,** and control unit **8** constitute the tilting device **A.**

[0074] Next, an explanation is made to an operation of the exercise assisting device of the present embodiment.

[0075] In the initial condition, the load detected by the load sensor **50** is less than the judgment value unless the user **M** rests one's foot on the foot support **4.** The control unit **8** controls the tilting mechanism unit **6** such that the bearing surface of the bearing member **40** is kept parallel to the horizontal plane (see FIG. 4A).

[0076] A following operation is performed when the user **M** rests one's foot on the foot support **4.**

[0077] For example, when the load applied to the outer portion **40a** of the bearing member **40** exceeds the load applied to the inner portion **40b** of the bearing member **40,** the bearing member **40** is inclined so as to raise the outer portion **40a** to a higher position than the inner portion **40b** (that is, the bearing member **40** is inclined inward) by the tilting device **A** (see FIG. 4B). As described in the above, the bearing member **40** is caused to tilt continuously until the difference between the threshold and the load detected by the load sensor **50** becomes zero While the outer portion **40a** of the bearing member **40** is raised to a higher position than the inner portion **40b,** the load applied to the inner part of the lower limb is increased by a greater extent than in the condition where the user's foot has its width direction kept parallel to the horizontal plane (i.e., the bearing surface of the bearing member **40** lies horizontally).. Accordingly, it is possible to intensively train the inner part of the muscles of the lower limbs.

[0078] Meanwhile, when the load applied to the inner portion **40b** of the bearing member **40** exceeds the load applied to the outer portion **40a** of the bearing member **40,** the bearing member **40** is inclined so as to raise the inner portion **40b** to a higher position than the outer portion **40a** (that is, the bearing member **40** is tilted outward) by the tilting device **A** (see FIG. 4C). As described in the above, the bearing member **40** is caused to tilt continuously until the difference between the threshold and the load detected by the load sensor **50** becomes zero. While the inner portion **40b** of the bearing member **40** is raised to a higher position than the outer portion **40a,** the load applied to the inner part of the lower limb is increased to a greater extent than in the condition where the user's foot has its width direction kept parallel to a horizontal plane (i.e., the bearing surface of the bearing member **40** is kept parallel to the horizontal plane). Accordingly, it is possible to intensively train the inner part of the muscles of the lower limb.

[0079] When the load applied to the inner portion **40b** of the bearing member **40** is equal to the load applied to the outer portion **40a** of the bearing member **40,** the tilting device **A** does not incline the bearing member **40** (see FIG. 4A).

[0080] The user **M** can make the aforementioned passive exercise by turning on the switch after resting one's feet respectively on the foot supports **4.**

[0081] According to the aforementioned exercise assisting device of the present embodiment, like the exercise assisting device of the first embodiment, the bearing member **40** is tilted so as to reduce the difference between the load applied to the outer portion **40a** of the bearing member 40 and the load applied to the inner portion **40b** of the bearing member **40.** Therefore, it is possible to intensively train the inner part of muscles of the lower limb when the user has bow legs. Further, it is possible to intensively train the outer part of muscles of the lower limb when the user has knock knees. Thus, it is possible to improve balancing or remedy capacity imbalance between the outer and inner parts of the muscles of the lower limb, even if the user has bow legs or knock knees. As a result, it is possible to remedy the deformed bones of the lower limb (that is, it is possible to recover the skeletal alignment of the lower limb). Further, the user can enjoy a comfortable passive exercise (training) while being alleviated of the knee pain, which means that even the user suffering from knee pains during one's walking can make the passive exercise.

[0082] Further, the bearing member **40** is inclined inward or outward with regard to the user's foot based on the load detected by the load sensor **50** of the load detection unit 5. Therefore, it is possible to adjust the tilt of the bearing member **40** to be a tilt suitable for the user. Notably, according to the present embodiment, it is possible to reduce a production cost because of that the number of the load sensor **50** of the load detection unit **5** can be reduced to one.

[0083] In the above mentioned instance, although the load sensor **50** is configured to detect the load applied to the inner portion **40b,** the load sensor **50** may be configured to detect the load applied to the outer portion **40a.** In this instance, the predetermined threshold can be the load applied to the outer portion **40a** in a condition where the user **M** applies the same load to the outer portion **40a** and inner portion **40b** of the bearing member **40.** Although the control unit **8** of the above mentioned instance is configured to control the tilting mechanism unit **6** to incline the bearing member such that the load detected by the load sensor **50** becomes equal to the threshold, the control unit **8** of another instance is configured to vary a tilt angle of the bearing member **40** in a stepwise fashion. For example, the control unit **8** inclines the bearing member **40** outward at a predetermined angle relative to the horizontal plane when the load detected by the load sensor **50** is not less than a first threshold. The control unit **8** inclines the bearing member **40** inward at a predetermined angle relative to the horizontal plane when the load detected by the load sensor **50** is not greater than a second threshold. The control unit **8** keeps the bearing member **40** horizontal when the load detected by the load sensor **50** exceeds the second threshold and is less than the first threshold.

[0084] By the way, FIGS. 5A to 5C illustrates the exercise assisting device of another embodiment of the present invention. The exercise assisting device shown in FIG. 5 is different in the configuration of the foot support **4** from the exercise assisting device shown in FIG. 4 and the exercise assisting device of the first embodiment. Other components of the exercise assisting device shown in FIG. 5 are the same as those of the exercise assisting device shown in FIG. 4 and the exercise assisting device of the first embodiment. Therefore the other components are designated by like reference numerals and dispensed with duplicate explanations.

[0085] The foot support **4** shown in FIG. 5 is provided with a pair of air bags (air cells) **60** configured to define a distance between the bearing member **40** and the basement **41.** The air bags **60** are the same in form. One air bag **60** is located so as to bear the outer portion 40a of the bearing member **40,** and another air bag **60** is located so as to bear the inner portion **40b** of the bearing member **40.** Therefore, the bearing member **40** is inclined when one air bag **60** expands or shrinks relative to another air bag **60.** In short, the exercise assisting device shown in FIG. 5 has the tilting mechanism unit **6** composed of the pair of air bags **60.** Moreover, the housing **3** is configured to house an air pump (not shown) configured to supply air to each of the air bags **60.** Further, the basement **41** is provided at opposite ends in its width direction with a regulation member **41 b.** The regulation member 41 **b** is configured to define a range within which the bearing member **40** is allowed to tilt.

[0086] The air bag 60 is provided with a valve member (not shown). The valve member is configured to close an exhaust port **60a** of the air bag **60** until pressure inside the air bag **60** exceeds a predetermined value. The predetermined value is selected to enable the air pump to supply sufficient air to the air bag **60** such that the bearing surface of the bearing member **40** of the foot support **4** is kept parallel to the horizontal plane. In other words, the predetermined value is a value where the air bag **60** which bears the bearing member **40** such that the bearing surface is kept parallel to the horizontal plane does not eject air.

[0087] A holder **40c** is provided to each of the outer portion **40a** and inner portion **40b** of the bearing member **40** shown in FIG. 5. A through hole **40d** for an exhaust valve **49** extends through a portion of the bearing member **40** opposite to the holder **40c** in a thickness direction thereof. The exhaust valve **49** is formed into a L-shape including a valve portion **49a** configured to gate the exhaust port **60** and a load detection portion **49b** integrally formed on the valve portion **49a** so as to extend laterally from the valve portion **49a.** The valve portion **49a** penetrates through the through hole **40d.** The exhaust valve **49** is adapted in use to forcibly close the exhaust port **60a** of the air bag **60.**

[0088] An elastic member 51 is interposed between the bearing member **40** and the load detection portion **49b** of the exhaust valve **49.** The elastic member **51** is made of an elastic material such as a rubber so as to shrink upon receiving a load not less than a prescribed value. While the load applied to the elastic member **51** is not greater than the prescribed value, the elastic member **51** keeps the exhaust valve **49** in a position where the exhaust valve **49** opens the exhaust port **60a.** By contrast, when the load applied to the elastic member **51** exceeds the prescribed value, the elastic member **51** shrinks so as to allow the exhaust valve **49** to move to a position where the exhaust valve **49** closes the exhaust port **60.** The prescribed value[s] is [a value] slightly less than the load applied to the outer portion **40a** (or inner portion **40b)** in a condition where the user **M** applies the same load to the outer portion **40a** and inner portion **40b** of the bearing member **40.** It is noted that the elastic member **51** may be of known configuration and therefore no detailed explanation thereof is deemed necessary.

[0089] In the instance shown in FIGS. 5A to 5C, the air bag **60,** exhaust valve **49,** and elastic member **51** constitute the tilting device **A.** In the following explanation, in order to distinguish the air bag **60,** exhaust valve **49,** and elastic member **51** corresponding to the outer portion **40a** from the air bag **60,** exhaust valve **49,** and elastic member **51** corresponding to the inner portion **40b** respectively, a suffix **"A"** is attached to the reference number of each of the air bag **60,** exhaust valve **49,** and elastic member **51** corresponding to the outer portion **40a,** and a suffix **"B"** is attached to the reference number of each of the air bag **60,** exhaust valve **49,** and elastic member **51** corresponding to the inner portion **40b,** as necessary.

[0090] Next, an explanation is made to an operation of the exercise assisting device shown in FIG. 5. In an initial condition, the air pump supplies air to each air bag **60** such that the bearing surface of the bearing member **40** is kept parallel to the horizontal plane. At the initial condition, the valve member closes the exhaust port **60a** of the air bag **60** before the user **M** rests one's foot on the foot support **4.** Therefore, as shown in FIG. 5A, the pair of air bags **60** bears the bearing member **40** such that the bearing surface is kept parallel to the horizontal plane.

[0091] When the user **M** rests one's foot on the foot support 4, a following operation is performed. For example, when the load applied to the outer portion **40a** of the bearing member **40** is equal to the load applied to the inner portion **40b** of the bearing member **40,** the valve members of each of the air bags **60A** and 60B open the corresponding exhaust port **60a** at an approximately-same timing. After the air bag **60** ejects air from its inside, the elastic members **51A** and **51B** start to shrink at an approximately-same timing. Therefore, the exhaust valves **49A** and **49B** close the exhaust ports **60a** of each of the air bags **60A** and **60B** open at an approximately-same timing. As a result, the bearing member **40** is not inclined, and the bearing surface is kept parallel to the horizontal plane.

[0092] When the load applied to the outer portion **40a** of the bearing member **40** exceeds the load applied to the inner portion **40b** of the bearing member **40,** each of the air bags **60A** and **60B** ejects air from its inside. However, the elastic member **51A** shrinks before the elastic member **51B** shrinks. That is, the exhaust port **60a** of the air bag **60A** is closed prior to closing of the exhaust port **60a** of the air bag **60B.** As a result, the air bag **60A** acts to keep the outer portion **40a** of the bearing member **40** spaced by a constant distance from the basement **41** (see FIG. 5B). This causes the increase of the load applied to the inner portion **40b,** followed by the elastic member **51B** being caused to start shrinking. Therefore, the exhaust port **60a** of the air bag 60B is closed, and the air bag **60B** acts to keep the inner portion **40b** of the bearing member **40** spaced by a constant distance from the basement **41** (see FIG. 5C). While the exhaust ports **60a** of each of the air bags **60A** and **60B** are closed as described in the above, the air bag **60A** having its exhaust port **60a** closed prior to closing of the exhaust port **60a** of the air bag **60B** holds a greater volume of the air than the air bag **60B** whose exhaust port **60a** is closed subsequent to closing of the exhaust port **60a** of the air bag **60A.** As a result, the distance between the basement **41** and the bearing member **40** is made greater towards the outer portion **40a** than at the inner portion **40b.** In short, the bearing member **40** is inclined inward with regard to the foot of the user **M.**

[0093] When the load applied to the inner portion **40b** of the bearing member **40** exceeds the load applied to the outer portion **40a** of the bearing member **40,** each of the air bags **60A** and **60B** ejects air from its inside. However, the elastic member **51B** shrinks before the elastic member **51A** shrinks. That is, the exhaust port **60a** of the air bag **60B** is closed prior to closing of the exhaust port **60a** of the air bag **60A.** As a result, the air bag 60B acts to keep the inner portion **40b** of the bearing member **40** spaced by a constant distance from the basement **41.** This causes the increase of the load applied to the outer portion **40a,** followed by the elastic member **51A** being caused to start shrinking. Therefore, the exhaust port **60a** of the air bag **60A** is closed, and the air bag **60A** acts to keep the outer portion **40a** of the bearing member **40** spaced by a constant distance from the basement **41**. While the exhaust ports **60a** of each of the air bags **60A** and **60B** are closed as described in the above, the air bag **60B** having its exhaust port **60a** closed prior to closing of the exhaust port **60a** of the air bag **60A** holds a greater volume of the air than the air bag **60A** whose exhaust port **60a** is closed subsequent to closing of the exhaust port **60a** of the air bag **60B.** As a result, the distance between the basement **41** and the bearing member **40** is made greater towards the inner portion **40b** than at the outer portion **40a.** In short, the bearing member **40** is inclined inward with regard to the foot of the user **M.**

[0094] As apparent from the above, the exercise assisting device shown in FIGS. 5A to 5C is capable of tilting the bearing member **40** so as to reduce the difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40.** Therefore, it is possible to improve a balance (capacity imbalance) between the outer part and the inner part of the muscles of the lower limb. As a result, it is possible to remedy the deformed bones of the lower limb (that is, it is possible to recover the skeletal alignment of the lower limb). Further, the user can enjoy a comfortable passive exercise (training) while being alleviated of the knee pain, which means that even the user suffering from knee pains during one's walking can make the passive exercise. Moreover, it is possible to reduce a production cost because an electric circuit for the load detection unit **5** or the like is made redundant.

[0095] Although the bearing member **40** of the exercise assisting device shown in FIGS. 5A to 5C is a one board, for example, the bearing member **40** may be divided into two in its width direction as shown in FIG. 6A. The exercise assisting device shown in FIG. 6A has a basic structure similar to that shown in FIG. 5. Therefore like parts are designated by like reference numerals and dispensed with duplicate explanations.

[0096] In the instance shown in FIG. 6A, the bearing member **40** is divided into the outer portion **40a** formed into a rectangular plate and the inner portion **40b** formed into a rectangular plate. The outer portion **40a** and inner portion **40b** are rotatively coupled to the side wall portions **42** provided on the center of the basement **41** in its width direction by use of the tilting axle **43** and the tilting bearing **44,** respectively. Accordingly, in the instance shown in FIG. 6A, the outer portion **40a** and inner portion **40b** are separately inclined each other.

[0097] In the instance shown in FIG. 6A, the air bag **60,** exhaust valve **49,** and elastic member **51** constitute the tilting device **A.**

[0098] The aforementioned configuration concerning the division of the bearing member **40** can be applied to the instance shown in FIG. 4 and the first embodiment. In short, the tilting device **A** may be configured to tilt at least one part of the bearing member **40** so as to reduce the difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40.** The bearing member **40** is not limited to the above mentioned instance, and may be configured to be capable of varying a balance between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40**.

[0099] The aforementioned instances shown in FIGS. 5 and FIG. 6 utilize shrinkage of the air bag **60** in order to incline the bearing member **40.** Further, another instance may be configured to control the air pump to supply air to the air bag **60** so as to expand the same, thereby inclining the bearing member **40.**

[0100] In the instance shown in FIG. 6B, the holders **40c** are positioned below the rear surfaces of the outer portion **40a** and inner portion **40b** of the bearing member **40** respectively, and are rotatively coupled to the tilting axles **43** together with the outer portion **40a** and inner portion **40b,** respectively. The outer portion **40a** and inner portion **40b** of the bearing member **40** respectively are formed with protrusions **40e** used as a valve for the exhaust port **60a.**
The elastic member **51** is interposed between the holder **40c** and each of the outer portion **40a** and inner portion **40b** (the elastic member **51** is not shown in FIG. 6B). The elastic member 51 is configured to shrink upon receiving the load greater than a predetermined load such that the protrusion **40e** closes the exhaust port **60a.** The predetermined load is equal to the load applied to the outer portion **40a** (or inner portion **40b)** in a condition where the user **M** applies the same load to the outer portion **40a** and inner portion **40b** of the bearing member **40.**

[0101] Further, in the instance shown in FIG. 6B, the air bag **60** is interposed between the holder **40c** and the basement **41.** Each air bag **60** has an air supply port **60b** connected to the aforementioned air pump. The air pump is configured to supply air to (pressurize) the each air bag **60** such that the bearing surfaces of each of the outer portion **40a** and inner portion **40b** of the bearing member **40** are kept parallel to the horizontal plane while the user **M** keeps applying the loads equally to the outer portion **40a** and inner portion **40b** of the bearing member **40.**

[0102] Next, an explanation is made to an operation of the exercise assisting device shown in FIG. 6B. When the user **M** rests one's foot on the foot support 4, and when the load applied to the outer portion **40a** of the bearing member **40** is equal to the load applied to the inner portion **40b** of the bearing member **40** (that is, the user has neither bow legs nor knock knees), the elastic members **51A** and **51B** do not shrink. Therefore, the exhaust ports **60a** of each of air bags **60A** and **60B** is not closed. In this case, to pressurize by the air pump keeps the bearing surfaces of each of the outer portion **40a** and inner portion **40b** parallel to the horizontal plane.

[0103] When the load applied to the outer portion **40a** of the bearing member **40** exceeds the load applied to the inner portion **40b** of the bearing member **40,** the elastic member **51A** shrinks before the elastic member **51B** shrinks. That is, the exhaust port **60a** of the air bag **60A** is closed prior to closing of the exhaust port **60a** of the air bag **60B.** Therefore, the air bag **60A** expands as being supplied with the air from the air pump, thereby lifting the outer portion **40a.** This causes an increase of the load applied to the inner portion **40b** (that is, the load applied to the elastic member **51B**), thereby shrinking the elastic member **51B.** The shrinkage of the elastic member **51B** causes closing of the exhaust port **60a** of the air bag **60B.** This causes a decrease of the load applied to the elastic member **51A,** thereby opening the exhaust port **60a** of the air bag **60A.** In this case, the air bag **60A** shrinks as the air bag **60A** expands. Thus, the inner portion **40b** is lifted to thereby cause a decrease of the load applied to the inner portion **40b.** As a result, the load applied to the outer portion **40a** increases so as to make closing of the exhaust port 60a of the air bag **60A** as well as opening the exhaust port **60a** of the air bag **60B.** Alternate repetition of the aforementioned operations is responsible for inclining each of the outer portion **40a** and the inner portion **40b** such that the load applied to the outer portion **40a** becomes equal to the load applied to the inner portion **40b.** Even when the load applied to the inner portion **40b** of the bearing member **40** exceeds the load applied to the outer portion **40a** of the bearing member **40,** the exercise assisting device operates in a similar manner as described in the above.

[0104] As apparent from the above, the exercise assisting device shown in FIG. 6B is capable of tilting the bearing member **40** so as to reduce the difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40.** Therefore, it is possible to improve a balance (capacity imbalance) between the outer part and the inner part of the muscles of the lower limb. As a result, it is possible to remedy the deformation of bones of the lower limb (that is, it is possible to recover the skeletal alignment of the lower limb). Further, the user can enjoy a comfortable passive exercise (training) while being alleviated of the knee pain, which means that even the user suffering from knee pains during one's walking can make the passive exercise. Moreover, it is possible to reduce a production cost because an electric circuit for the load detection unit **5** or the like is made redundant.

[0105] The technical feature of the present invention can be applied to the exercise assisting device shown in FIGS. 7A and 7B.

[0106] The exercise assisting device shown in FIG. 7 includes a carrier **30** to be placed on a predetermined position such as a floor. There are a supporter **32** and a handle post **33** provided on the carrier **30.** The supporter **32** is provided at its upper end with a seat **9** configured to bear the buttocks of the user **M.** The handle post **33** has handles **33a** adapted in use to be held with the hand of the user **M** as necessary. The pair of foot supports **4** is attached to the carrier **30** and between the supporter **32** and the handle post **33.** This foot support **4** has the same configuration as the foot support **4** of the first embodiment or the foot support **4** of respective FIGS 4 to 6. In the exercise assisting device shown in FIG. 7, the pair of foot supports **4** constitutes the support unit **1** together with the seat **9.**

[0107] The supporter **32** is provided with the drive device **2** configured to reciprocate the seat **9.** The drive device **2** is configured to reciprocate the seat **9** which is one part of the support unit **1** by use of a driving source (not shown), thereby displacing the buttocks of the user **M** with one's feet resting respectively on the foot supports **4** and one's buttocks resting on the seat 9. In short, the drive device **2** is configured to vary the weight acting on the legs of the user **M.** The drive device 2 displaces the buttocks of the user **M,** thereby varying a proportion of bearing the user's weight between the seat **9** and the foot supports **4.** In this consequence, the drive device **2** varies the user's weight acting on the buttocks, thereby varying the weight acting on each of the feet of the user.

[0108] Under the condition that an angle of a knee is kept to a predetermined angle, a load applied to a femoral region of the user **M** is increased as a proportion of bearing the user's weight by the seat **9** is decreased. This is similar to bending user's own knee during a squat exercise and can trigger muscle contraction of femoral muscles. That is, an oscillation of the seat **9** induces a passive exercise not an active exercise of the user **M.** According to this passive exercise, the femoral muscles repeat tonus and laxity. Therefore, the user **M** can mainly exercise for own femoral muscles.

[0109] As apparent from the above, the exercise assisting device shown in FIG. 7 is capable of tilting the bearing member **40** so as to reduce the difference between the load applied to the outer portion **40a** of the bearing member **40** and the load applied to the inner portion **40b** of the bearing member **40.** Therefore, it is possible to improve a balance (capacity imbalance) between the outer part and the inner part of the muscles of the lower limb even if the user has bow legs or knock knees. As a result, it is possible to remedy the deformed bones of the lower limb (that is, it is possible to recover the skeletal alignment of the lower limb). Further, the user can enjoy a comfortable passive exercise (training) while being alleviated of the knee pain, which means that even the user suffering from knee pains during one's walking can make the passive exercise.

Claims

1. An exercise assisting device comprising:

> a support unit configured to bear a user's body, said support unit including a pair of foot supports having a bearing member configured to bear the user's left foot and right foot respectively;
> a drive device configured to drive said support unit to move the user's body so as to vary a load applied to user's lower limb; and
> a tilting device configured to tilt at least one part of said bearing member so as to reduce a difference between a load applied to an outer portion of said bearing member corresponding to an outer part of user's foot and a load applied to an inner portion of said bearing member corresponding to an inner part of the user's foot.

2. An exercise assisting device as set forth in claim 1, wherein
said tilting device comprises:

a load detection unit provided to said foot support so as to detect a load applied to said bearing member;
a tilting mechanism unit configured to tilt at least one part of said bearing member inward or outward with regard to the user's foot; and
a control unit configured to control said tilting mechanism unit based on the load detected by said load detection unit.

3. An exercise assisting device as set forth in claim 2, wherein
said load detection unit includes two load sensors provided to said outer portion and said inner portion of said bearing member respectively,
said control unit being configured to control said tilting mechanism unit so as to reduce a difference between loads respectively detected by said two load sensors.

4. An exercise assisting device as set forth in claim 2, wherein
said load detection unit includes a load sensor provided to either said outer portion or said inner portion of said bearing member,
said control unit being configured to make a comparison of a load detected by said load sensor with a predetermined threshold, and determine the difference between the load applied to said outer portion of said bearing member and the load applied to said inner portion of said bearing member based on the resultant comparison.

FIG. 1A

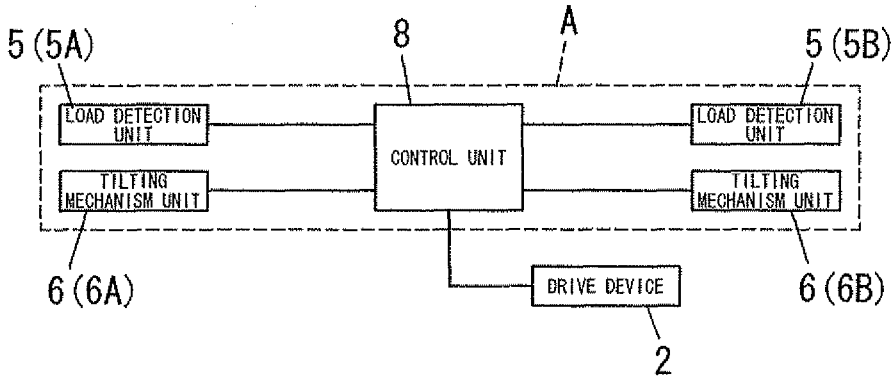
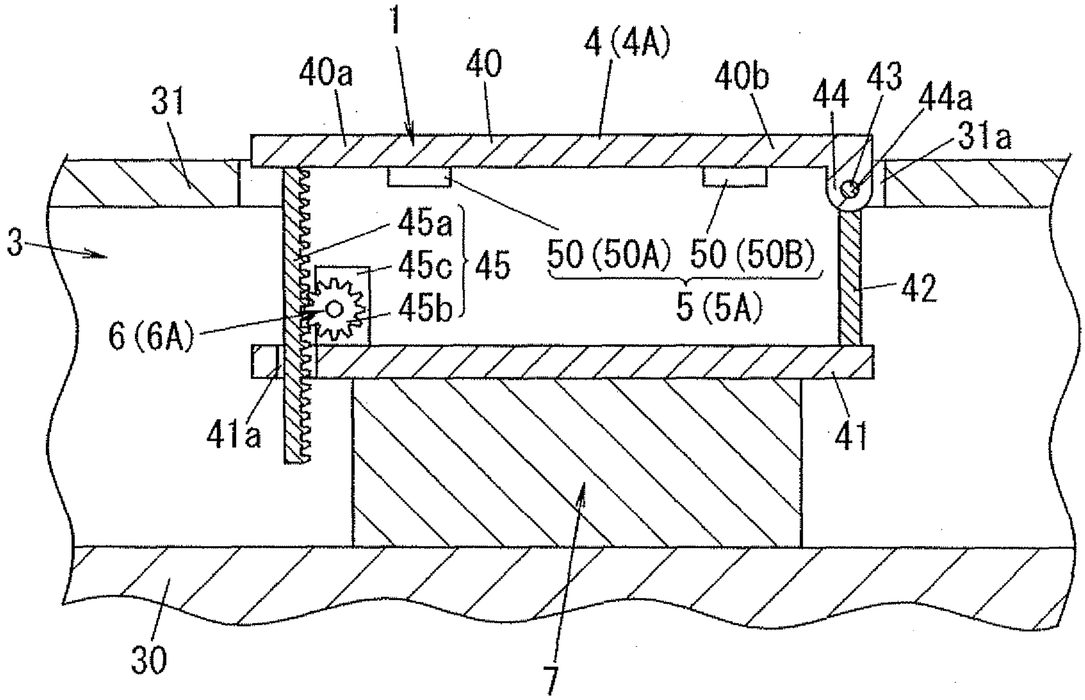

5(5A)
8
A
5(5B)
LOAD DETECTION UNIT
CONTROL UNIT
LOAD DETECTION UNIT
TILTING MECHANISM UNIT
TILTING MECHANISM UNIT
6(6A)
DRIVE DEVICE
6(6B)
2

FIG. 1B


1
40a
40
4(4A)
40b
44
43
44a
31a
31
3
45a
45c
45
45b
50(50A) 50(50B)
5(5A)
42
6(6A)
41a
41
30
7

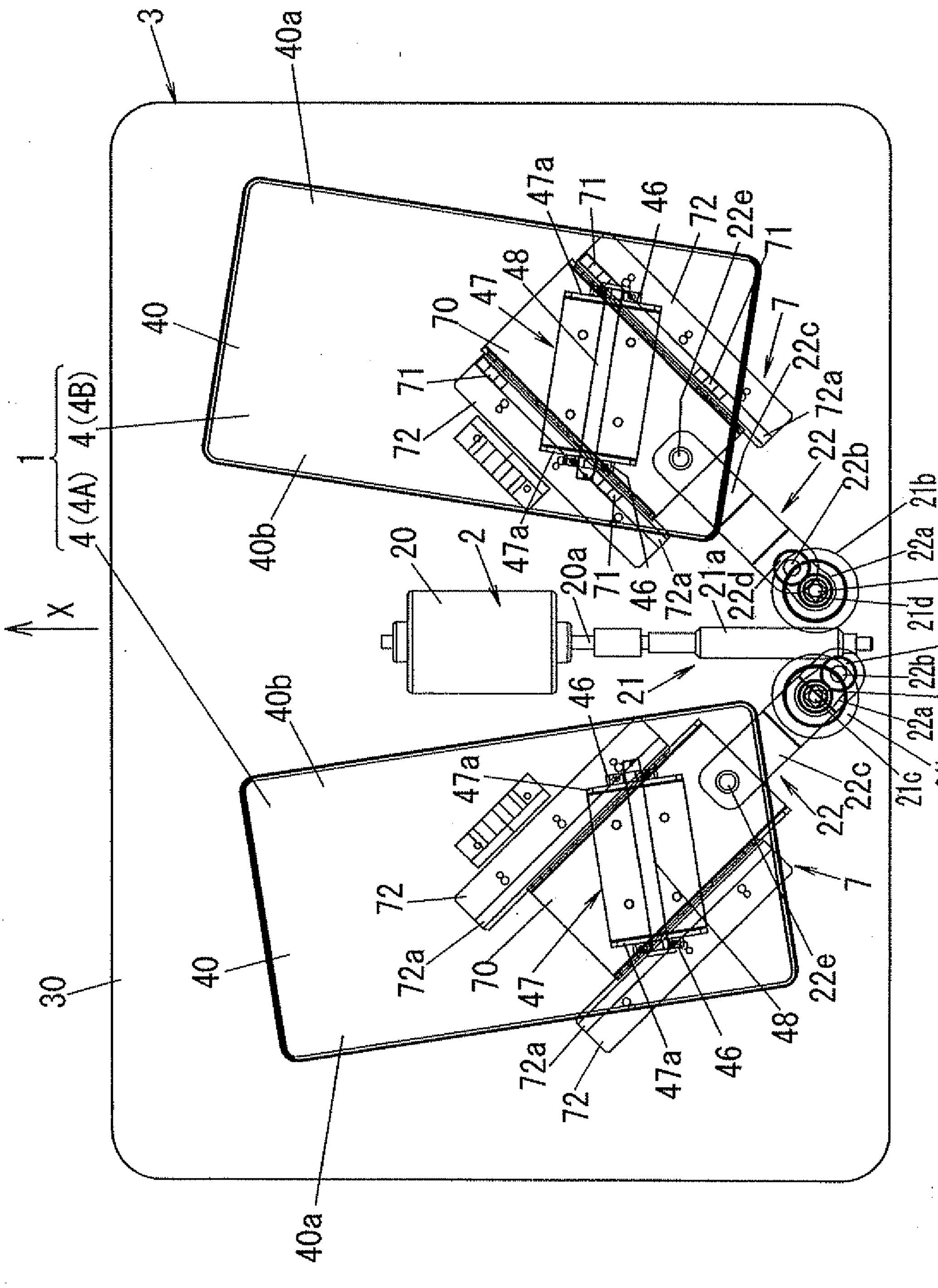

3
30
40
40a
40b
1
4 (4A)
4 (4B)
X
2
20
20a
21
21a
21b
21c
21d
22
22a
22b
22c
22d
22e
46
47
47a
48
7
70
71
72
72a

FIG. 2

FIG. 3A

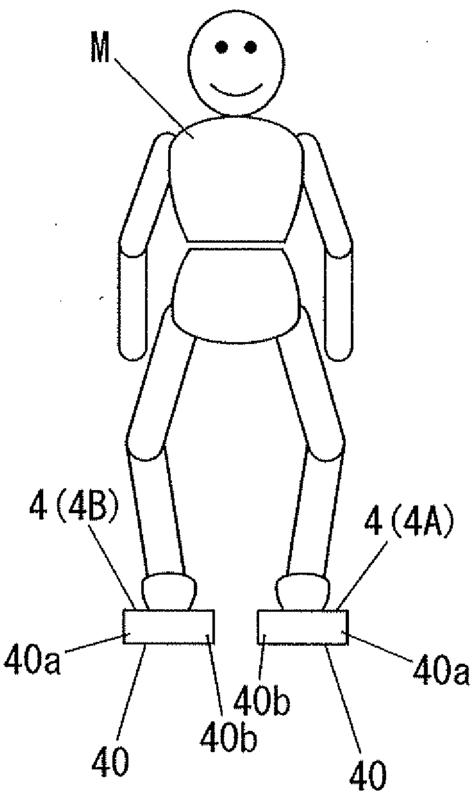


FIG. 3B

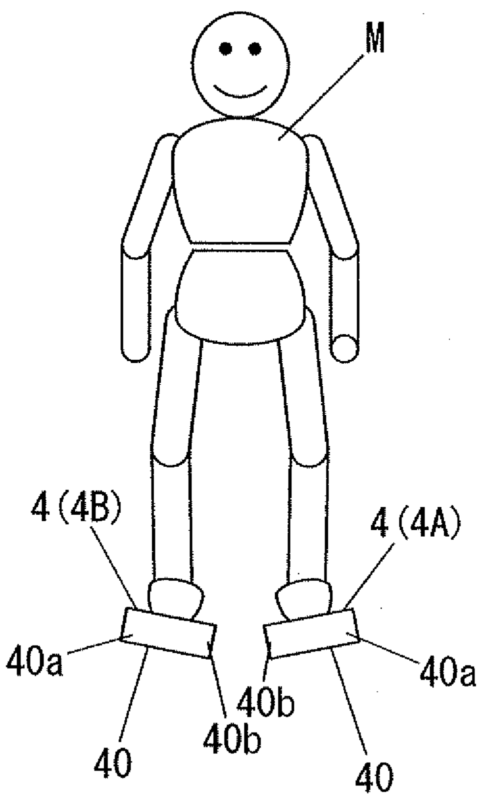


FIG. 4A

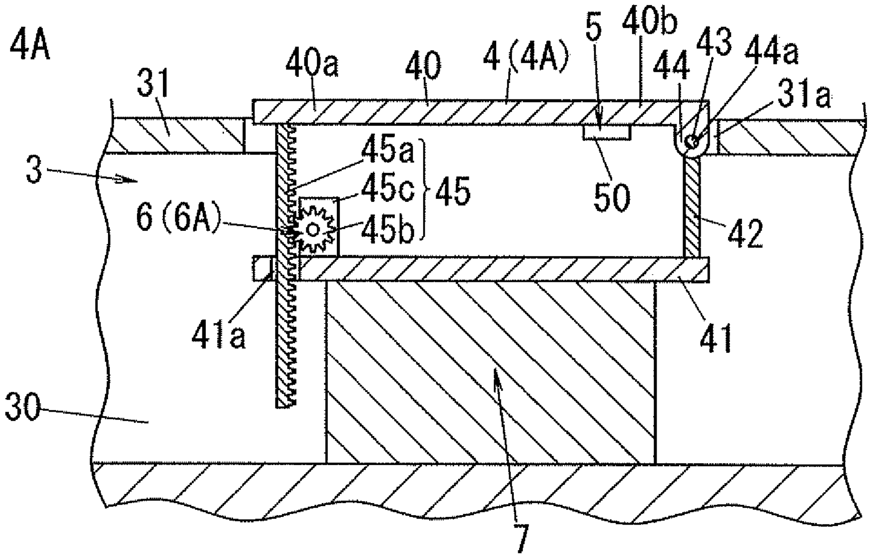


FIG. 4B

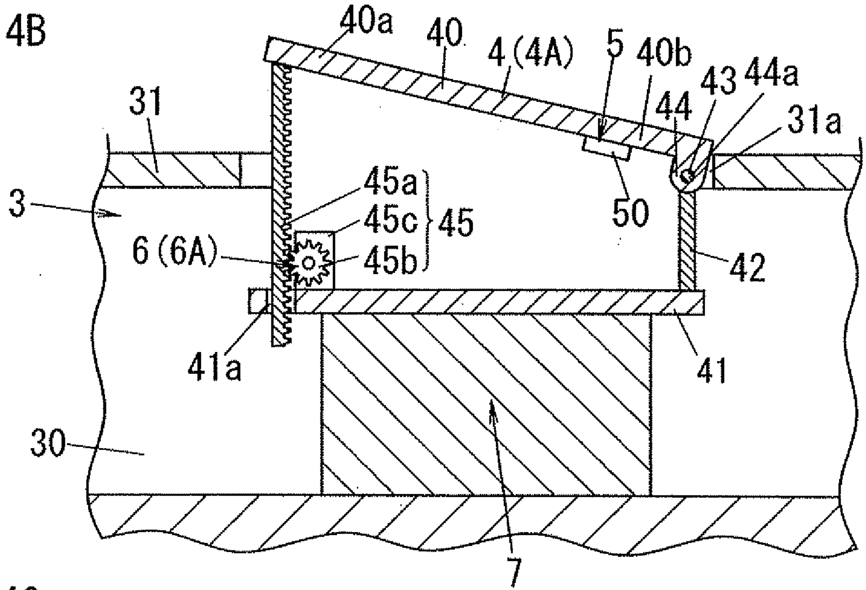


FIG. 4C

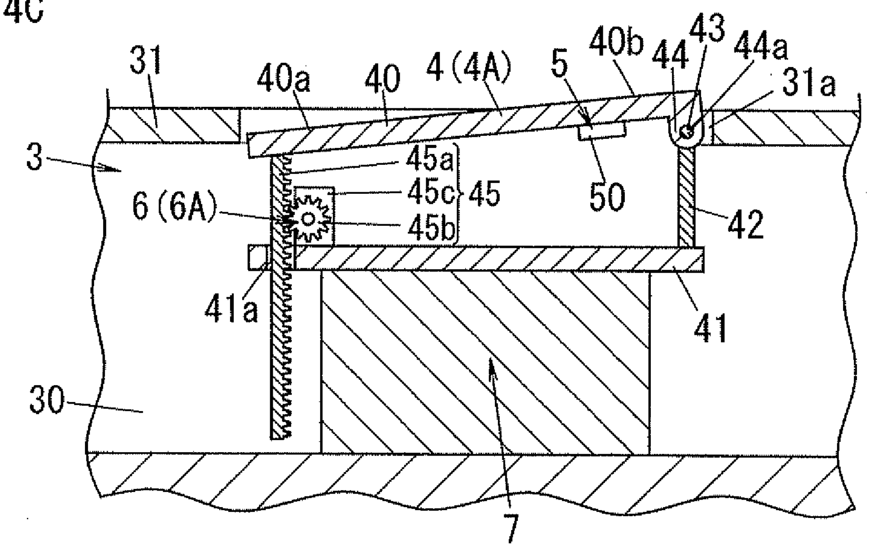


FIG. 5A

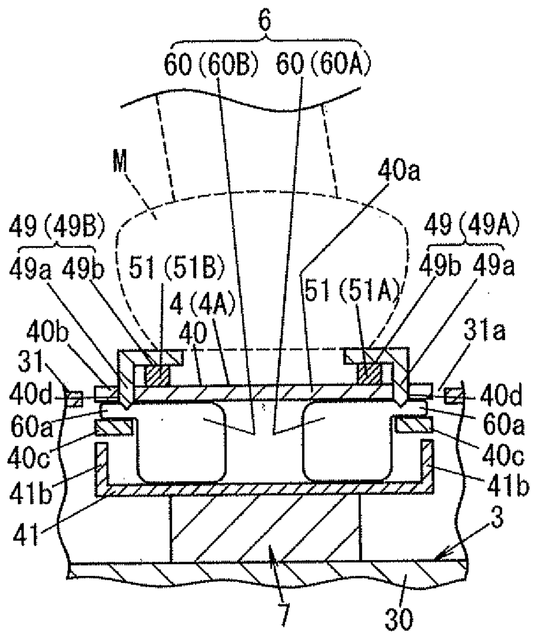


FIG. 5B

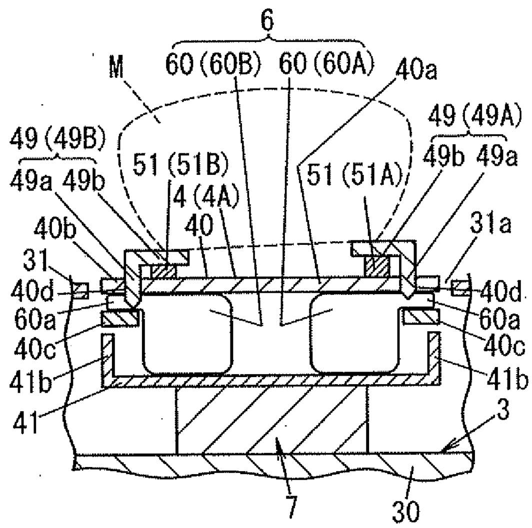


FIG. 5C

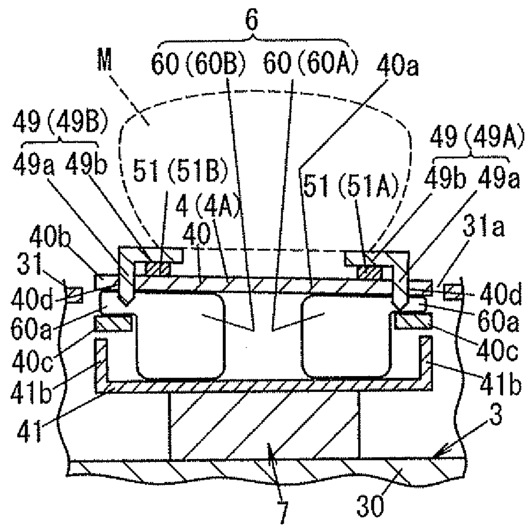


FIG. 6A

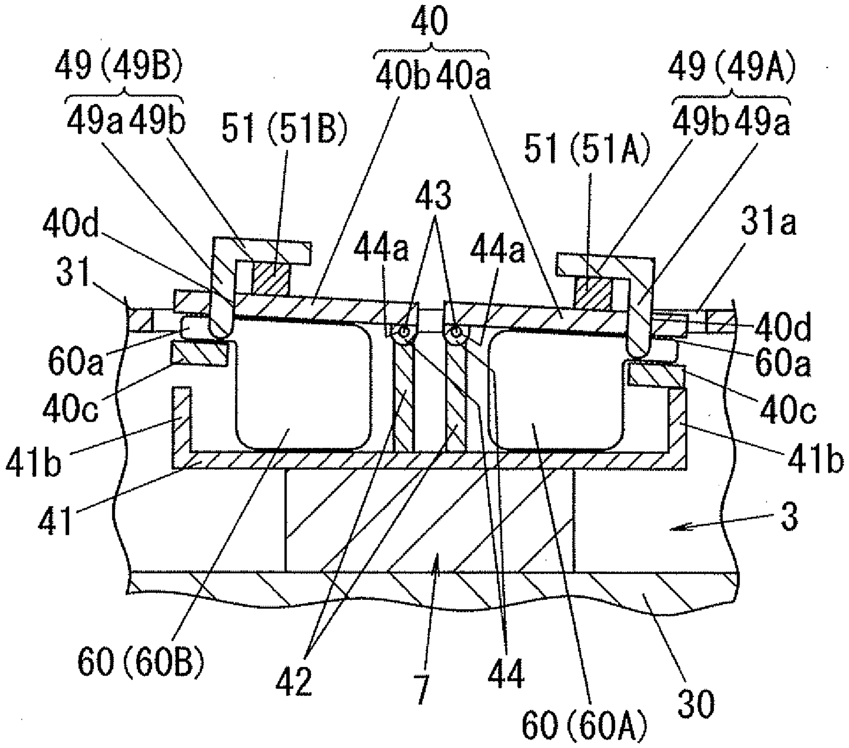

40
40b 40a
49 (49B)
49a 49b
51 (51B)
49 (49A)
49b 49a
51 (51A)
43
44a
44a
31a
40d
31
40d
60a
60a
40c
40c
41b
41b
41
3
60 (60B)
42
7
44
60 (60A)
30

FIG. 6B

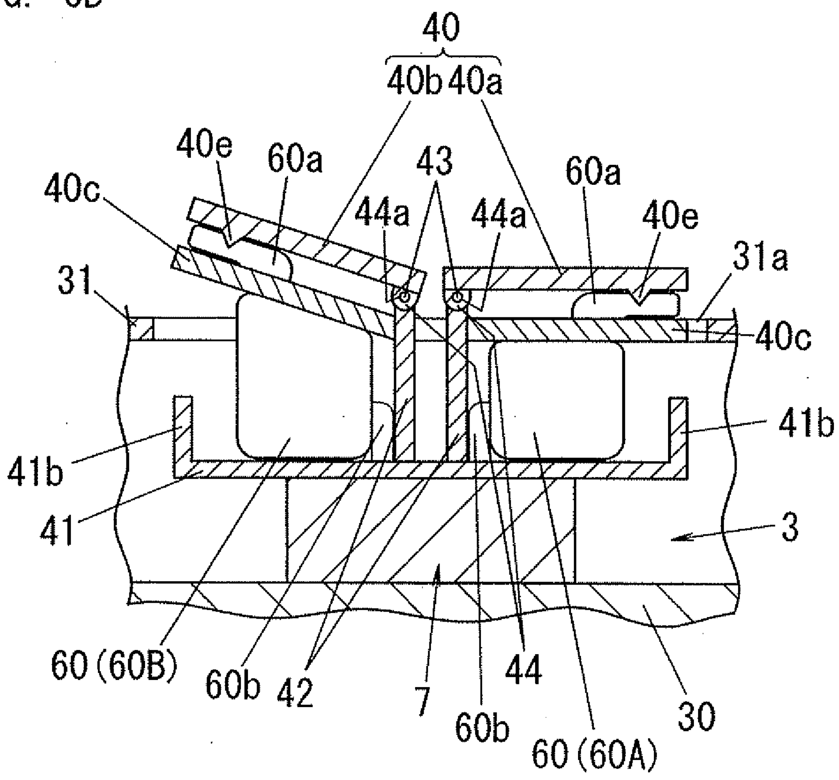

40
40b 40a
40e
60a
43
60a
40c
44a
44a
40e
31a
31
40c
41b
41b
41
3
60 (60B)
60b
42
7
60b
44
60 (60A)
30

FIG. 7A

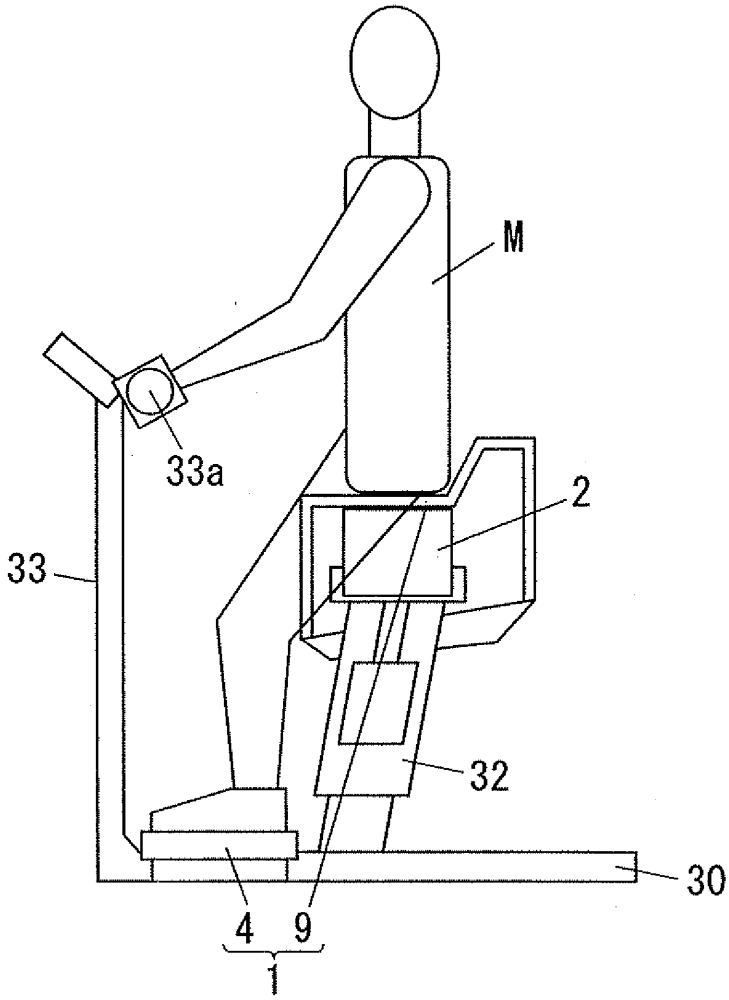
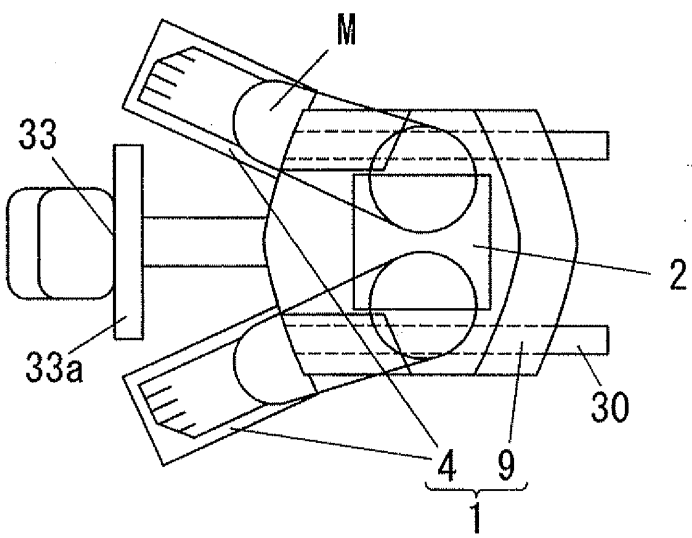


FIG. 7B



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/073273

A. CLASSIFICATION OF SUBJECT MATTER
A63B23/04(2006.01)i, *A61H1/02*(2006.01)i, *A63B23/00*(2006.01)i, *A63B24/00*(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)
A63B23/04, A61H1/02, A63B23/00, A63B24/00

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	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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.
Y A	JP 2005-058733 A (Matsushita Electric Works, Ltd.), 10 March, 2005 (10.03.05), Full text; all drawings & US 2006/0229170 A1 & EP 1629868 A1 & WO 2004/110568 A1	1,2 3,4
Y A	JP 10-108884 A (Okayama-Ken), 28 April, 1998 (28.04.98), Par. No. [0021]; Figs. 10 to 12 (Family: none)	1,2 3,4
Y A	JP 2003-245376 A (Kinesio Co., Ltd.), 02 September, 2003 (02.09.03), Par. No. [0029]; Fig. 5 (Family: none)	2 3,4

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 March, 2009 (26.03.09)	07 April, 2009 (07.04.09)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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- JP 2003290386 A **[0004] [0005] [0006]**
- JP 10055131 A **[0004] [0005] [0006]**