LOWE R LIM B VIBRAT ION DE V I CE, AND HIP JOINT STIMULATION METHOD

Disclosed is a lower limb bouncing device capable of causing knee bouncing motion by stimulating the hip joint, or base end of a lower limb, while allowing the lower leg, or terminal end of the lower limb, to relax. The lower limb bouncing device 1 includes: a flap 2 on which a heel 41 of a foot 4 is to be placed; and a motor 3 coupled to the flap 2. The flap 2 is configured so that a heel resting surface 21 thereof is swung up and down by a driving force of the motor 3, but does not fall below a minimum height position that is not more than 4 cm above a floor surface G on which toes 42 are to be placed. The motor 3 includes: an output axis 32 on which an eccentric cam 34 is provided; and a pivotable plate 6 sitting on the eccentric cam 34. The pivotable plate 6 has an end thereof pivotally attached so as to be pivotable. The flap 2 is disposed on a side of an enclosure so that the heel 41 can be placed at a minimum height position that is not more than 4 cm above the floor surface G when the foot 4 is placed on the floor surface G on which the enclosure 50 is disposed. The flap 2 is connected to another end of the pivotable plate 6 so as to be swung up and down by the pivotable plate 6 pivoting up and down around the pivotally attached end in response to rotation of the eccentric cam 34.
The present invention relates to a lower limb bouncing device mechanically causing "knee bouncing," or the habitual up and down motion of the heel while resting the toes on the ground.

Background Art

A lower limb bouncing device in accordance with the present invention, to solve the problems, includes: a flap on which a heel of a foot is to be placed; and a motor coupled to the flap. The flap is configured so that a heel resting surface thereof is swung up and down by a driving force of the motor, but does not fall below a minimum height position that is not more than 4 cm above a floor surface when the foot is placed on the floor surface on which the enclosure is disposed. The flap is connected to another end of the pivotable plate so as to be swung up and down by the pivotable plate pivoting up and down around the pivotally attached end in response to rotation of the eccentric cam.

Problems to Be Solved by the Invention

In the lower limb bouncing device, the flap, when at the minimum height position, has therebelow a gap of 1 cm or larger, and when at a maximum height position, is elevated not more than 10 cm above the floor surface.

Advantageous Effects of the Invention

As described in the foregoing, according to the present invention, the flap on which the heel is to be placed is configured so that the heel resting surface is swung up and down by a driving force of the motor, but does not fall below the minimum height position that is not more than 4 cm above the toe resting surface on which toes are to be placed.
Description of Embodiments

The following will describe embodiments of the present invention in reference to drawings.

Figures 1 to 3 show a lower limb bouncing device 1 in accordance with the present invention. Figure 4 shows the internal structure of the lower limb bouncing device 1. Figures 5 and 6 show the lower limb bouncing device 1 in actual use.

The lower limb bouncing device 1 includes a flap 2 and a motor 3. The flap 2 is coupled to the motor 3 so that a heel resting surface 21 of the flap 2 swings up and down.

The flap 2 has such dimensions that the heel 41 of the foot 4 can be placed on the heel resting surface 21. A vertical abutment 22 may be provided extending upwards from an edge of the heel resting surface 21. The vertical abutment 22 serves as a stopper for the heel 41 when the heel 41 is placed on the heel resting surface 21 of the flap 2. The flap 2, or at least the heel resting surface 21 thereof, may be non-slip finished so that the heel 41 of the foot 4 can be placed on the heel resting surface 21 does not lurch and contact the floor surface 2 when the heel 41 of the foot 4 is placed on the heel resting surface 21 of the flap 2.

According to the structure, the pivotable plate 6 pivots around the hinge 64 in response to the rotation of the eccentric cam 34 driven by the motor 3. The pivoting in turn swings up and down the flap 2 secured to the motor 3.

Specifically, a minimum height position PL for the flap 2 is preferably specified so that a 1-cm or larger gap DL is left between the underside of the flap 2 and the extension of the board 5 when the heel 41 of the foot 4 is placed on the heel resting surface 21 of the flap 2. The swing distance may be set by adjusting the eccentricity of the eccentric cam 34, the length of the pivotable plate 6, or the position of the pivotable plate 6 that comes into contact with the eccentric cam 34.

Specifically, a minimum height position PL for the flap 2 is preferably specified so that a 1-cm or larger gap DL is left between the underside of the flap 2 and the extension of the board 5 when the heel 41 of the foot 4 is placed on the heel resting surface 21 of the flap 2. The swing distance may be set by adjusting the eccentricity of the eccentric cam 34, the length of the pivotable plate 6, or the position of the pivotable plate 6 that comes into contact with the eccentric cam 34.
minimum height position PL is still excessively higher than the toes 42 placed on the floor surface G when the heel 41 of the foot 4 is placed on the heel resting surface 21 of the flap 2. The ankle joint is plantar flexed further from this position, increasing load on the lower leg. Therefore, the minimum height position PL for the flap 2 is specified so that the heel 41 is not more than 4 cm above the floor surface G on which the toes 42 of the foot 4 are placed. Assuming that the flap 2 has a thickness of 2 mm, the minimum height position PL is specified 12 mm to 4 cm above the floor surface G.

[0023] A maximum height position PH for the flap 2 is also specified so that the underside of the flap 2 is separated by a distance of not more than 10 cm from the floor surface G on which the toes 42 of the foot 4 are placed when the pivotable plate 6 is in contact with the eccentric cam 34 in such a manner that the flap 2 is at its highest in height. If the distance exceeds 10 cm, the foot (ankle) 4 is plantar flexed so much as to receive excessive load on the lower leg.

[0024] A difference, PH-PL, (i.e., the swing distance) between a state where the pivotable plate 6 is in contact with the eccentric cam 34 in such a manner that the flap 2 is at the minimum height position PL where the flap 2 is at its lowest in height and a state where the pivotable plate 6 is in contact with the eccentric cam 34 in such a manner that the flap 2 is at the maximum height position PH where the flap 2 is at its highest in height is set not more than 6 cm, preferably not more than 4 cm, more preferably not more than 2 cm. If the swing distance exceeds 6 cm, the foot (ankle) 4 receives excessive load from the planter flexion in each swing; an aged user, for example, may not be able to keep the toes 42 on the floor surface G, ending up placing the entire foot 4 on the heel resting surface 21 of the flap 2. Although this may be one of available use modes, the foot 4 and nearby parts of the foot experience no motion in the mode. That in turn leads undesirably to insufficient knee bouncing motion, increased load on the heel resting surface 21, and increased workload for the motor 3.

[0025] The lower limb bouncing device 1, constructed as above, may rely on an external power supply or a charged battery (not shown) provided inside the enclosure 5, to power the motor 3.

[0026] The lower limb bouncing device 1, when used, is disposed close to a front leg of a chair 7 on which the user U is sitting. The heel 41 of the foot 4 is then placed on the heel resting surface 21 of the flap 2, and the motor 3 is subsequently actuated.

[0027] Next will be described how to use the lower limb bouncing device 1.

[0028] First, the lower limb bouncing device 1 is disposed close to a front leg of the chair 7 on which the user U is sitting. The heel 41 of the foot 4 is then placed on the heel resting surface 21 of the flap 2, and the motor 3 is subsequently actuated.

[0029] The motor 3 may be actuated/deactuated by turning on/off a switch (not shown) provided on a power supply cord (not shown) or on the enclosure 5 or by remote-controlling control circuitry (not shown) for the motor 3 using a separately provided remote control device (not shown). The motor 3 may maintain a constant rotational speed or provide a rotational speed that can be varied using a switch (not shown), remote control device (not shown), or like device.

[0030] The actuated motor 3 causes the heel resting surface 21 of the flap 2 to swing up and down relative to the floor surface G on which the toes 42 are placed. The up and down swings P in turn move the heel 41 up and down, which achieves a motion mimicking knee bouncing motion.

[0031] The foot (ankle) 4 is prevented from experiencing excessive plantar flexion at the start of the motion because the minimum height position PL for the heel resting surface 21 of the flap 2 is set not more than 4 cm above the floor surface G on which the toes 42 are placed. In addition, since the maximum height position PH is set not more than 10 cm above the floor surface G, the foot (ankle) 4 experiences suitable plantar flexion throughout the knee bouncing motion. If the rotational speed of the motor 3 is too fast, however, the heel 41 cannot keep up with the up and down swings P of the flap 2; the flap 2 may beat the heel 41 so that the toes 42 cannot be kept on the floor surface G. On the other hand, if the rotational speed of the motor 3 is slow, the heel 41 can keep up with the up and down swings of the flap 2. If the rotational speed is too slow, the frequency of the knee bouncing motion is insufficient. Therefore, the rotational speed of the motor 3 should be set to generate approximately 5 to 150, preferably 30 to 120, more preferably 60 to 90 sets of an up swing and a down swing P per minute. The knee bouncing motion stimulates the foot (ankle) 4, or terminal end of the lower limb, by the repetitive plantar flexion motion and at the same time stimulates the hip joint, or base end of the lower limb, by effective pivoting motion T of the hip joint. The knee bouncing motion hence stimulates the entire lower limb by the bouncing motion.

[0032] Therefore, the lower limb bouncing device 1 enables aged users who are unable to be engaged in active exercise to effectively relax their hip joints, which helps them walk easily by virtue of expanded range of motion of the lower limb and improve blood flow.

[0033] The user, whether aged or not, can prevent development of so-called economy-class syndrome by, for example, disposing the lower limb bouncing device 1 close to a front leg of a seat in a long distance bus, airplane, train coach, etc.

[0034] In the present embodiment, the lower limb bouncing device 1.
In the present embodiment, the toes 42 of the foot (ankle) 4 with the heel 41 of the foot 4 being placed on the heel resting surface 21 of the flap 2, so that the hip joint can effectively experience pivoting motion T for stimulation. Alternatively, the lower limb bouncing device 1 may be used to dorsiflex the foot (ankle) 4 with the toes 42 of the foot 4 being placed on the heel resting surface 21 of the flap 2, so that stimulation only comes from dorsiflexion of the foot (ankle) 4. When this is actually the case, the swing distance for the lower limb bouncing device 1 should be set to not more than 4 cm, preferably not more than 2 cm, because the dorsiflexion angle for a typical user is approximately 2/3 of the plantar flexion angle, that is, the dorsiflexion angle to the horizontally placed foot 4 is about 20° for the plantar flexion angle of about 45°. In addition, to cause knee bouncing motion by plantar flexing the foot (ankle) 4 in up and down swings P with the heel 41 of the foot 4 being placed on the heel resting surface 21 of the flap 2, the lower limb bouncing device 1 may be set up to cause the heel 41 to undergo up and down swings P within any angle range between the abovementioned plantar flexion angle of about 45° and the abovementioned dorsiflexion angle of about 20°. If the lower limb bouncing device 1 is to be set up to cause the heel 41 to undergo up and down swings P almost up to the plantar flexion limit (45°) or the dorsiflexion limit (20°), the foot (ankle) 4 is preferably plantar flexed starting from a horizontal position or from a position where the foot (ankle) 4 is already plantar flexed a little as illustrated in Figure 6 to cause the up and down swings P, hence the knee bouncing motion, to avoid excessive load on the foot (ankle) 4 and the lower leg. Furthermore, as long as the user is sitting on a chair, the upper limb does not need to be kept in a vertical position as shown in Figure 6; the user may bend forward or backward if necessary.

In the present embodiment, the toes 42 of the foot 4 are placed on the floor surface G. Alternatively, the lower limb bouncing device 1 may be designed to have an extension of the board 5 serving as a heel rest 52 so that the toes 42 can be placed thereon as illustrated in Figure 7. When this is actually the case, since the toes 42 of the foot 4 are placed not on the floor surface G, but on the surface of the heel rest 52, the gap DL, the minimum height position PL, and the maximum height position PH are measured not from the floor surface G, but from the surface of the heel rest 52. The heel rest 52 may be provided with, for example, a strap (not shown) securing the toes 42 to prevent the toes 42 from being displaced during knee bouncing motion.

In the lower limb bouncing device 1 of the present embodiment, the motor 3 rotates the eccentric cam 34 which pivots up and down the pivotable plate 6 which in turn swings up and down the flap 2 secured to the pivotable plate 6. The flap 2 is not necessarily swung up and down by this particular drive mechanism. Alternatively, the mechanism may include a combination of various gears, a chain complete with a sprocket, or a belt.
the enclosure is disposed, the flap being connected to another end of the pivotable plate so as to be swung up and down by the pivotable plate pivoting up and down around the pivotally attached end in response to rotation of the eccentric cam.

3. The lower limb bouncing device as set forth in claim 1 or 2, wherein the flap, when at the minimum height position, has therebelow a gap of 1 cm or larger, and when at a maximum height position, is elevated not more than 10 cm above the floor surface.

4. The lower limb bouncing device as set forth in any of claims 1 to 3, wherein the flap is swung up and down 2 cm ± 1 cm between the minimum and maximum height positions.

5. A method of stimulating a hip joint which is a base end of a lower limb, said method comprising mechanically moving a heel of a foot up and down by using a lower limb bouncing device that moves the heel up and down relative to stationary toes of the foot while the user is sitting, so as to stimulate the hip joint while the lower limb is relaxing.

6. The method as set forth in claim 5, wherein while the heel is being moved up and down relative to the toes, the foot stays within any desired angle range between a state where an ankle joint is dorsiflexed 20° or less relative to a horizontal position thereof and a state where the ankle joint is plantar flexed 45° or less relative to the horizontal position so that the ankle joint is not overloaded.

Amended claims under Art. 19.1 PCT

1. A lower limb bouncing device, comprising: a flap on which a heel of a foot is to be placed; and a motor coupled to the flap, the flap being configured so that a heel resting surface thereof is swung up and down by a driving force of the motor, but does not fall below a minimum height position that is not more than 4 cm above a toe resting surface on which toes are to be placed, the motor including: an output axis on which an eccentric cam is provided; and a pivotable plate sitting on the eccentric cam, the pivotable plate having an end thereof pivotally attached so as to be pivotable, and the flap being disposed on a side of an enclosure so that the heel can be placed at a minimum height position that is not more than 4 cm above a floor surface when the foot is placed on the floor surface on which the enclosure is disposed, the flap being connected to another end of the pivotable plate so as to be swung up and down by the pivotable plate pivoting up and down around the pivotally attached end in response to rotation of the eccentric cam.

2. The lower limb bouncing device as set forth in claim 1, wherein the flap, when at the minimum height position, has therebelow a gap of 1 cm or larger, and when at a maximum height position, is elevated not more than 10 cm above the floor surface.

3. The lower limb bouncing device as set forth in claim 1 or 2, wherein the flap is swung up and down 2 cm ± 1 cm between the minimum and maximum height positions.

4. A method of stimulating a hip joint which is a base end of a lower limb, said method comprising mechanically moving a heel of a foot up and down by using a lower limb bouncing device that moves the heel up and down relative to stationary toes of the foot while the user is sitting, so as to stimulate the hip joint while the lower limb is relaxing.

5. The method as set forth in claim 4, wherein while the heel is being moved up and down relative to the toes, the foot stays within any desired angle range between a state where an ankle joint is dorsiflexed 20° or less relative to a horizontal position thereof and a state where the ankle joint is plantar flexed 45° or less relative to the horizontal position so that the ankle joint is not overloaded.

Statement under Art. 19.1 PCT

Claim 1 now contains the contents of claim 2 which involves novelty and an inventive step with respect to each of the cited references in the Written Opinion of the International Search Authority; and the scope of the claims was thus restricted.

Thus, the invention described in claim 1 or claim 4 is rendered novel and involves an inventive step with respect to each of the cited references.
INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/054320

A. CLASSIFICATION OF SUBJECT MATTER
A61H1/00(2006.01)

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)

A61H1/00

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 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013
Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO 2003/045301 A1 (Eroica Corp.), page 2, line 25 to page 8, line 11; fig. 1 to 7</td>
<td>1,3-4</td>
</tr>
<tr>
<td>A</td>
<td>AU 200234383 A1 (Kabushiki Kaisha MRR-J), 06 October 2011 (06.10.2011), entire text; all drawings (Family: none)</td>
<td>1-4</td>
</tr>
<tr>
<td>A</td>
<td>JP 62-72378 A (Matsushita Electric Works, Ltd.), 02 April 1987 (02.04.1987), entire text; all drawings (Family: none)</td>
<td>1-4</td>
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</tbody>
</table>

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referred to in the written description of the invention
  "P" document published prior to the international filing date but later than the priority date claimed
  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  "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
01 April, 2013 (01.04.13)

Date of mailing of the international search report
09 April, 2013 (09.04.13)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.
## INTERNATIONAL SEARCH REPORT

**Category** | **Citation of document, with indication, where appropriate, of the relevant passages** | **Relevant to claim No.**
---|---|---
A | JP 2007-268140 A (TOTO Ltd.), 18 October 2007 (18.10.2007), entire text; all drawings (Family: none) | 1-4 |
A | JP 2002-143269 A (Shinkoh Electronics Co., Ltd.), 21 May 2002 (21.05.2002), entire text; all drawings (Family: none) | 1-4 |
A | JP 2005-205133 A (Sadamu MIZOBUCHI), 04 August 2005 (04.08.2005), entire text; all drawings (Family: none) | 1-4 |

Form PCT/ISA/210 (continuation of second sheet) (July 2009)
**INTERNATIONAL SEARCH REPORT**

**Box No. II**  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ✓ Claims Nos.: 5-6  
   because they relate to subject matter not required to be searched by this Authority, namely:  
   The inventions of claims 5-6 pertain to methods for treatment of the human body by therapy and thus relate to a subject matter on which this International Searching Authority is not required to carry out an international search under the provisions of PCT Article 17(2)(a)(i) and PCT Rule 39.1(iv).

2. ☐ Claims Nos.:  
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:  
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III**  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)
REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader’s convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

• JP 2011194051 A [0003]