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"THERAPEUTIC EXERCISE DEVICE"

The present invention relates to an exercise device. The exercise device of the invention is especially suitable in the prevention of venous thrombosis in persons confined to a particular stance or position for considerable periods of time, e.g. in wheelchairs, in bed or during prolonged travel. The exercise device of the invention also finds use in the physiotherapy of patients recovering from illness or surgery.

R.E.C. Collins, S. Field and W. Castleden, B.M.J. 2, 1478 (1979) have reported that venous thrombosis and subsequent pulmonary embolism occurs after prolonged sedentary travel. Such thrombosis can be avoided if normal blood-flow is maintained. Normal blood-flow can be maintained by exercise. There is therefore a need for an inexpensive, simple, quiet, soft, pliable, light-weight, portable and hygienic exercise device which can be used during periods of prolonged travel. Such a device is provided by the present invention.

In addition to prolonged sedentary travel, similar problems are likely to occur also in geriatrics and persons occupied in sedentary trades or professions. The exercise device of the invention finds use in these applications.

In post-operative and ill patients undergoing bed

rest, bed sores and potential thrombosis are problems. The exercise device of the invention is also useful in providing gentle but effective exercise for such patients and in avoiding and/or alleviating such problems.

5 The present invention provides a therapeutic exercise device operable by at least two portions of a human body, said device comprising two closed containers formed from flexible, substantially inextensible sheet material and having substantially the same shape, said containers being
10 located one above the other with no fluid communication between said two containers; the upper one of said two containers being filled with fluid to partially pressurise the interior of said upper container with the pressure therein being less than that required to make said upper
15 container rigid; said upper container being formed into at least two compartments by partitions; and each of said compartments being in direct fluid communication with at least one other of said compartments via at least one passage to restrict the flow of fluid between said
20 compartments in response to an external force applied to at least one of said compartments by movement of one of said human body portions to reduce the volume of said one compartment, whereby the remainder of said compartments expand in volume thereby exerting a movement inducing force
25 on the other ones of said human body portions.

It is preferred that the exercise device be provided with a valve whereby it may be partially inflated with, or emptied of, the preferred fluid, air.

30 The exercise device is especially useful to persons engaged in prolonged sedentary travel, and is preferably of such size that, when deflated, it may be folded to approximately the size of a man's handkerchief. In use, this device is semi-inflated, and placed under the feet of a seated traveller or other user. Pressure with one foot on
35 one compartment transfers air to the other compartment thereby raising the foot thereon. A pedalling or jogging on the spot movement is thus obtainable. All joints from toes to ankle, and knee to hip experience movement and alteration

of position. Thighs are raised naturally and easily from contact with the seat. It has been found that once movement on the device is commenced subconscious movement continues, which makes the device especially useful in the case of
5 geriatrics. The user may readily alter the inclination of either foot and hence change the angle between foot and leg.

It has been found in the case of one patient who had a tendon transplant on one ankle that use of the exercise device enabled the patient to get some hip extension and
10 foot plantarflexion which movements were desirable post-operation.

Preliminary tests into the effect of this device on vascular circulation have been conducted using the Doppler ultra-sound technique. The tests have indicated that
15 circulation increased 7% after 5 minutes exercise by heel-toe action on the exercise device. This indicates that 5 minutes use of the exercise device approximates to a walk of 200m.

Whilst the exercise device is described above in relation to use under the feet of a seated user, its use is
20 not restricted thereto. It may be used, with corresponding alteration of size if necessary, under any parts of the body whether the user is in a seated or lying position, e.g. under the calves, thighs, buttocks, lumbar regions,
25 shoulders or neck. It also finds use in exercising the hands and fingers where one compartment is held in each hand and air squeezed to and fro between the compartments.

The degree of inflation in the device is preferably 75% to ensure that some of the air displaced by pressure on
30 one compartment by a heel, calf or thigh reaches the compartment under the other heel, calf or thigh.

The partitions between the compartments can be non-linear. When used under calves or thighs, the legs are thus prevented from slipping into the partitions.

This device has been found useful in the prevention of
35 the onset of venous thrombosis in the lower legs and pressure injury, which are frequent complications of immobility and bed-rest.

An adjustment means is provided which is adapted to adjust the height of the plane in which the compartments in direct fluid communication with each other are located. The adjustment means preferably takes the form of the

5 abovementioned second container which, as well as permitting height adjustment, provides insulation against transferred impact.

Preferred embodiments of the invention will now be described with reference to the drawings in which:

10 Fig. 1 illustrates the first embodiment of the present invention.

Fig. 2 is a section through the line IIIa-IIIa of Fig. 1.

15 Fig. 3 illustrates a second embodiment of the present invention, and

Fig. 4 is a section through the line IVa-IVa of Fig. 3.

Figs. 1 and 2 depict an embodiment where the exercise device 31 is formed from three sheets of plastics material, an upper sheet 311, a middle sheet 312 and a lower sheet 313. Partitions 33 are formed by welding sheets 311 and 312 together, and the device 31 completed by joining sheets 311, 20 312 and 313 by perimeter welds 32. The exercise device 31 is thus divided into an upper container having a left compartment 34 and a right compartment 35, and a lower container 38. The left compartment 34 and right compartment 35 are in direct communication with each other via passage 36. The right compartment 35 and the lower container 38 are provided with valves 371 and 372 respectively.

This device is designed to be used primarily by 30 persons in the sitting position for leg exercise. The user places both feet on the partially inflated upper container of the device, one foot on each compartment, and by exerting pressure with one foot causes fluid to flow from the compartment under the foot into the other compartment 35 thereby exerting a lifting force on the other foot. 35 Pressure is applied sequentially by each foot thereby exercising the legs.

The device has an additional advantage that it can be

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adjusted to take in to account different physical dimensions of various users. Lower container 38 can be fully inflated when the device is being used by shorter persons and uninflated or partially inflated for taller persons.

5 Preferably the containers are inflated with air.

The exercise device 41 of Figs. 3 and 4 is depicted with an upper container having compartments 441, 442, 451 and 452 in semi-inflated condition and in direct communication with their direct neighbours via passages 46.

10 A lower container 48 is shown in Fig. 4 in a fully inflated condition. The compartments 441, 442, 451 and 452 are separated by non-linear partitions 43 which include internal welds 421 between upper sheet 411 and middle sheet 412. The perimeter welds 42 joining the sheets 411 and 412 to a lower
15 sheet 413 form the lower container 48. Compartment 452 and container 48 are provided with valves 471 and 472 respectively.

This embodiment can be used in like manner to the embodiment of Figs 1 and 2, container 48 being uninflated or
20 inflated to a greater or lesser degree to raise or lower the legs of the user under which the exercise device 41 is placed.

To be useful for exercise purposes, it is important that there be sufficient inhibition to flow of fluid between
25 compartments of the exercise devices of the invention that fluid in one compartment is not immediately displaced by placing one body portion on that compartment with little or no force being applied.

It has been found that the average force applied by
30 the foot of a seated healthy human adult on one compartment of the device depicted in Fig. 1 is about $70N \pm 30N$. A convenient size for use by travellers of the device of Fig. 1 is such that when the upper compartment is semi-inflated with fluid, it contains $2.0 L \pm 0.2 L$. On such an exercise
35 device, it has been determined that with the device resting on a surface under the feet of a seated average healthy adult, left foot on left compartment 34 and right foot on right compartment 35, the left foot fully depressed,

application of an average force by the right foot to effect a single stroke of exercise will fully depress the right foot in 0.5s to 0.7s, thereby displacing $0.7 L \pm 0.1 L$ (about 30% of the total volume of fluid) to the left compartment 34 when the perimeter of the cross-section of the passage 36 is about 38 mm.

In the device of Fig. 3, two passages 46 are shown between each pair of adjacent compartments 441 and 442, 442 and 451, and 451 and 452. This device is primarily intended for use by patients recovering from surgery or illness who are usually not able to apply as great a force to the exercise device as a healthy adult. Accordingly, it has been found that when the perimeters of the cross-sections of the passages 46 are also about 38 mm, a single stroke of exercise can be achieved in 0.4s to 0.8s.

It should be emphasised that this does not mean that exercise on the devices as described immediately above is restricted to a stroking rate of 0.4s to 0.8s, this will be, however, the average maximum rate of exercise achievable on those devices by the average users thereof.

It is therefore preferred that, in the exercise devices according to the invention, the total area of cross section of the passage or passages between adjacent compartments is such that, on application of an average force on a first compartment by a first body portion, the time taken to displace sufficient fluid from said first compartment to achieve a stroke of exercise is between 0.4s and 0.8s. It should be emphasised, however, that the invention is not restricted to exercise devices having such an area of cross-section of passage or passages between adjacent compartments. The exercise devices of the invention, can also find use in the training of athletes or by persons wishing to improve their fitness, in which cases a passage of smaller cross-sections is desirable to require a greater force to be applied for more strenuous exercise.



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CLAIMS

1. A therapeutic exercise device operable by at least two portions of a human body, said device comprising two closed containers formed from flexible, substantially inextensible sheet material and having substantially the same shape, said containers being located one above the other with no fluid communication between said two containers; the upper one of said two containers being filled with fluid to partially pressurise the interior of said upper container with the pressure therein being less than that required to make said upper container rigid; said upper container being formed into at least two compartments by partitions; and each of said compartments being in direct fluid communication with at least one other of said compartments via at least one passage to restrict the flow of fluid between said compartments in response to an external force applied to at least one of said compartments by movement of one of said human body portions to reduce the volume of said one compartment, whereby the remainder of said compartments expand in volume thereby exerting a movement inducing force on the other ones of said human body portions.

2. The device as claimed in claim 1 wherein said upper container includes a valve means for introducing fluid into, and removing fluid from said upper container.

3. The device as claimed in claims 1 or 2 wherein the lower one of said containers includes a valve means for introducing fluid into, or removing fluid from, said lower container, height adjustment of said upper container being achieved by introducing fluid into, and removing fluid from, said lower container.

4. The device as claimed in any one of the claims 1, 2 or 3 wherein said fluid is air.

5. The device as claimed in any one of the preceding claims wherein said upper container has two compartments formed by a single partition, said one passage comprising an opening through said partition.

6. The device as claimed in any one of the

preceding claims wherein said upper container is formed into four compartments, which compartments are arranged in tandem, each of said compartments being separated from the next adjacent compartment by one of said partitions.

5 7. The device as claimed in claim 6 wherein said partitions are non-linear and each of said partitions includes two of said passages.

10 8. The device as claimed in any one of the preceding claims wherein the cross-sectional area of the, or each, passage is determined by the uninterrupted extent of the corresponding partition and restricts the flow of fluid between adjacent compartments whereby the time taken to transfer sufficient fluid between said adjacent compartments is from 0.4 seconds to 0.8 seconds.

15 9. The device as defined in any one of the preceding claims wherein said lower container comprises a single compartment.

20 10. A therapeutic exercise device substantially as herein described with reference to Figs. 1 to 4 of the accompanying drawings.

The text of the specification has been reproduced by photocopying the applicants original typescript. It may contain a few amendments which are difficult to read. The original typescript containing these amendments may be inspected on the premises of the Patent Office



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