(54) Title: DEVICE FOR PREVENTING OR RELIEVING PAIN IN THE LOWER BACK

(57) Abstract: A device (10) for preventing or relieving pain in the lower back of a human subject includes a body-engaging element (12) configured for engaging a region of the subject's body inferior to the lumbar vertebrae while the subject lies in a supine position. A drive mechanism (14) is configured to move the body-engaging element (12) through a repetitive cyclic motion which includes an operative motion along a first path including a primarily vertical lifting motion followed by a primarily horizontal tensioning motion, and a return motion along a second path, the second path lying generally below the first path. The body-engaging element (12) preferably includes at least one surface configured for engaging a rear surface of both of the subject's legs from the knees downwards.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
DEVICE FOR PREVENTING OR RELIEVING PAIN IN THE LOWER BACK

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a stretching device, particularly useful for the relieving or preventing of lower back pains.

It is well known that lower back pains affect a very large proportion of adults, especially middle aged adults and older. As a consequence, a great deal of suffering and disability is experienced by a large fraction of the population resulting, among other things, in a large number of lost work days and greatly diminished quality of life.

A brief physiological analysis will help illustrate the cause of back pains and give an insight as to possible remedies.

The spinal column consists of thirty three vertebrae which are joined together by cartilage tissue and ligaments. The upper twenty four vertebrae are discrete and movable while the lower nine vertebrae are fixed. Five of the lower nine vertebrae are fused together to form the sacrum while the terminal four vertebrae are normally fused to form the coccyx. The normal spinal column may be considered to have seven cervical, twelve thoracic, five lumbar, five sacral and four coccygeal vertebrae. Mobility of the vertebrae in the cervical, thoracic and lumbar regions is relatively free compared with movement of the fused vertebrae of the sacrum and coccyx which is relatively constrained.

The main causes of common back pain are the continual stresses and strains experience by the lower back region which is the major, albeit not the sole, weight supporting element of the upper body.

These stresses and strains eventually cause the damage symptomatic of back pain in that the cartilage material forming the discs separating the vertebrae is worn away over a period of time. In its extreme pathological condition, the patient may develop anchilosing spondylitis, namely, the partial, bent-down stiffening of the spinal column.
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The sensation of pain is felt because the distance separating the vertebrae becomes narrower, causing pressure to be exerted on the nerve roots which extend from the spinal cord.

Due to the degenerative nature of the causes of back pain of this sort there is currently no permanent relief available, except for surgery where appropriate. There are, however, a multitude of known procedures for the relief of pain in the lumbar region of the back. These procedures involve the stretching of the lower back to achieve the separation of the discs in the affected lumbar area. However, these treatments typically require the use of weights and other mechanical equipment and must be undertaken only under close professional supervision.

U.S. Patent No. 5,772,612 to Daniel Ilan, hereby incorporated by reference, proposes a device suitable for home use in which a user lies on an underlying surface with his or her knees over a frame and feet against a foot rest. The lower end of the device contacts the underlying surface, acting as a fulcrum. When the user pushes against the device, the device pivots so as to tend to lift the user’s legs along a slightly arched path. A motor-driven version of the device is also proposed.

The device of the aforementioned patent represents a useful attempt to provide a device for relieving lower-back pain suitable for home use. It has been noted, however, that the resulting motion, namely, a slightly arched reciprocating motion, differs considerably from the sequence of motion performed by a trained physiotherapist. Specifically, with reference to Figures 1A-1C, a trained physiotherapist typically performs an initial lifting movement by raising the subject’s legs from the position of Figure 1A to that of Figure 1B so as to neutralize the arched concavity of the back. This is followed by a primarily horizontal pulling motion (Figure 1C), thereby applying tension tending to relieve pressure between the lumber vertebrae. The tension is then released, thereby allowing the body to return under the action of gravity to a resting position.
There is therefore a need for a device for preventing or relieving pain in the lower back of a human subject which would more closely emulate the aforementioned therapeutic movement used by trained physiotherapists.

SUMMARY OF THE INVENTION

The present invention is a device for preventing or relieving pain in the lower back of a human subject.

According to the teachings of the present invention there is provided, a device for preventing or relieving pain in the lower back of a human subject, the device being configured for use while the subject lies in a supine position on an underlying surface, the device comprising: (a) at least one body-engaging element configured for engaging at least one region of the body of the subject inferior to the subject's lumbar vertebrae; and (b) a drive mechanism mechanically linked to the at least one body-engaging element, the drive mechanism being configured to move at least part of the at least one body-engaging element through a repetitive cyclic motion including: (i) an operative motion along a first path operative to apply tension to the lower back of the subject, and (ii) a return motion along a second path, the second path lying generally below the first path.

According to a further feature of the present invention, the body-engaging element includes at least one surface configured for engaging a rear surface of knees of the subject.

According to a further feature of the present invention, the first path includes a primarily vertical lifting motion followed by a primarily horizontal tensioning motion.

According to a further feature of the present invention, the second path includes a primarily vertical lowering motion followed by a primarily horizontal return motion.
According to a further feature of the present invention, the first and second paths together form a closed curve lying substantially in a vertical plane. The closed curve preferably approximates to the form of an ellipse.

According to a further feature of the present invention, the drive mechanism includes at least one rotating element, the repetitive cyclic motion being generated at least in part by an off-axis linkage to the rotating element.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIGS. 1A-1C are schematic representations of a sequence of positions occurring during manual physiotherapy for lower back pain;

FIG. 2 is an isometric view of a first embodiment of a device, constructed and operative according to the teachings of the present invention, for preventing or relieving pain in the lower back of a human subject;

FIG. 3 is a partially cut-away view similar to Figure 2 showing the main internal components of the device;

FIG. 4 is a view similar to Figure 2 with the walls of the device removed;

FIG. 5 is a partially cut-away side view of the device of Figure 2;

FIGS. 6A-6D are schematic views similar to Figure 3 showing successive positions during operation of the device (somewhat exaggerated for clarity of presentation);

FIG. 7 is a schematic representation of the drive mechanism of the device of Figure 2 showing the form of motion produced thereby;

FIGS. 8A and 8B are side views of the device of Figure 2 showing a preferred range of adjustment;

FIG. 9 is a partially cut-away side view of a second embodiment of a device, constructed and operative according to the teachings of the present invention, for preventing or relieving pain in the lower back of a human subject;
FIG. 10 is an enlargement of the region of Figure 9 designated X; and
FIG. 11 is a schematic side view of a third embodiment of a device, constructed and operative according to the teachings of the present invention, for preventing or relieving pain in the lower back of a human subject, the device being implemented as part of a chair.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a device for preventing or relieving pain in the lower back of a human subject.

The principles and operation of devices according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, Figures 2-8 show a device, generally designated 10, constructed and operative according to the teachings of the present invention. Device 10, configured for use while lying in a supine position, is helpful for preventing or relieving pain in the lower back of a human subject.

Generally speaking, device 10 provides at least one body-engaging element 12 configured for engaging at least one region of the body of the subject inferior to the subject’s lumbar vertebrae, and a drive mechanism 14, mechanically linked to body-engaging element 12. It is a particular feature of the present invention that drive mechanism 14 is configured to move at least part of body-engaging element 12 through a repetitive cyclic motion which includes an operative motion along a first path operative to apply tension to the lower back of the subject, and a return motion along a second path, the second path lying generally below the first path.

The second path is described as “lying generally lower than” the first path. In other words, the path followed by at least part of body-engaging element 12 as viewed from the side circumscribes a non-zero area. This
property preferably results from the preferred form of one or both of the first and second paths. Specifically, the operative motion along the first path preferably includes a primarily vertical lifting motion followed by a primarily horizontal tensioning motion. Furthermore, the return motion along the second path preferably includes a primarily vertical lowering motion followed by a primarily horizontal return motion.

It will be immediately apparent that this cyclic motion provides a much better emulation of the aforementioned therapeutic movement used by trained physiotherapists than is offered by the prior art devices. Specifically, the preferred form of the operative motion along the first path closely parallels the sequence described above with reference to Figures 1A-1C. Furthermore, the preferred form of the return motion serves to first lower the body back into full contact with the underlying surface before releasing the horizontal tension, thereby tending to retain a proportion of the stretching effect at the end of each cycle. Without in any way limiting the scope of the present invention, it is thought that this residual stretching effect from each cycle gives rise to a cumulative stretching effect which may be responsible for the highly effective pain relief which has been experienced by users of the device during preliminary trials.

Turning now to the features of device 10 in more detail, it should be noted that body-engaging element 12 may engage any part of the body inferior to the subject’s lumbar vertebrae in order to apply appropriate tension on the lumbar region of the subject’s back. In the non-limiting preferred examples described herein, body-engaging element 12 includes at least one portion for engaging the rear surface of each of the user’s knees. Optionally, although not necessarily, element 12 may also be provided with at least one surface 16 configured for supporting the rear side of the subject’s legs below the knees for added comfort. In this case, the subject lies on the underlying surface in a supine position with his or her legs resting on surface 16. Preferably, surface 16 is angled downwardly-away from the user’s body so that the user’s knees
effectively lock around the surface 16 to enable exertion of tension along the upper leg away from the body. A preferred angle of inclination relative to the underlying surface is between about 5° and about 70°. For compact storage, all or part of surface 16 may be hinged or otherwise foldable to a stowed position when not in use. If desired, additional mechanical body-engaging elements such as foot straps (not shown) or the like may be provided to engage the body to the device more securely. In most cases, however, such additional elements have not been found necessary.

As mentioned before, the repetitive cyclic motion generated by drive mechanism 14 includes an operative motion along a first path and a return motion along a second path, the second path lying generally below the first path. In other words, the motion of at least one, and typically all, points on surface 16 undergo cyclic motion along a closed path which encloses a non-zero area. Preferably, in order to avoid percussive motion, the first and second paths are chosen to together form a closed curve lying substantially in a vertical plane. Most preferably, the closed path approximates to the form of an ellipse. Optionally, although not necessarily, at least one point on surface 16 may follow a substantially circular path (a circle being a special case of an ellipse).

The dimensions of the path followed depend of the type of treatment required and the state of health of the subject. In most cases, the maximum dimension of the closed curve is less than about 10 cm, and in most preferred cases, falls within the range from about 2 cm to about 6 cm. Optionally, a user-operable adjustment may be provided to allow selection of the magnitude of the motion as desired.

In structural terms, Figures 3-6 illustrate one particularly simple implementation of drive mechanism 14 for producing elliptical motion. Specifically, drive mechanism 14 as shown includes at least one rotating element, typically a drive wheel 18 driven by an electric motor 20 with a suitable step down gear arrangement. By way of a non-limiting example, a typical implementation employs an 80W AC motor operating at about 1400 rpm
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with step-down gears etc. bringing the final motion down to a frequency of
roughly 30 rpm. Suitable motors with external and/or built-in gear arrange-ments
are commercially widely available. The repetitive cyclic motion of
body-engaging element 12 is then generated, at least in part, by a mechanical
linkage 22 which links element 12 to an off-axis point on the rotating element.
In the implementation shown, a second part of linkage 22 is mounted via one or
more sliding pivots 24 within slots 26.

The motion resulting from this structure is illustrated schematically in
Figure 7. As the point of attachment of linkage 22 moves with turning of drive
wheel 18 through positions a, b, c and d, the uppermost portion of surface 16
follows an elliptical path through positions a’, b’, c’ and d’, respectively. This
is an example of a primarily horizontal tensioning motion (b’ to c’), together making up the first
path, and the return motion (c’ via d’ back to a’) along a lower second path. A
similar motion is represented by the sequence of Figures 6A-6D, the initial
position being shown for reference in each Figure by a dashed outline.

It will be noted that the smoothly curved form of the motion provides
gradual transitions between the various “primarily vertical” and “primarily
horizontal” movements. As a result, the specific points identified by the
symbols a’, b’, c’ and d’ are not necessarily uniquely and unambiguously
defined. Nevertheless, it is clear that an elliptical motion in a vertical plane
inherently includes portions in which the vertical component of the motion is
significantly greater than the horizontal component and vice versa, paths
including such portions being referred to as “primarily vertical” and “primarily
horizontal” movements, respectively.

In order to facilitate use of device 10 for subjects of different sizes, an
adjustment mechanism is preferably provided for varying the height of
body-engaging element 12 above the underlying surface. This adjustment
mechanism may be implemented in a range of ways, including, but not limited
to, varying the length of linkage 22, either above or below sliding pivots 24, or by raising or lowering the entirety of drive mechanism 14.

In the embodiment of Figures 2-8B, adjustment is achieved by mounting the entirety of drive mechanism 14 in a cradle 40 (see Figure 4) which can be raised and lowered along a vertical alignment rod 41 relative to a housing of the device. Specifically, as seen in Figures 2, 3, 8A and 8B, side walls 42 of the housing feature a set of adjustment slots 44 within which a lever arm 46 may be locked. Lever arm 46 is pivotally linked to cradle 40 to that adjustment of lever arm 46 raises or lowers adjustment mechanism 14, and hence body-engaging element 12 between the lowered position of Figure 8A and the raised position of Figure 8B. Slots 26 are made sufficiently long to accommodate both the range of adjustment and the range of motion during operation in each of the extreme positions. The range of adjustment may extend from about 30 cm up to about 65 cm as measured to the highest part of surface 16 above the underlying surface. In practice, a range from about 40 cm to about 55 cm is sufficient to accommodate most adult users.

It should be noted that this is just one exemplary implementation of an adjustment mechanism. Clearly, many alternative implementations of such mechanisms are within the ability of one ordinarily skilled in the art. One further example will be illustrated below with reference to Figures 9 and 10.

Turning now to Figures 9 and 10, there is shown a second embodiment of a device, generally designated 100, constructed and operative according to the teachings of the present invention. Device 100 is generally similar to device 10, equivalent elements being designated similarly. Device 100 differs primarily in the implementation of the adjustment mechanism used.

Specifically, Figure 10 illustrates schematically a further possible implementation of an adjustment mechanism in which the length of linkage 22 is adjustable above pivots 24. This is achieved by use of a lockable telescopic connection in which the main support element of linkage 22 is slidably engaged within a sleeve 28 attached to body-engaging element 12. Sleeve 28 features a
pin 30 which engages one of a row of recesses 32 in the support element. A spring element 34 urges the support element into against pin 30 tending to maintain engagement between pin 30 and one of recesses 32. To adjust the height, the elements are twisted so as to compress spring element 34 and free pin 30 from engagement with its initial recess 32. Body-engaging element 12 can then be raised or lowered telescopically relative to the support element and pin 30 brought into engagement with an appropriate recess 32 to maintain the desired height.

Finally, with reference to Figure 11, it should be appreciated that the device of the present invention may be integrated with various other devices and structures. By way of one particular preferred example, Figure 11 shows an implementation of the device of the present invention, generally designated 200, in which body-engaging element 12 is implemented as at least one body-supporting surface of a chair. The “underlying surface” which supports the back of the user is, in this case, the back rest 202 of the chair. Parenthetically, as will be noted from this example, the “underlying surface” of the present invention is not necessarily horizontal. In other respects, device 200 is similar in structure and operation to device 10 described above, equivalent elements being labeled similarly.

It will be appreciated that the above descriptions are intended only to serve as examples, and that many other embodiments are possible within the spirit and the scope of the present invention.
WHAT IS CLAIMED IS:

1. A device for preventing or relieving pain in the lower back of a human subject, the device being configured for use while the subject lies in a supine position on an underlying surface, the device comprising:

   (i) at least one body-engaging element configured for engaging at least one region of the body of the subject inferior to the subject’s lumbar vertebrae; and

   (ii) a drive mechanism mechanically linked to said at least one body-engaging element, said drive mechanism being configured to move at least part of said at least one body-engaging element through a repetitive cyclic motion including:

       (8) an operative motion along a first path operative to apply tension to the lower back of the subject, and

       (2) a return motion along a second path, said second path lying generally below said first path.

2. The device of claim 1, wherein said body-engaging element includes at least one surface configured for engaging a rear surface of knees of the subject.

3. The device of claim 1, wherein said first path includes a primarily vertical lifting motion followed by a primarily horizontal tensioning motion.

4. The device of claim 1, wherein said second path includes a primarily vertical lowering motion followed by a primarily horizontal return motion.

5. The device of claim 1, wherein said first and second paths together form a closed curve lying substantially in a vertical plane.
6. The device of claim 5, wherein a maximum dimension of said closed curve is no greater than about 10 cm.

7. The device of claim 1, wherein said first and second paths together approximate to the form of an ellipse.

8. The device of claim 7, wherein a maximum dimension of said ellipse is no greater than about 10 cm.

9. The device of claim 7, wherein said ellipse is a circle.

10. The device of claim 1, wherein said drive mechanism includes at least one rotating element, said repetitive cyclic motion being generated at least in part by an off-axis linkage to said rotating element.

11. The device of claim 1, further comprising a housing configured for supporting said drive mechanism above the underlying surface, wherein said drive mechanism is adjustably mounted relative to said housing to allow adjustment of a height of said drive mechanism, and hence also of said body-engaging element, above the underlying surface.

12. The device of claim 1, wherein said body-engaging element is linked to said drive mechanism via an adjustable linkage configured to allow adjustment of a height of said body-engaging element relative to said drive mechanism.

13. The device of claim 1, wherein said body-engaging element is implemented as at least one body-supporting surface of a chair.
Fig. 4
A. CLASSIFICATION OF SUBJECT MATTER
   IPC(7) : A61H 1/00
   US CL : 601/26
   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)
   U.S. : 601-26, 23-25, 33, 34; 660/337; 240-245; 609/32-35; 482/901

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

   Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
   East search terms: (knee or leg) and passive and (circle or circular or ellipse), path.

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>US 4,621,620 A (Anderson) 11 November 1986, see the entire document.</td>
<td>1-3, 5, 10-12</td>
</tr>
<tr>
<td>Y</td>
<td>US 4,637,379 A (Saringer) 20 January 1987, see figure 5.</td>
<td>4, 6-9, and 13</td>
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<td>Y</td>
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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents.
+ Document defining the general state of the art which is not considered to be of particular relevance.
* Earlier document published on or after the international filing date.
* 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).
* Document referring to an oral disclosure, use, exhibition or other means than the priority date claimed.
* Document published prior to the international filing date but later than the priority date claimed.

Document member of the same patent family.

Date of the actual completion of the international search: 18 MAY 2001

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
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Fax number: (703) 305-3230

Date of mailing of the international search report: 27 JUN 2001

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