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(54) Title of the Invention: **Portable therapeutic strengthening apparatus using adjustable resistance**
 Abstract Title: **Leg strengthening apparatus including biased movable guide means and calf support**

(57) A leg strengthening apparatus includes a longitudinal body 109; a guide member 120 moveable along the body 109 and a footplate 104 for receiving a portion of a user's leg; at least one resilient biased means 108 is secured to the guide means 120 to provide variable resistance to movement of the guide member 120 along the body 109; the footplate includes a calf support 103. The footplate 104 and the calf support 1030 may be pivotally connected to each other and the guide member 120; the resilient biased means are preferably elastic or rubber cords or springs. The apparatus may include a removable liner and the footplate may be removable from the guide means and replaced by a gripping means for a user's arms. Preferably the apparatus includes a counter and bed end stops to stabilize the device when used on a bed.

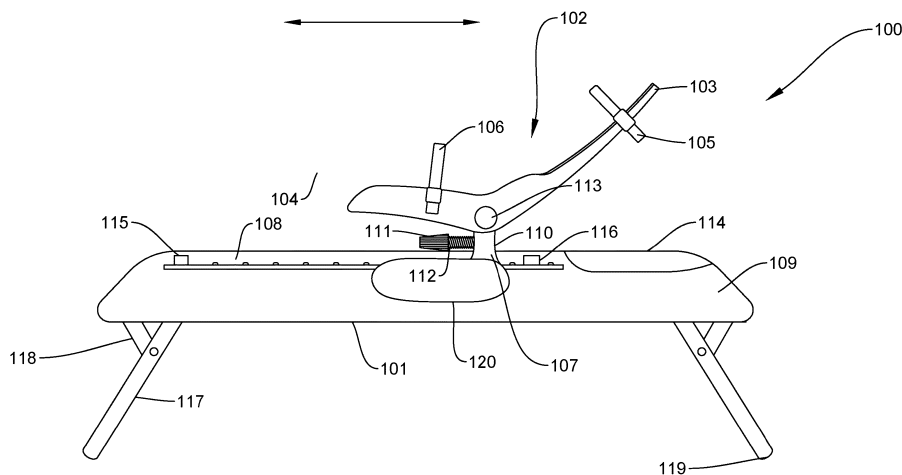


FIG. 1

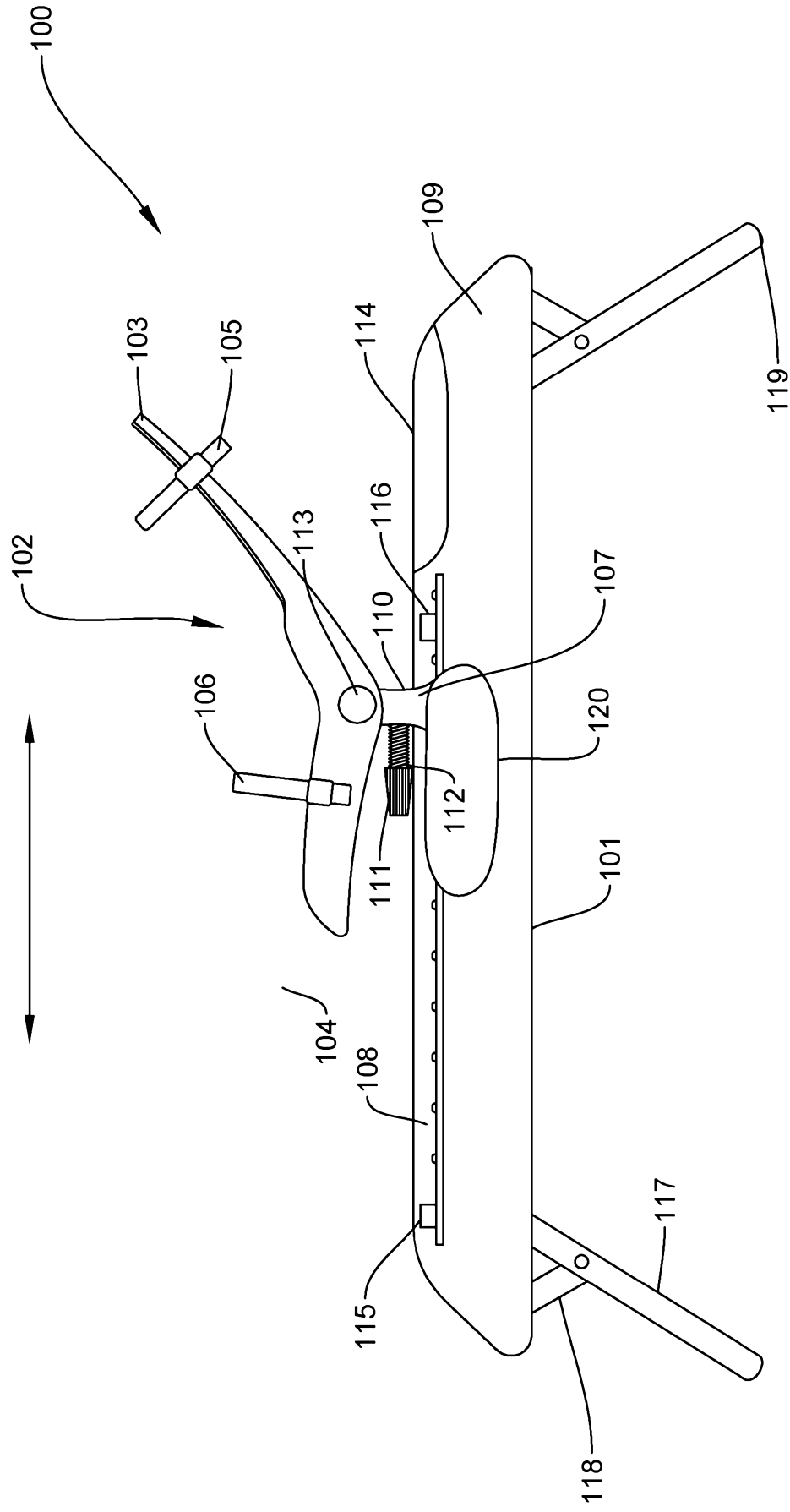


FIG. 1

30 10 18

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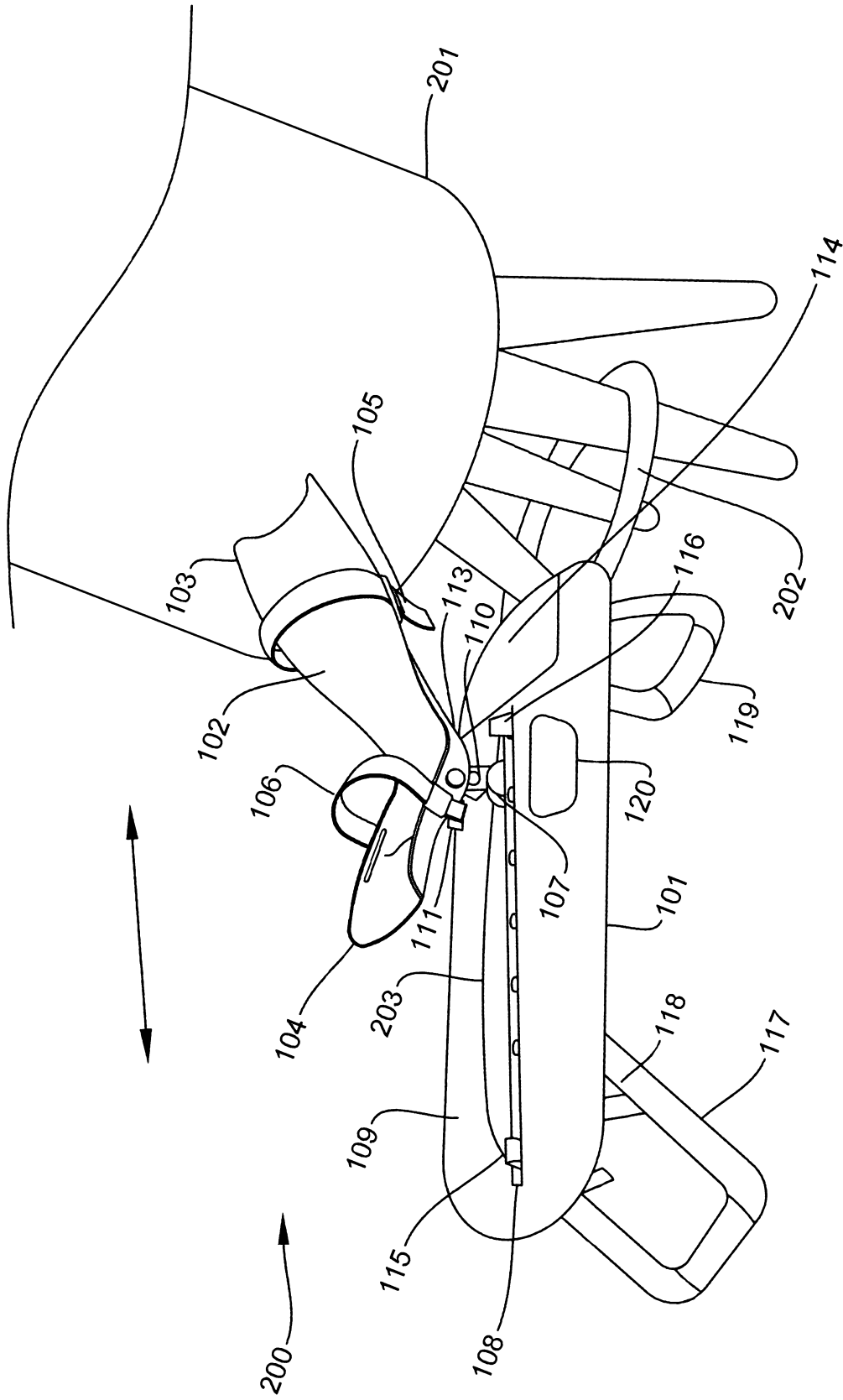


FIG. 2

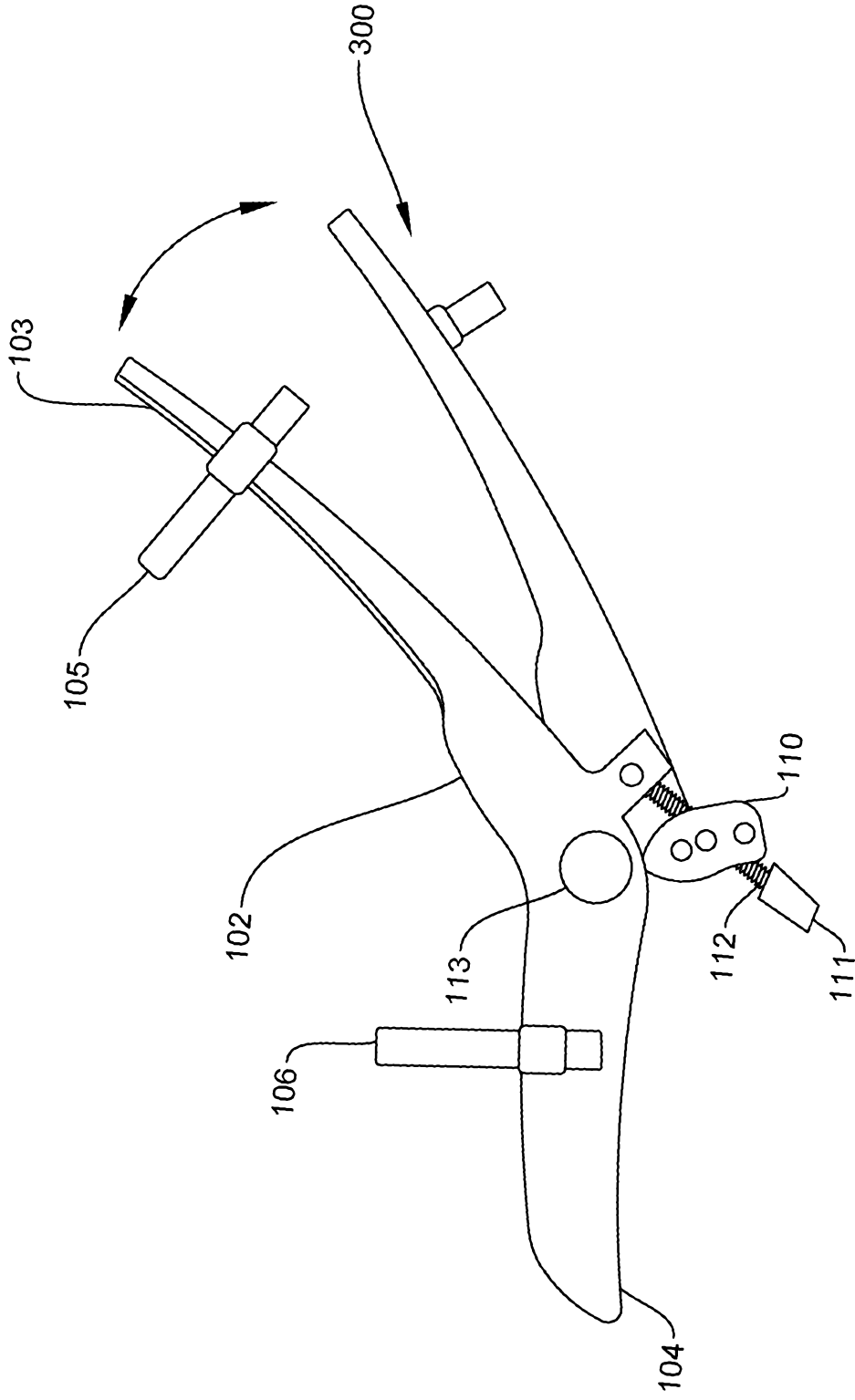


FIG. 3

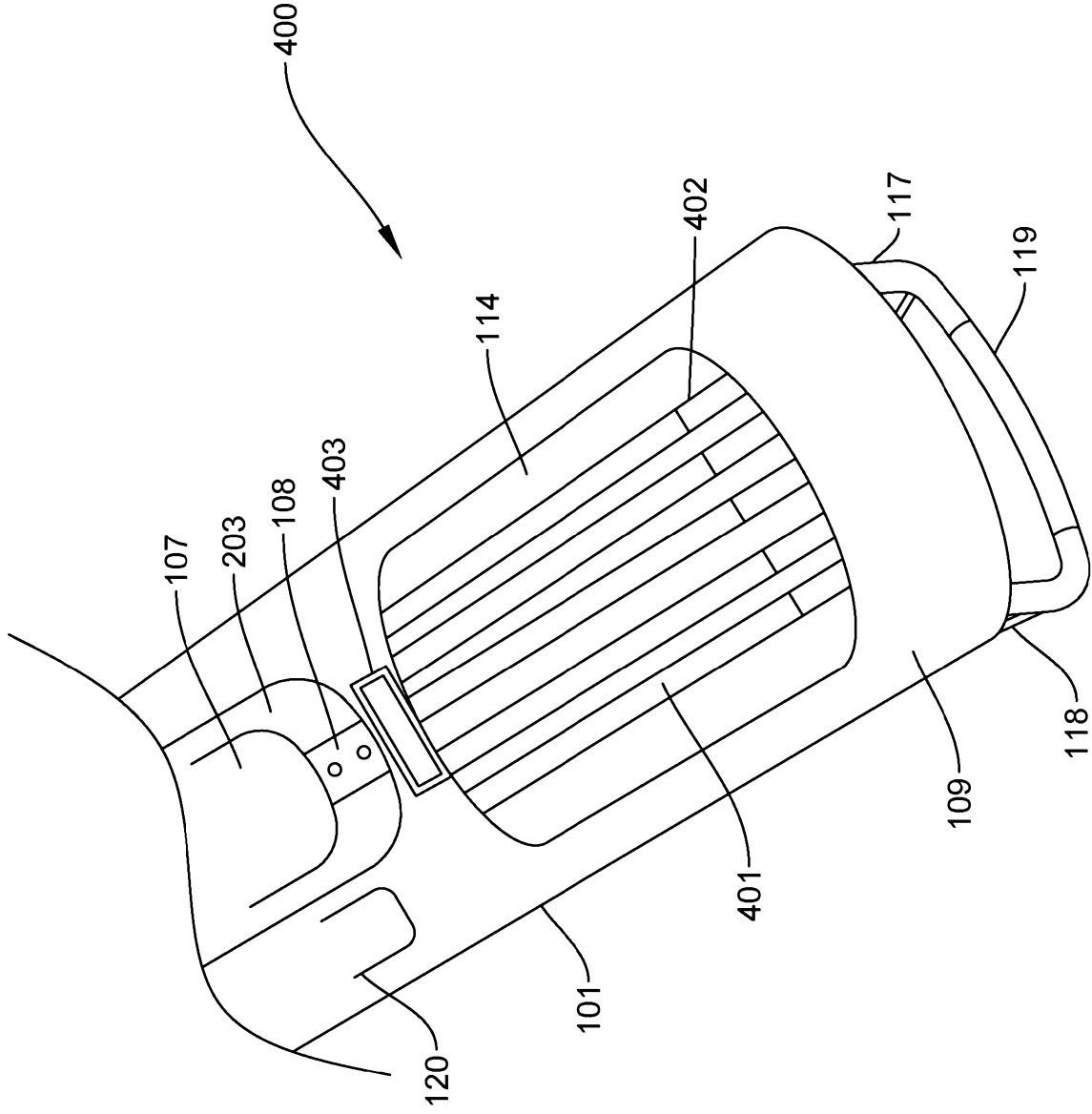


FIG. 4

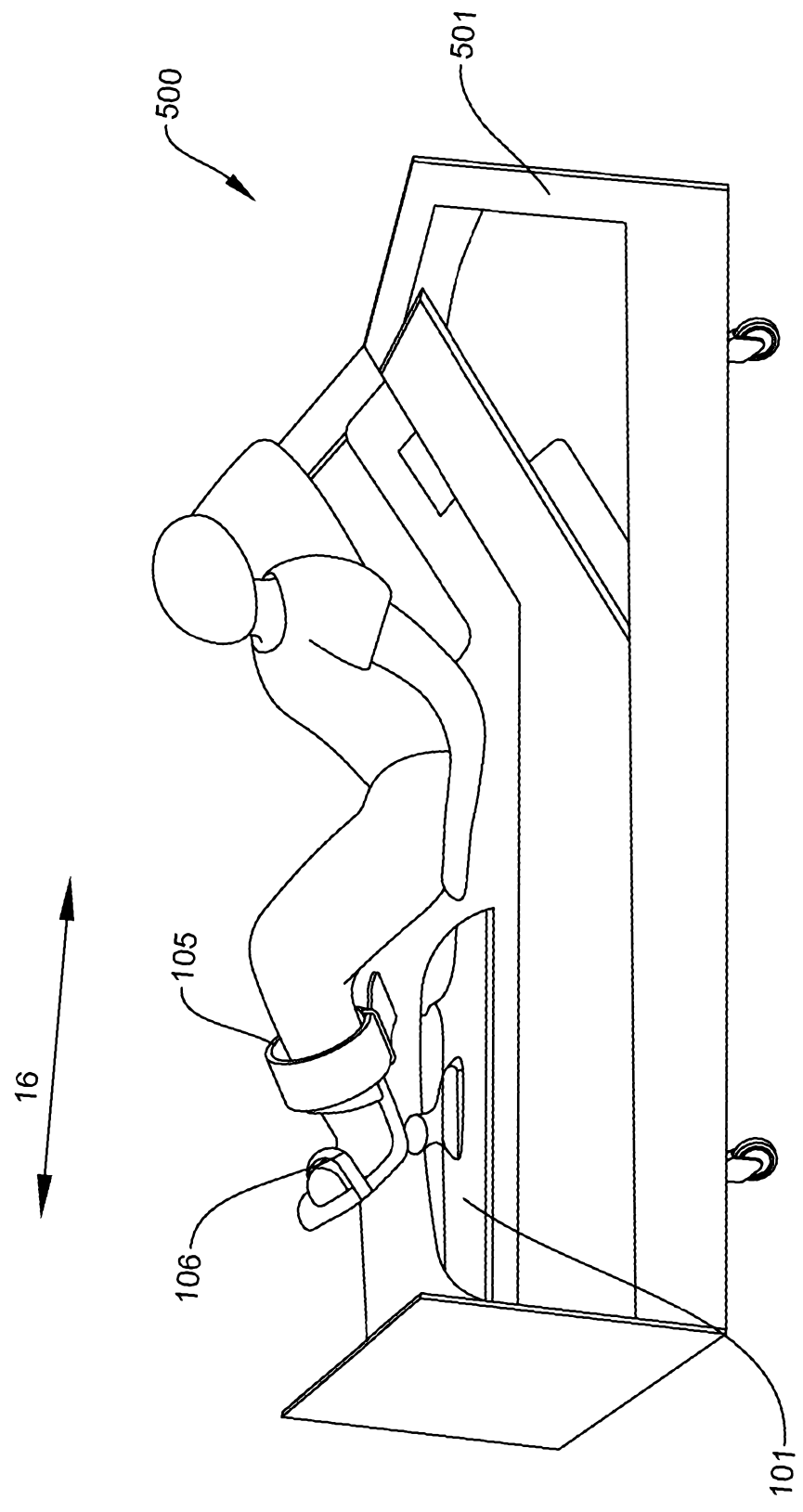


FIG. 5

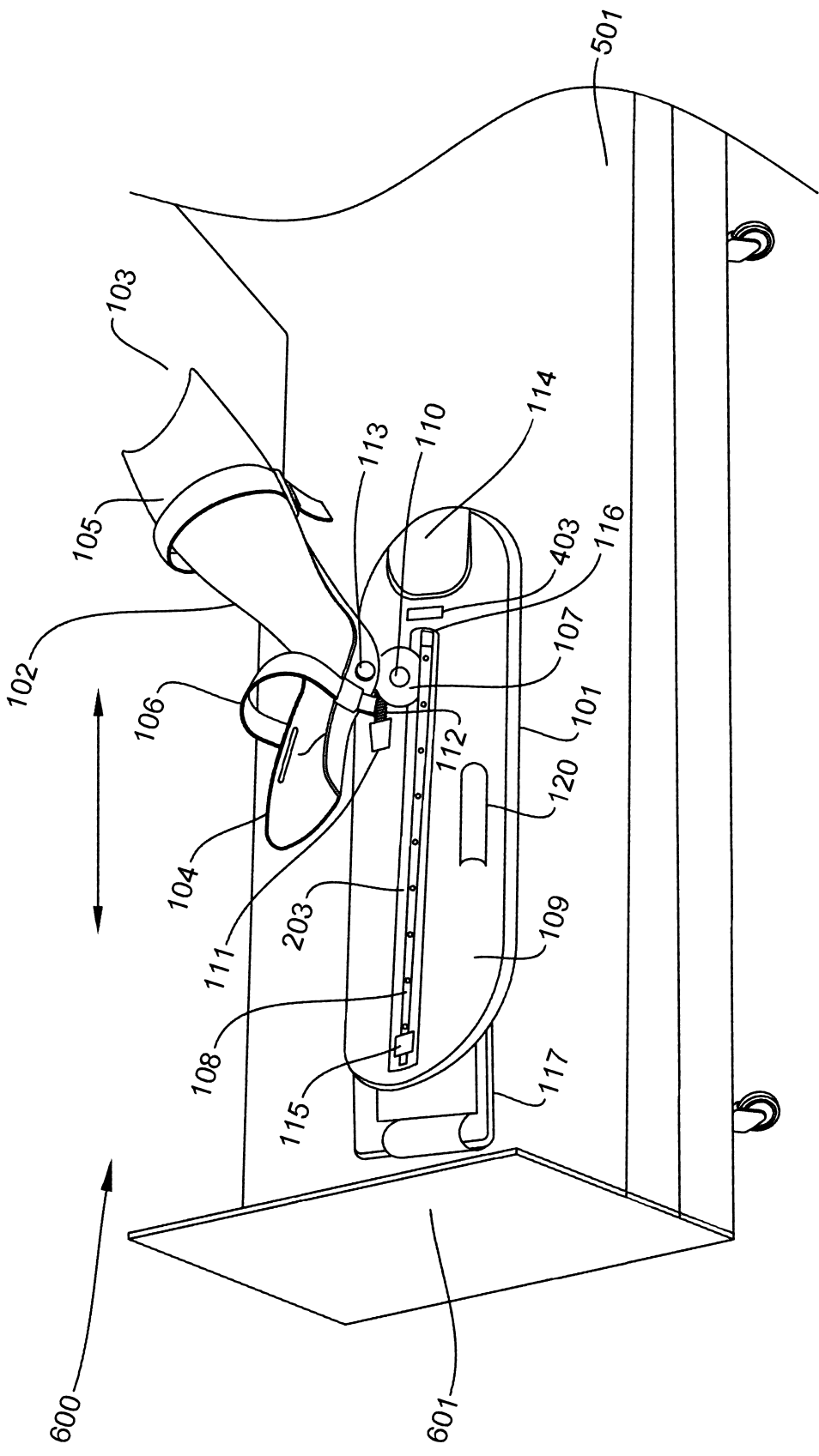


FIG. 6

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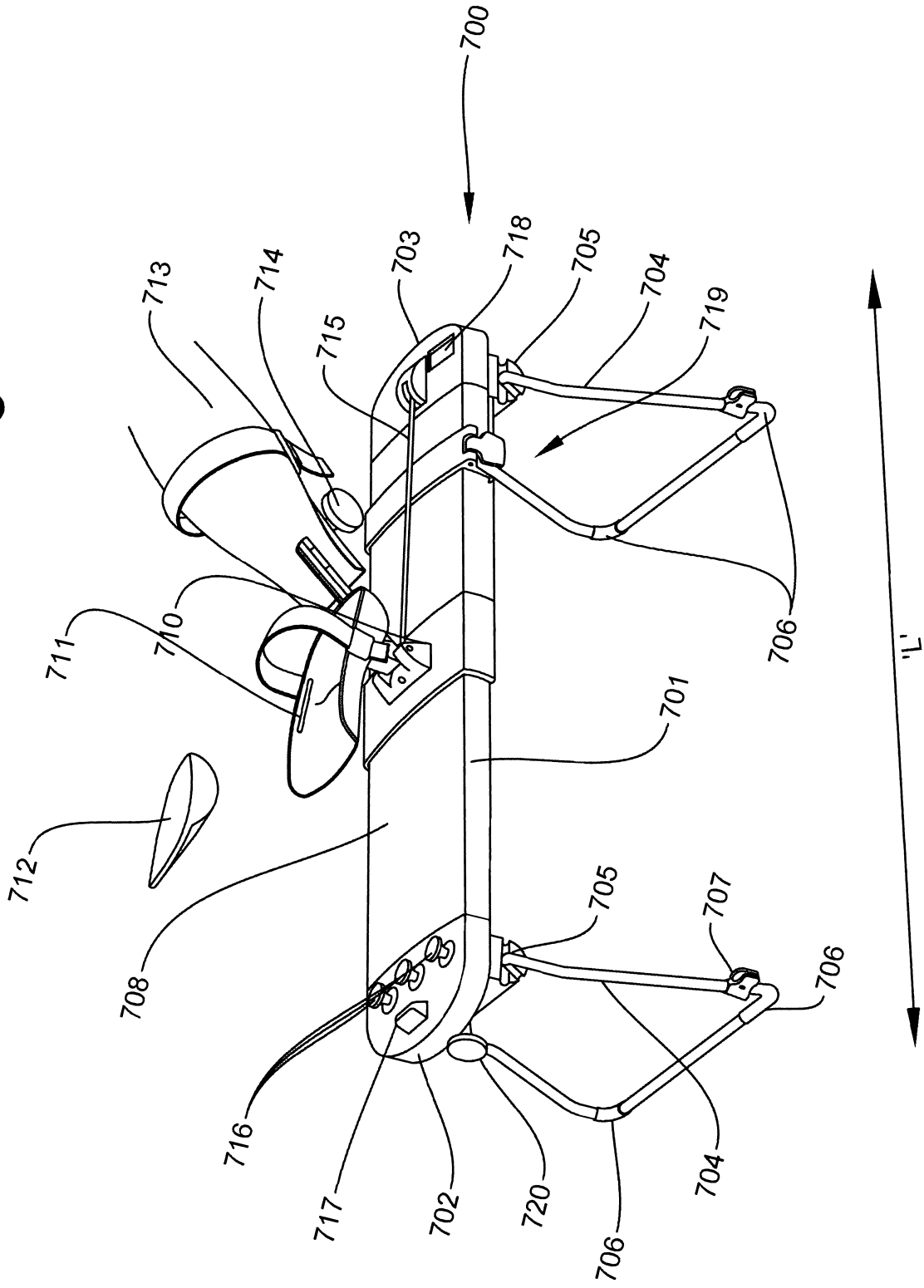


FIG. 7

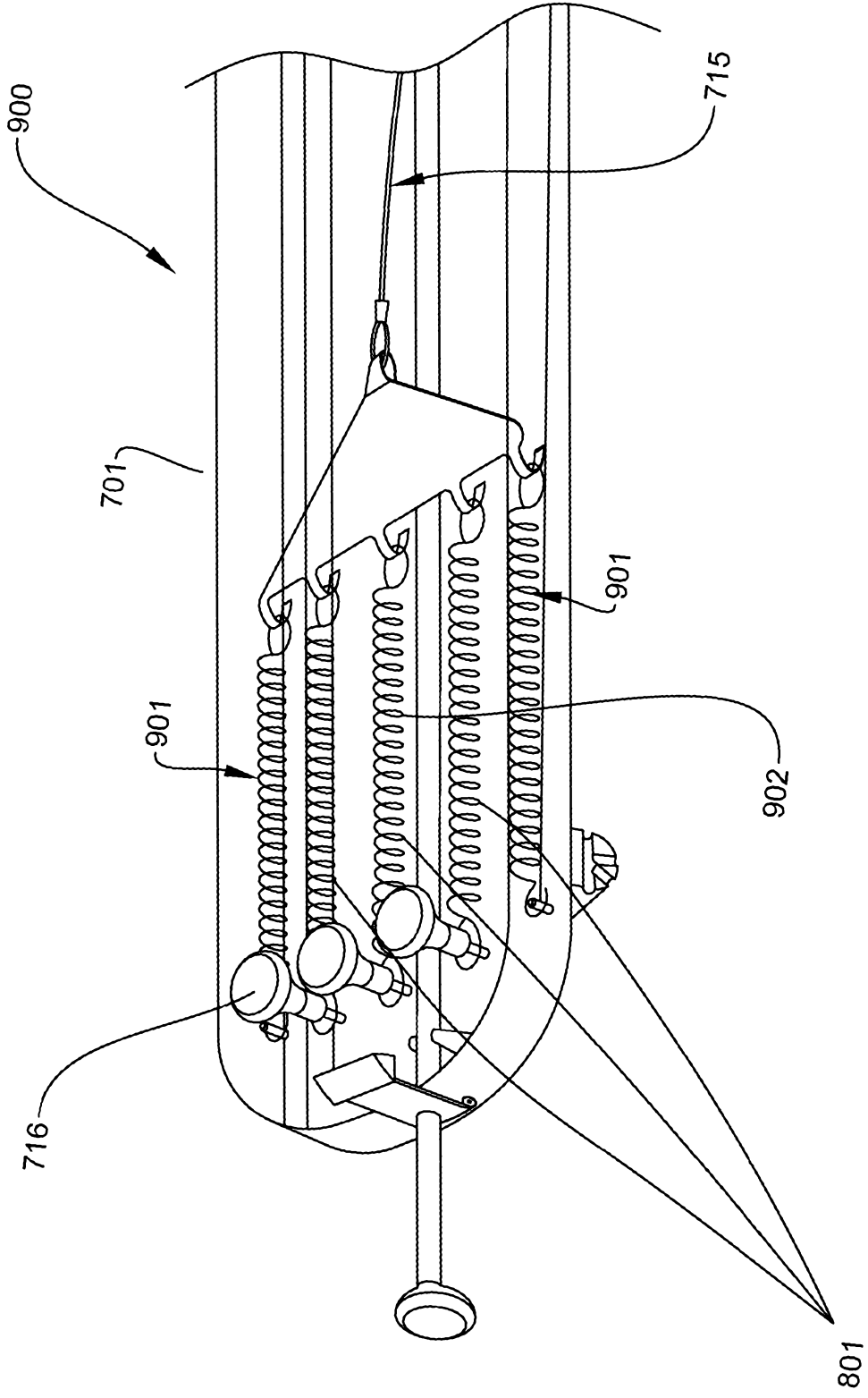


FIG. 9

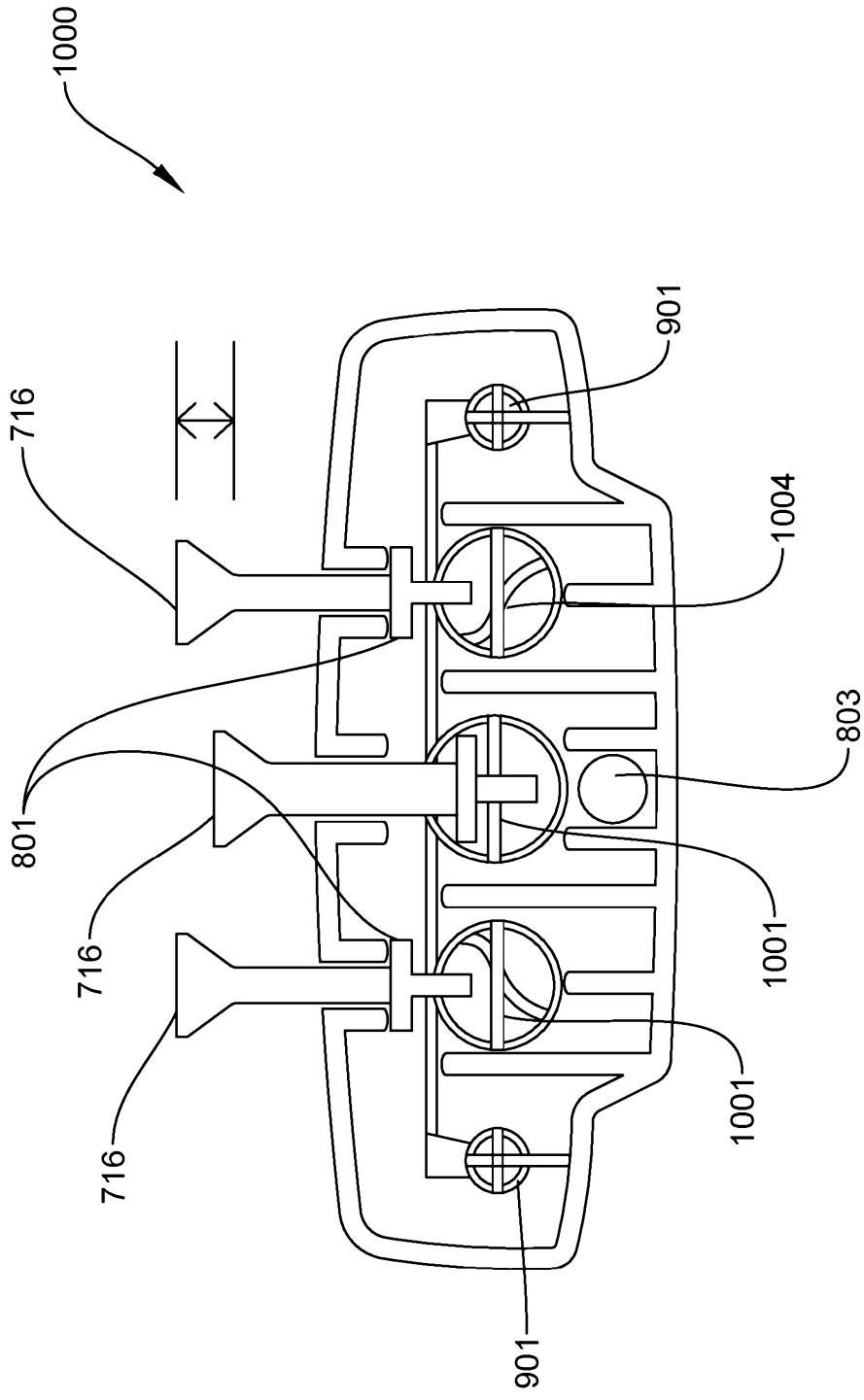


FIG. 10

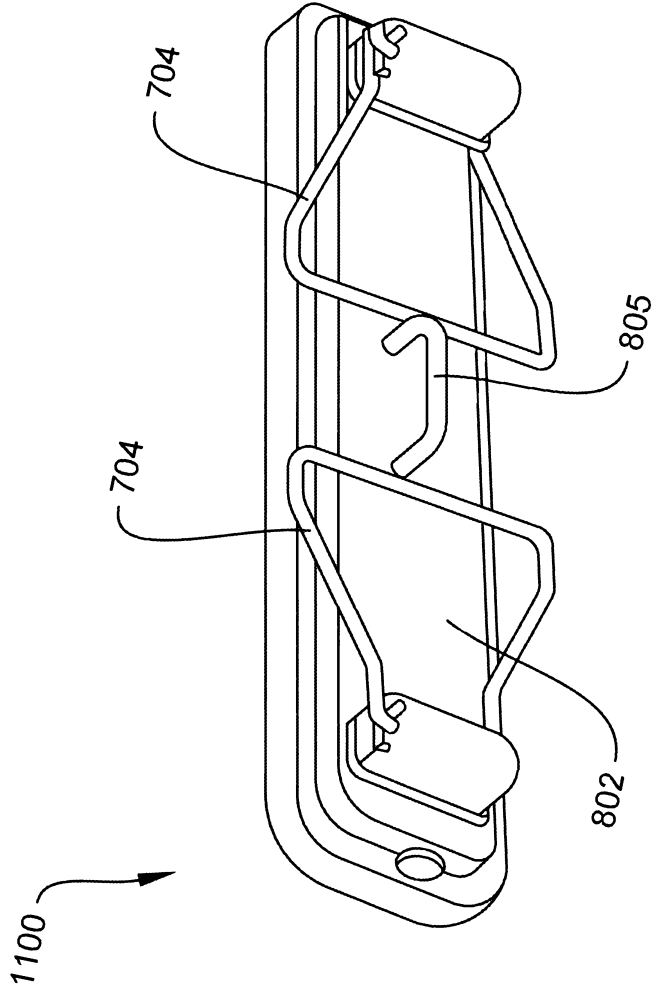


FIG. 11

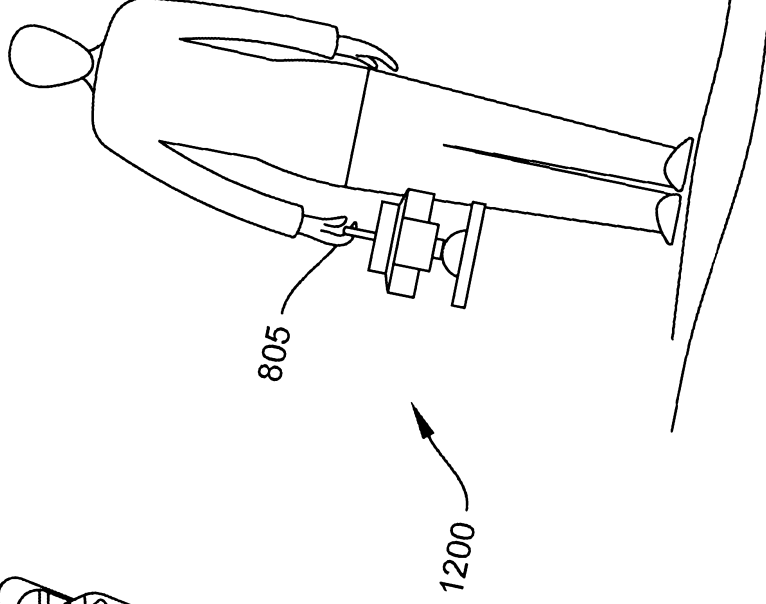


FIG. 12

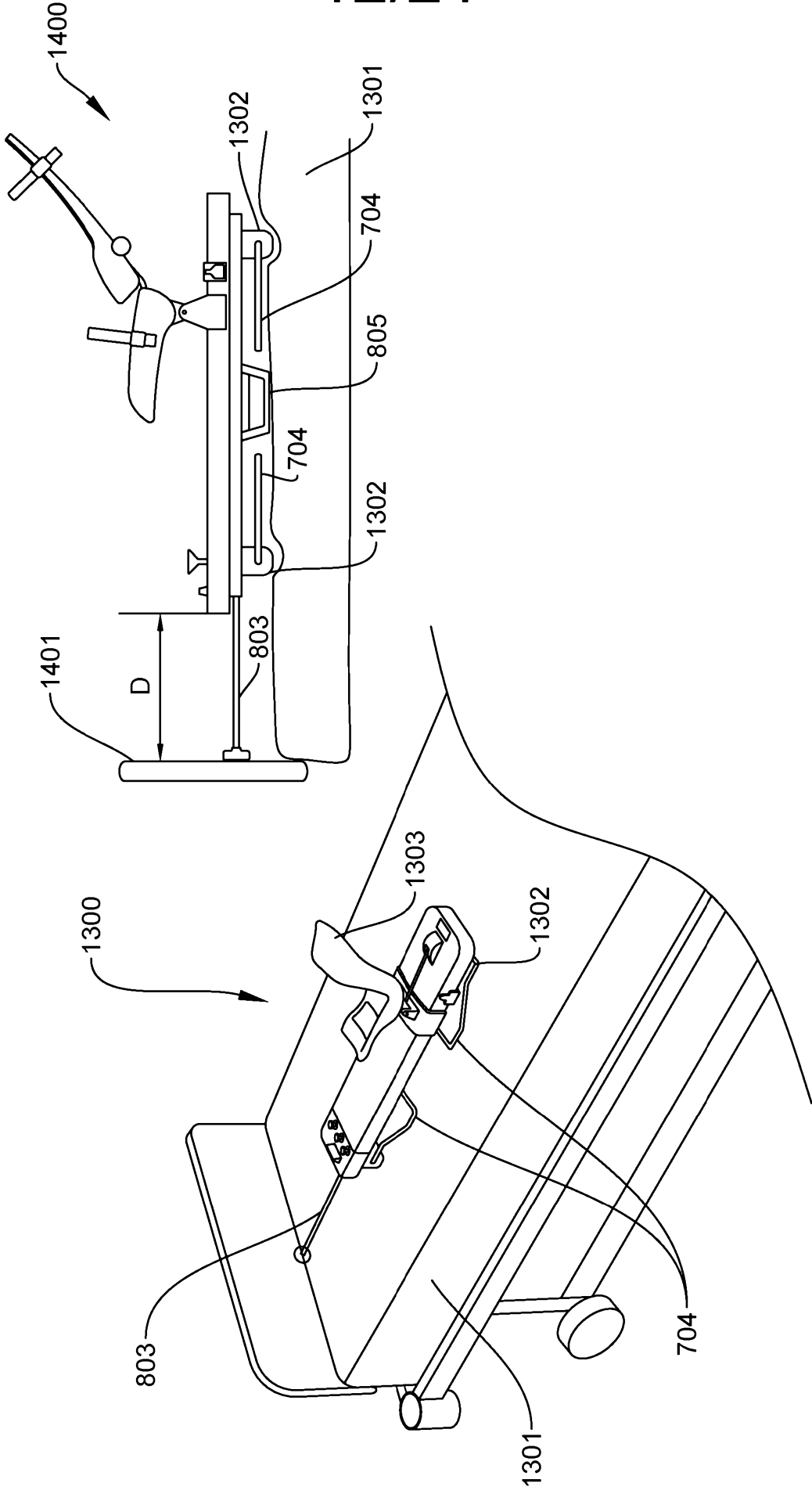


FIG. 13

FIG. 14

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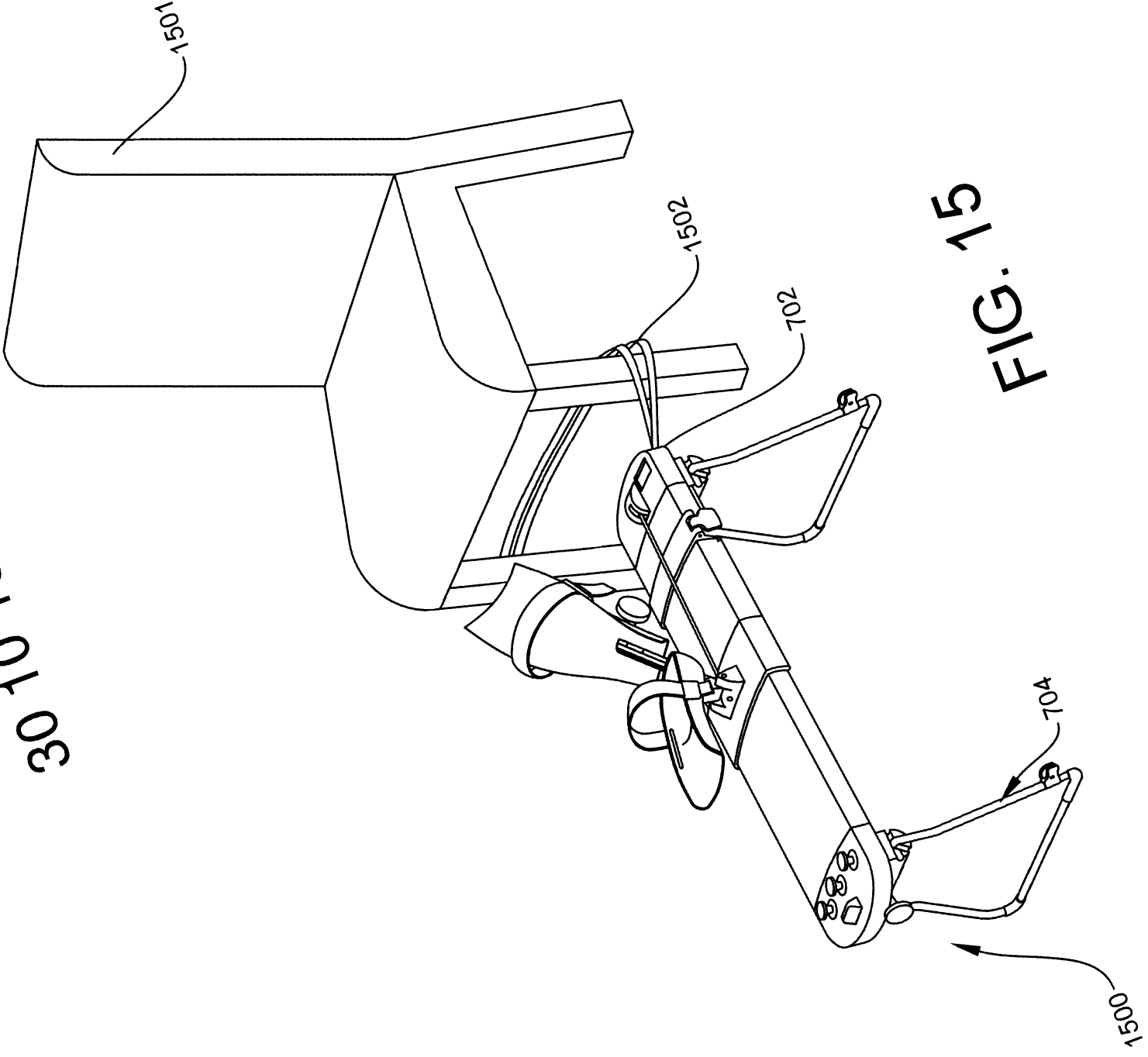


FIG. 15

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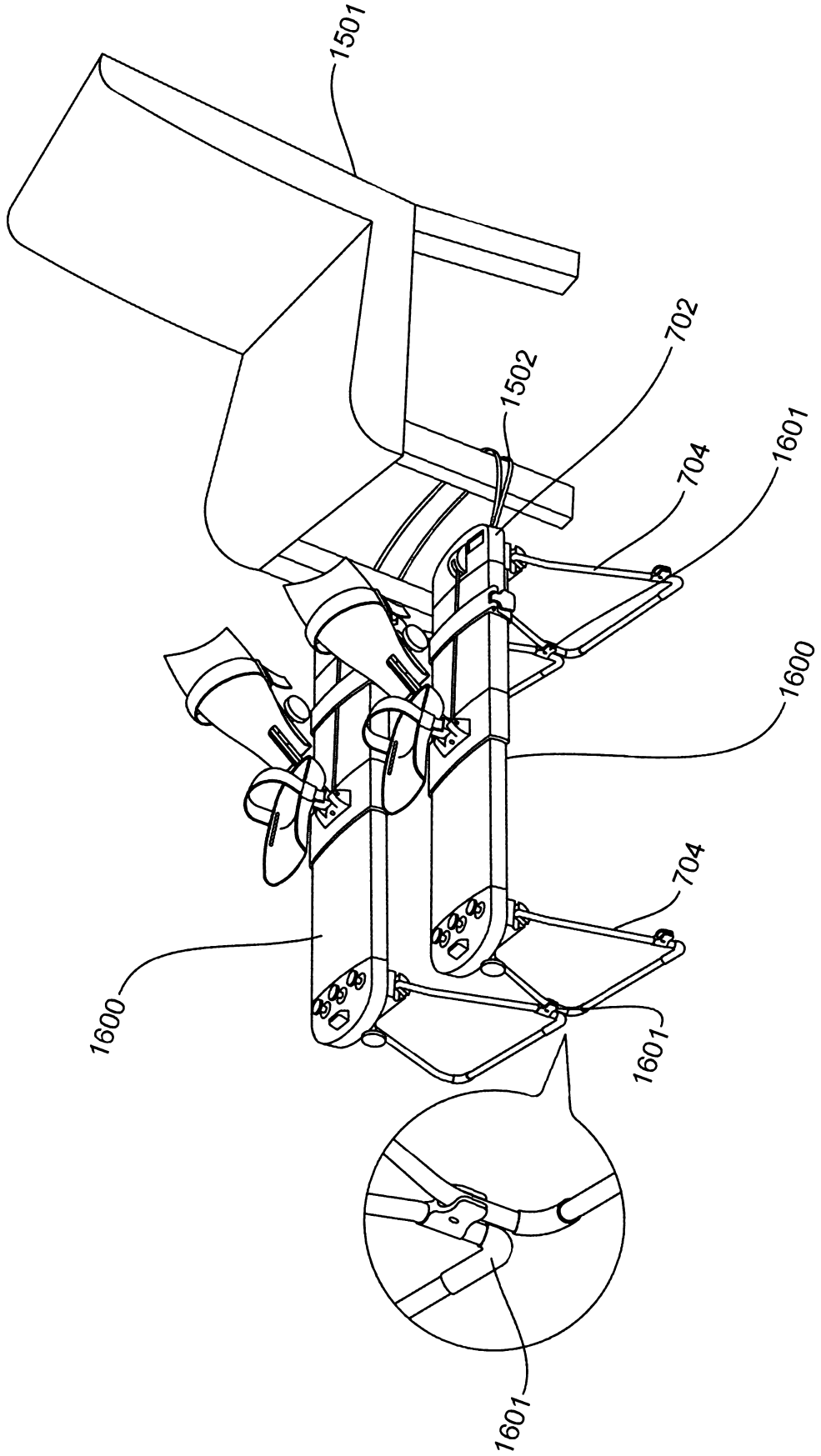


FIG. 16

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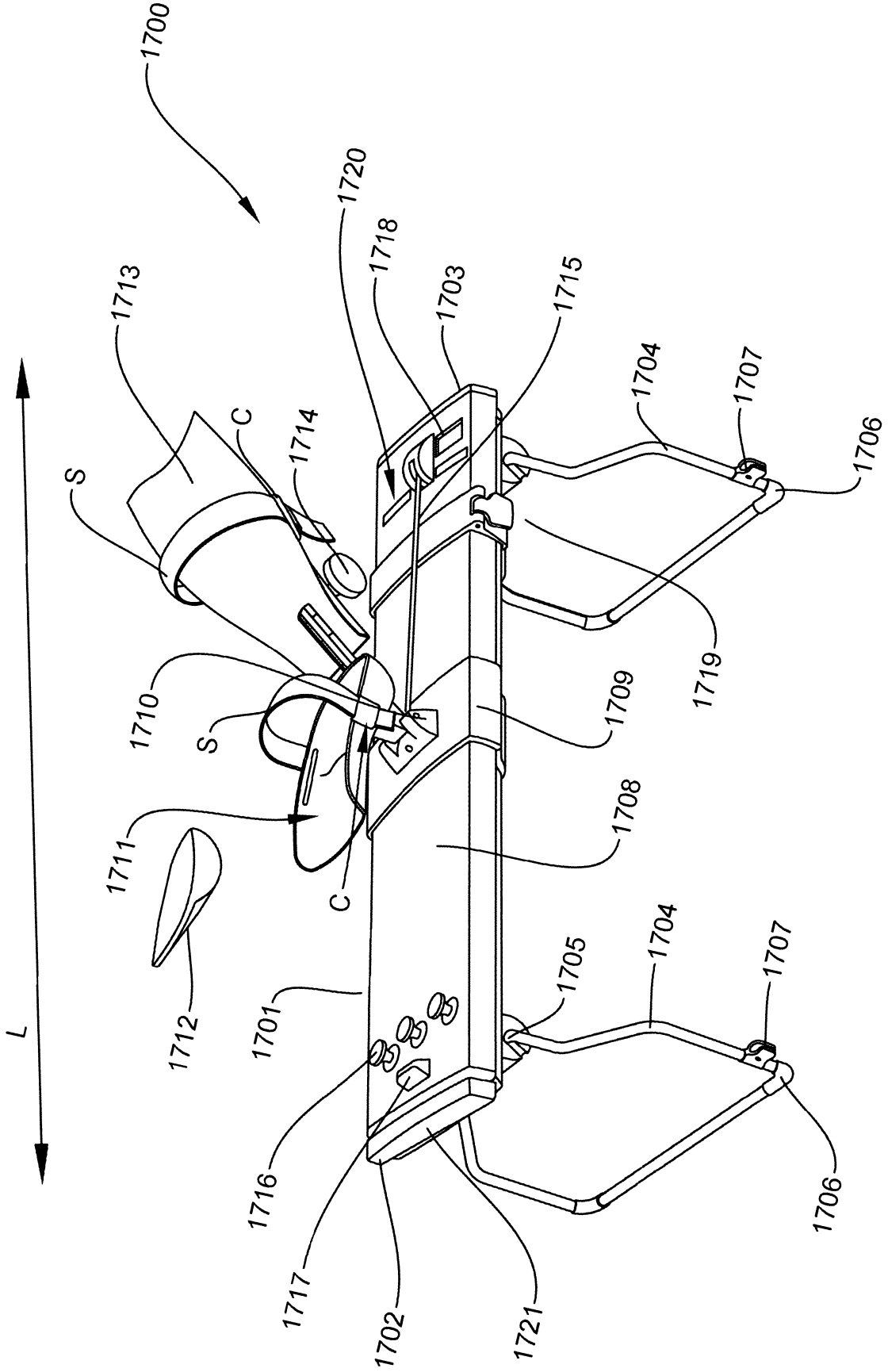


FIG. 17

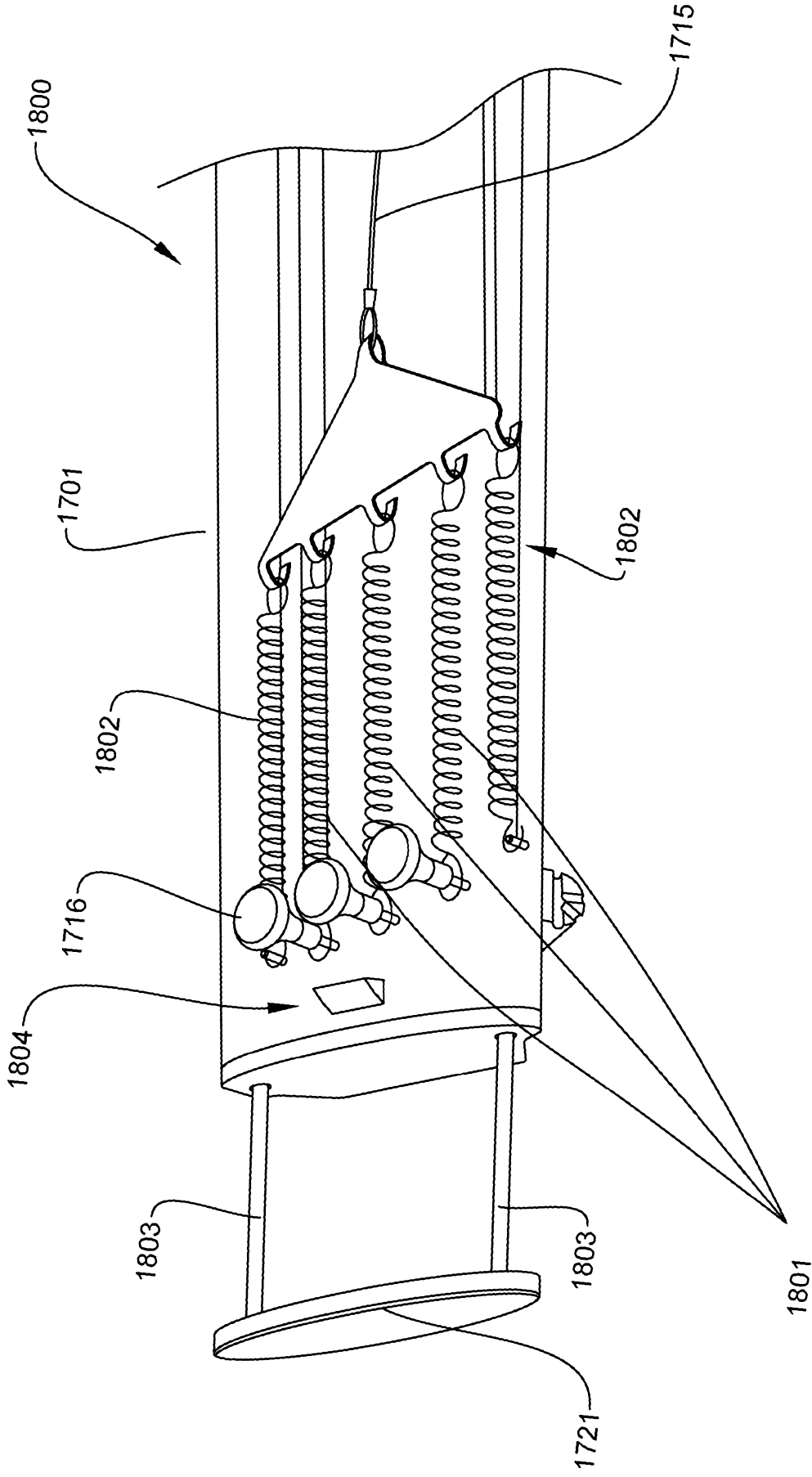


FIG. 18

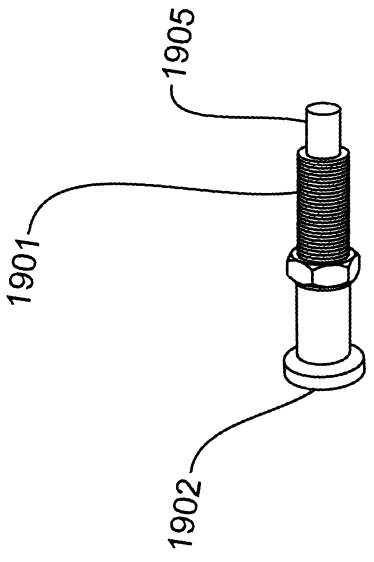


FIG. 19B

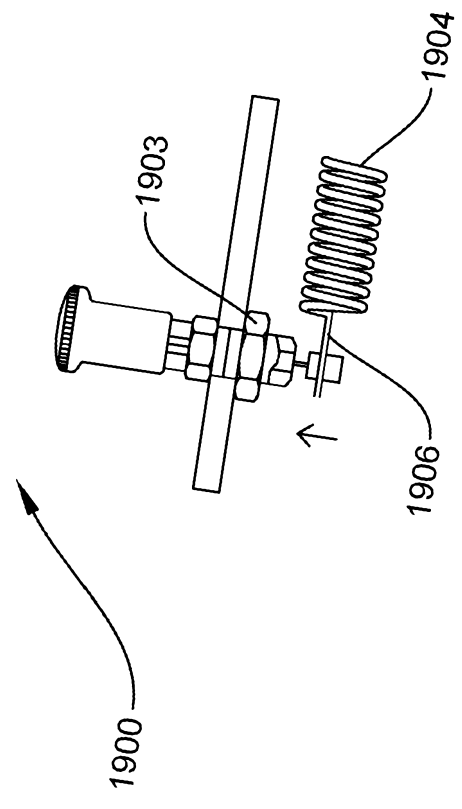


FIG. 19

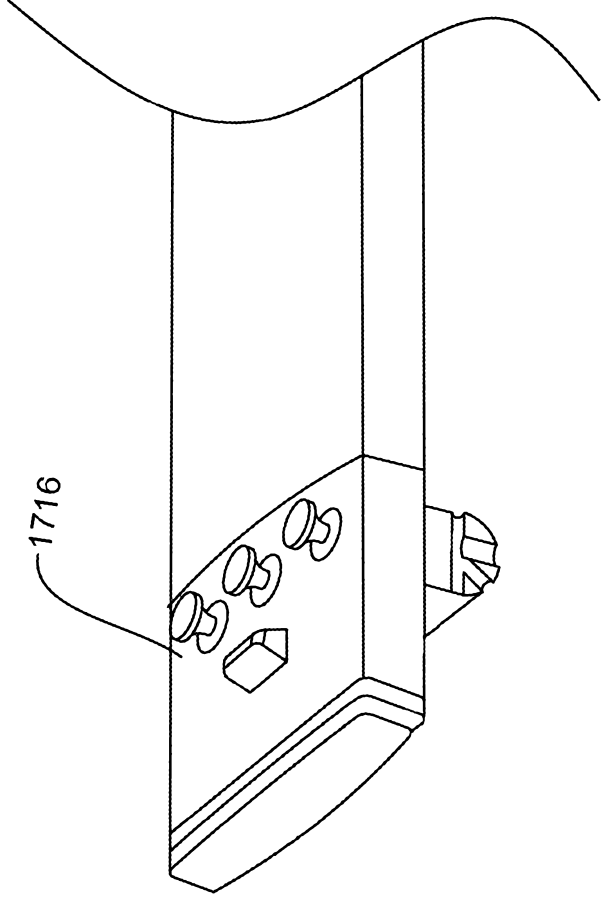


FIG. 19A

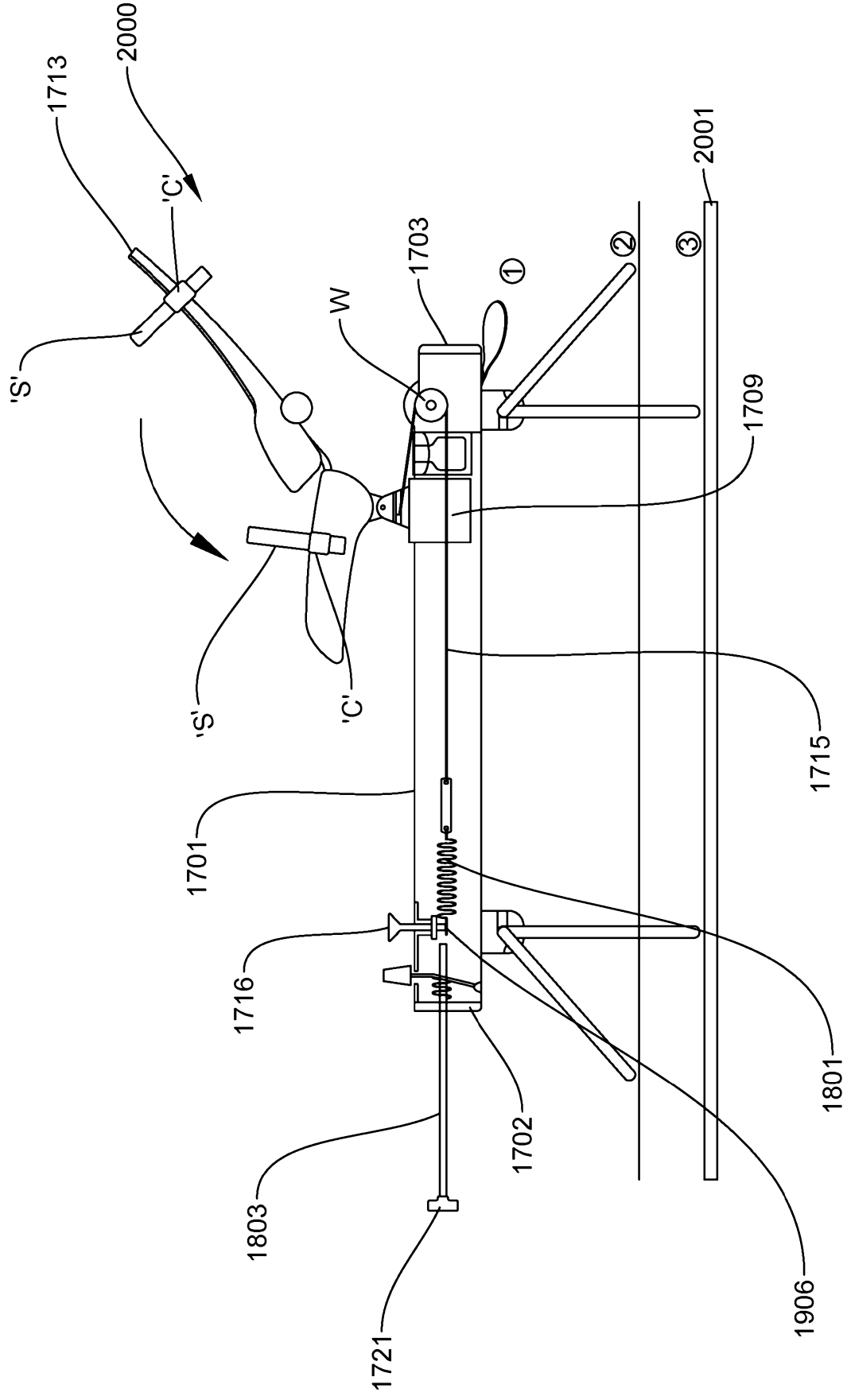


FIG. 20

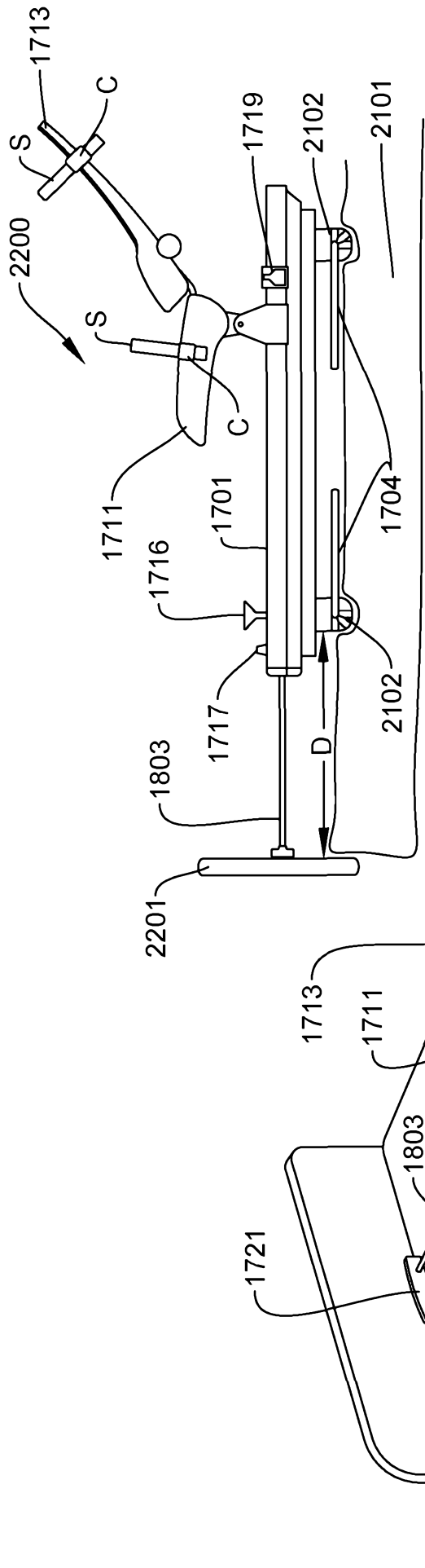
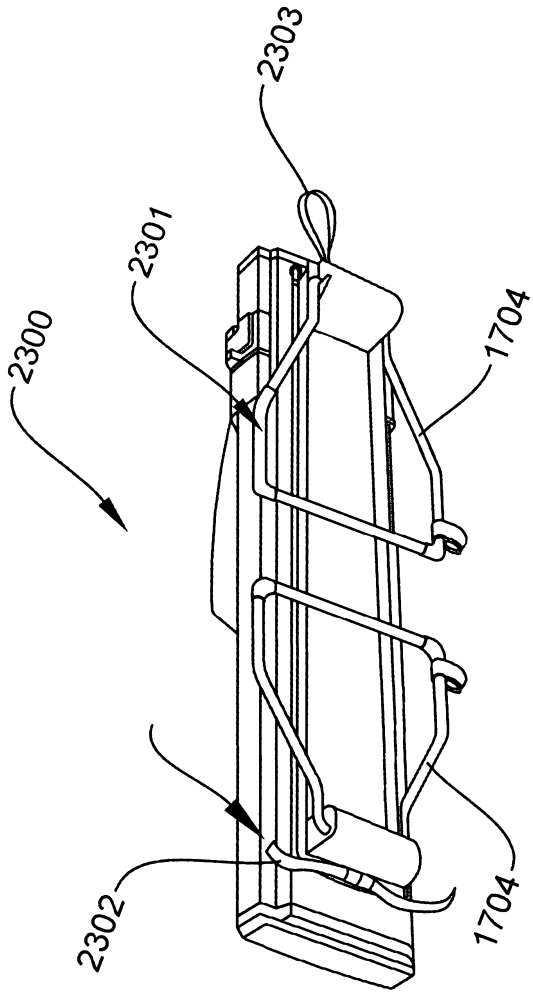


FIG. 22

FIG. 21

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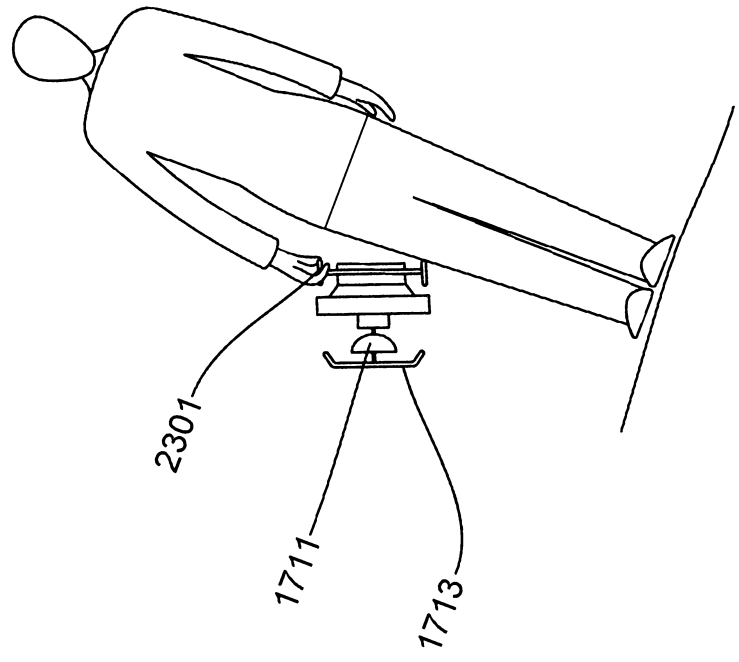


FIG. 23

FIG. 24

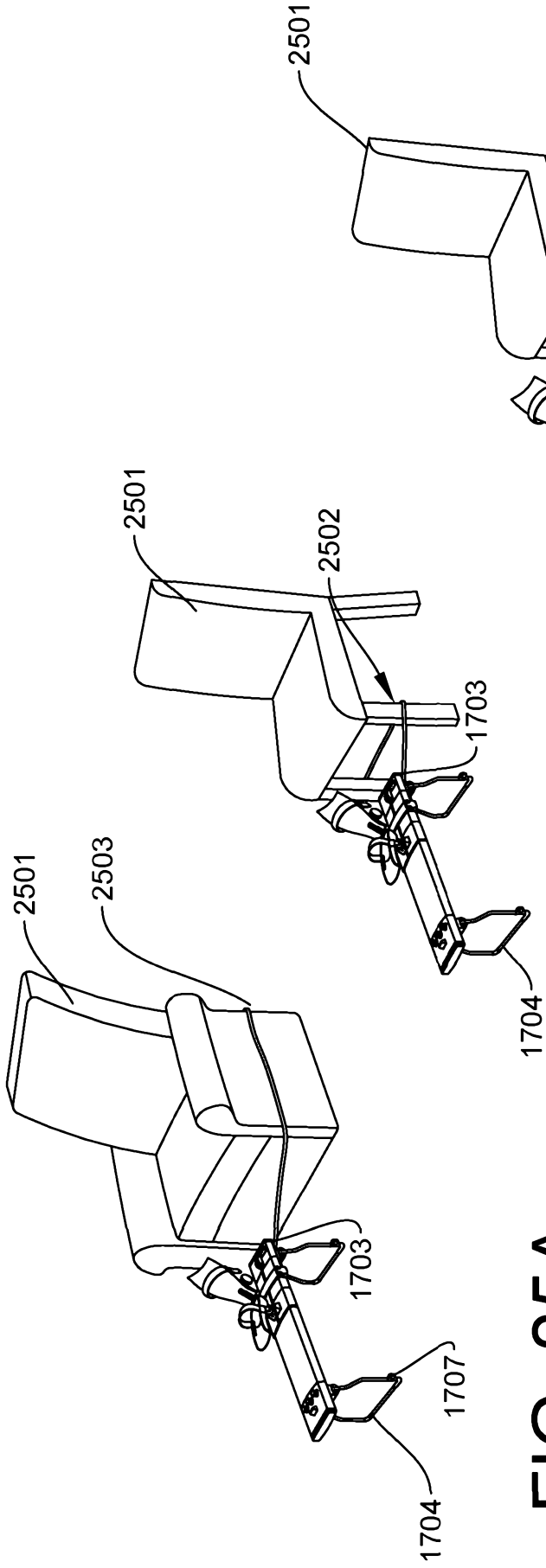


FIG. 25A

FIG. 25B

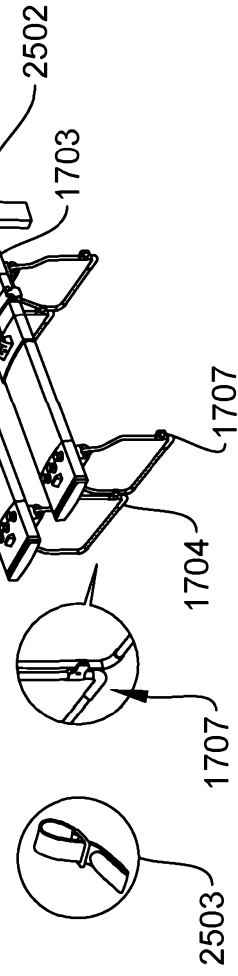


FIG. 25C

PORTABLE THERAPEUTIC STRENGTHENING APPARATUS USING ADJUSTABLE RESISTANCE

5 **Field of the Invention**

[0001] The present invention relates to a portable device for strengthening leg muscles.

Background of the Invention

10 **[0002]** When a person is unwell or injured and is immobile for a period, they can lose up to 20% of muscle strength within the first 7 days. It is common for patients in hospital to be in bed for extended periods of time, especially those who are more elderly and frail, have suffered fractures or have complex multi pathologies. The significant and rapid reduction of muscle strength otherwise
15 known as the de-conditioning effect, can be extreme for bed ridden patients and can have life changing effects. Physiotherapists have limited time and are under a huge amount of pressure to successfully rehabilitate these patients and get them home quickly. There is limited effective strengthening equipment available to use with patients and there is a need for a better solution to speed up the rehabilitation
20 process.

[0003] In order to treat de-conditioned muscles, leg muscles in particular, physiotherapists require a muscle strengthening machine that is safe and effective and can be used in the correct manner by the patient independently. They need
25 to be able to set a patient up on a device and be confident that the patient can utilise the equipment easily so that they can manage their own exercises safely and well. This will allow the Physiotherapist the ability to treat another patient nearby, therefore optimising their time allowing more patients to be treated.

30 **[0004]** Known strengthening equipment currently available for use by Physiotherapists include resistance bands, which are elastic bands typically held in place during exercise to increase the resistance experienced by the exerciser to increase strength of the exercised muscle. However, whilst resistance bands are portable and inexpensive, many patients find them too difficult to hold in the

correct position for doing leg strengthening exercises. Furthermore, injuries have been reported, whereby the band may snap, causing injury to the skin or eyes, the band may dig into fragile skin on the outside edge of the foot causing pressure damage or the user may also become tired and release a grip on one side of the band thus incurring injury. It is also easy for an inexperienced user to use the resistance band incorrectly, applying resistance to an incorrectly executed exercise rendering the exercise ineffective and potentially damaging.

[0005] Alternative forms of rehabilitation are available for example the use of ankle weights in combination with physical activity or use of a static bicycle or pedals. However, such weights applied for example around a user's ankle can damage fragile patient's skin. Static bicycles are expensive, heavy and awkward to move longer distances and these gym-style apparatuses require a user to perform the exercise with both lower limbs together. There are many patients for example, those with lower limb fractures in plaster, splints or external fixators, spinal injuries, stroke, those lacking core stability and control, that these are not suitable for and are better served by equipment that enables the use of one leg at a time. It is a further problem that some patients need to be restricted to bed rest due to their condition, this causes complications to be able to exercise the leg muscles sufficiently as they cannot weight bear or do standing exercises. Known static gym-style devices cannot be used on a bed or whilst the user is sitting in a chair.

[0006] Strengthening equipment in the form of exercise devices which employ movement along a horizontal plane against resistance are known. However, these are not lightweight, and due to having irregular metal edges can incur tissue damage from sharp edges, increasing the risk of infection by users. Such devices are not safe enough for unsupervised use for many patient groups.

[0007] It is a problem with known strengthening exercises which employ movement along a horizontal plane against resistance that the machines only have a foot plate and do not support the leg adequately to allow for unsupervised use by weaker patients. To achieve the desired strengthening results, the lower leg needs to be maintained in a safe, stable position. It is advantageous to have

the calf and ankle supported to maintain a correct position throughout the exercise period to avoid any misalignment of the lower leg occurring due to fatigue or user error. Therefore, there is a need for a piece of equipment which can be used unsupervised, which maintains and supports the position of the lower leg in relation to the angle of the foot, that will address the problem of unsupervised strengthening patients leg muscles whilst fully supporting the patients leg in a safe and comfortable way. Further, because people have varying degrees of flexibility of their ankles such apparatus need to be able to accommodate variability in the angle of ankle movement to ensure that all users can perform the exercise comfortably.

[0008] Known exercising equipment has a flat foot plate that the user places their feet on whilst performing the exercise. This is problematic since the force exerted by a user transfers pressure through the heel area which is at risk of breaking down in those that are frail and on sustained bed rest. There is a need for a device which ensures that no pressure goes through the heel area of the user, to avoid the potential for skin destruction and long-term complications of such an event. For those users who already have broken skin on their heels or pressure sores, they need to be able to use leg strengthening equipment safely without any further risk or damage to their skin condition.

[0009] It is a further problem with prior art exercise devices which employ movement along a horizontal plane against resistance that they do not include stops or means to limit the user's joint movement when using the device. Thus, a user can engage in physical movement of their leg beyond what is appropriate for their condition thus potentially causing muscle or joint damage.

[0010] Accordingly, there is a need for an inexpensive, lightweight and portable, exercising device which can be used unsupervised for treatment of lower limb de-conditioning. The apparatus should be versatile so that users in bed or in a chair can perform the exercises equally as effectively and there is a necessity for the device to be simple to set up and use independently. The apparatus needs to be safe for those with pressure sores to use and prevent damaging heel tissue whilst performing their required exercises. It needs to be easy to use and

easy to store so that hospitals and independent users at home can get benefit from use of the device.

Summary of the Invention

5 **[0011]** Accordingly, it is the primary goal of the present invention to provide a portable, safe and effective device for leg muscle strengthening. According to a first aspect there of the present invention, there is provided A portable therapeutic leg strengthening apparatus comprising:

10 a longitudinal body having first and second ends;

 a guide member moveable between said first and second ends of the longitudinal body of the device;

15 a plurality of resiliently biased means located at a first end of the longitudinal body; and

 a connecting means for connecting said plurality of resiliently biased means to the guide member;

20

 wherein said guide member further comprises a footplate for receiving a portion of a user's foot therein; and

 a pivotal calf support adjustably attached to said footplate for supporting a
25 portion of a user's leg therein;

 said plurality of resiliently biased means provide variable resistance to the connecting means to increase or decrease the force required by the user to move said guide member between said first and second ends of the longitudinal body of
30 the device.

[0012] Advantageously the angle between the footplate and the calf support is adjustable to vary the angle of the ankle in said foot and calf support to

account for the varying degree of flexibility each user has in their ankle joint.

[0013] Preferably the angle of the footplate and the calf support are adjustably joined by a hinge.

5

[0014] It is envisaged that the footplate is a two-part assembly for ease of manufacture and/or storage and transportation.

[0015] Advantageously, the apparatus further comprises a removable heel support allowing the area through which a user of the apparatus exerts force to be adjusted. In the presence of the heel support pressure can be exerted through the heel. When the device is used without the heel support pressure is exerted through the ball of the foot rather than the heel.

[0016] It is envisaged that the device will include a removable liner which assists in the comfort of the user. Furthermore, because of the removable nature of the liner, the device can be used by multiple individuals changing the internal liner for hygiene purposes between users.

[0017] Preferably the removable liners will be magnetically aligned with the footplate and calf support for easy fitting.

[0018] It is envisaged that the footplate and calf support will be replaceable with a gripping portion to allow the device to be used to exercise the upper body and/or arms or a smaller 'leg rest' for use by children.

[0019] Advantageously the device will include a manual or electronic counter since there is a need when exercising to accurately record the number of repetitions that the user has performed so the therapist and user can keep track of easily, see progress and assess improvement.

[0020] Preferably the connecting means will be a steel cable which is hard wearing and durable.

[0021] The present invention has a foot support and calf support otherwise referred to as a 'leg rest'. The foot support and calf support are attached to a

sliding element or guide member that moves longitudinally along the body of the device. The calf support has a shaped length of plastic material; covered by pressure relieving material; which supports the patient's calf in a comfortable relaxed position. The foot support is attached to the calf support piece by a hinged joint to allow for changes of angle of user's foot position. The foot and calf support has no material that comes into contact with the user's heel. All pressure from the user is through the forefoot to push the sliding element along the body of the device. The sliding element or guide member may be a nylon slide plate, an aluminium slide plate or a trolley

10

[0022] Having a 'leg rest' ensures that the therapist and patient are confident that the entire set of exercises will be done correctly as it will not allow the user's leg to drift out of alignment as the muscles fatigue. The 'leg rest' also enables the user's leg to be supported against gravity allowing the user to perform more exercises before the leg muscles fatigue.

15

[0023] The 'leg rest' of the present invention will be designed to not allow the user to put any pressure through the heel area of their foot. This will ensure safe use by those users with heel sores and prevent other users damaging the delicate skin on their heels. The material used in the lining of the 'leg rest' will have pressure relieving qualities and comply with tissue viability and infection control global policy.

20

[0024] The 'leg rest' of the present invention will also have an adjustable ankle position, to allow for individual setting for each user to ensure comfort of foot position throughout the movement/exercise period. This is due to all people having different degrees of available movement of their ankles.

25

[0025] The entire 'leg rest' of the present invention can tilt in the longitudinal plane. This enables maintenance of support of the user's lower leg as the user extends the knee out along the length of the device and flexion of the leg as the user returns the sliding element back to the start position at the rear of the device. The present invention will also therefore help to improve range of movement of the hip and knee due to the movement of the sliding element and 'leg rest' along

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the length of the device.

5 **[0026]** The present invention has a sliding element on which sits the pivoting 'leg rest'. The friction free property of the sliding element is such that the user can move the trolley with using minimal exertion for those who have extremely weak muscles and just starting their rehabilitation. The friction free sliding element will ensure a quiet, smooth movement without jarring effect on the limb whilst in use.

10 **[0027]** To achieve the versatility desired for the apparatus to be used by a wide variety of patients including those on the bed or for users sitting in a chair, the present invention has support legs that can be rotated out from under the device and locked into position for use in a chair or the legs can be folded / rotated away under the device and clipped into place to allow for use on a bed.

15 **[0028]** The present invention is lightweight and portable enough to carry easily. It has a handle on its side elevation for carrying. The leg rest folds down flat against the device and the legs will rotate away under the device and secure for optimal ease of transportation and portability.

20 **[0029]** The present invention is manufactured out of material that complies with infection control and tissue viability policy and will not be damaged by the necessary cleaning processes. Clinicians and users will be able to wipe the machine down easily due to the shape and design of the body of the device this having smooth lines and surfaces and no cracks or indentations for dirt or dust to gather.

25 **[0030]** To comply with infection control policy the device is designed so that the internal mechanical workings are at least partially, preferably fully covered. This is to minimise the accumulation of dust and skin cells around the workings and also assists in maintaining the cleanliness of the device and reduces the likelihood of cross infection between users. The sliding element with the 'leg rest' a top will stand minimally proud of the cover on the longitudinal body to allow for smooth movement and effective use of the device.

35

[0031] To operate the device from a seated position the current invention will have a securing mechanism that attaches to the legs of the user's chair or around the body of a larger recliner chair. This will ensure stability of the device when in use and prevent forward movement away from the chair.

5

[0032] To operate the current invention whilst the user is on the bed, the legs will be folded under the body of the device and secured in place and there will be an adjustable mechanism by means of an adjustable bar, which will extend from the front of the device to butt up against the bed end. This will prevent movement of the device down the bed whilst in use.

10

[0033] Behind the sliding element securing the leg rest, is a flexion block which itself also comprises a sliding element and fixing clip. This block will be required if there needs to be any restriction of knee or hip flexion movement for the user. This is to ensure that there is no possibility of over flexing the joints if there is a medical reason to prevent this i.e. post knee replacement stitches or early post-surgical repair of anterior cruciate ligament. The flexion block can be moved longitudinally along the device to be positioned where is appropriate for individual users.

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[0034] The present invention incorporates a contact sensor within the apparatus which relays information to a digital display at the rear of the apparatus. This shows the number of full repetitions of movement that have been achieved by the user.

25

[0035] The present invention uses resistance material by means of elastic or rubber cords or springs to create the resistive forces required to enable strengthening of the muscles. There are plurality of cords or springs available to be used in the present invention. These springs have varying resistance quality. The user is able to have no springs resisting the longitudinal movement for free solely active movement or add in single springs at a time as the muscle strength improves to facilitate effective muscle strengthening through progressive resistance exercise. A steel cable is secured to the back of the sliding element and goes into the device via an aperture at the rear end of the device. Within the

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body of the device the steel cable is affixed to a metal plate upon which are affixed the resistance providing springs. The resistance of the device can be adjusted by depressing the organ stop type buttons atop the device at the front end to engage the required number of springs and achieve the required level or resistance.

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[0036] Other aspects are as set out in the claims herein.

Brief Description of the Drawings

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[0037] For a better understanding of the invention and to show how the same may be carried into effect, there will now be described by way of example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

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Figure 1 is a side view of a first embodiment of the present invention.

Figure 2 is a perspective view of a first embodiment of the present invention in chair configuration.

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Figure 3 is a side view of the foot and calf support of a first embodiment of the present invention.

Figure 4 is a partial perspective rear view of a first embodiment of the present invention in chair configuration.

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Figure 5 is a side view of a first embodiment of the present invention in use in a bed configuration.

30

Figure 6 is a perspective view of a first embodiment of the present invention in use in a bed configuration.

Figure 7 is a perspective view of a second embodiment of the present invention.

35

Figure 8 is a partial cross section of a side view of a second embodiment of the present invention.

Figure 9 is a partial cross section of a partial perspective view of a second embodiment of the present invention.

40

Figure 10 is a vertical cross section of the organ stops according to a second

embodiment of present invention.

Figure 11 is a representative illustration of the folding nature of the device in accordance with a second embodiment of the present invention.

5

Figure 12 is a representative illustration of the portable nature of the device in accordance with a second embodiment of the present invention.

Figure 13 is a perspective view of a device in accordance with a second
10 embodiment of the present invention in use on a bed.

Figure 14 is a side illustration of a device in accordance with a second embodiment of the present invention in use on a bed.

15 Figure 15 is a representative perspective illustration of a single device in accordance with a second embodiment of the present invention for use by a seated individual.

Figure 16 is a representative perspective illustration of two conjoined devices in
20 accordance with a second embodiment of the present invention for use by a seated individual.

Figure 17 is a perspective view of a third embodiment of the present invention.

25 Figure 18 is a partial cross section of a partial perspective view of the device in accordance with a third embodiment of the present invention.

Figures 19a-c illustrate the organ stop feature in accordance with the third embodiment of the invention.

30

Figure 20 is a partial cross section of a side view according to a third embodiment of the present invention.

Figure 21 is a perspective view of a device in accordance with a third embodiment of the present invention in use on a bed.

Figure 22 is a side illustration of a device in accordance with a third embodiment
5 of the present invention in use on a bed.

Figure 23 is a representative illustration of the folding nature of the device in accordance with a third embodiment of the present invention.

10 Figure 24 is a representative illustration of the portable nature of the device in accordance with a third embodiment of the present invention.

Figure 25a and b are perspective illustrations of a single device in accordance with a third embodiment of the present invention for use by a seated individual.
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Figure 25c is a perspective illustration of two conjoined devices in accordance with a third embodiment of the present invention for use by a seated individual.

20 **Detailed Description of the Embodiments**

[0038] There will now be described by way of example a specific mode contemplated by the inventors. In the following description numerous specific details are set forth in order to provide a thorough understanding. It will be apparent however, to one skilled in the art, that the present invention may be
25 practiced without limitation to these specific details. In other instances, well known methods and structures have not been described in detail so as not to unnecessarily obscure the description.

[0039] The present invention is to be used for strengthening the leg
30 muscles and can be used whilst sitting in a chair as shown in FIG 2 or when the user is in long sitting on a bed as shown in FIG 5. The current invention can also be used by a patient who is unable to sit up at all and is in a supine position on the bed, for example those with spinal cord injuries.

[0040] Referring to figure 1 herein there is shown a side view of the device 100 according to a first embodiment of the present invention for use by a seated user. The device comprises an elongate body 101 having a leg rest 102 comprising a calf support 103 and foot support 104. Straps 105 and 106 are applied around the calf and the foot respectively to fasten a user's leg to the device. The leg rest 102 is attached to a trolley 107 mounted on a friction-free longitudinal rail 108 which runs the predominant length of the elongate body 101, such that the trolley can move forward and backward along said longitudinal rail 108 in the direction of the arrow. Moving the trolley 107 longitudinally forward is against the resistance of the resistance cords described in figure 4.

[0041] The friction-free rail is affixed inside the device under a wipeable external cover 109. Attachment of the leg rest 102 to the friction-free rail 108 mounted within the elongate body 101 is via pivot joint 110. The leg rest 102 has an angle adjusting mechanism 111 to alter the angle between the foot rest 104 and the calf support 103. The angle adjuster 111 is connected to a mechanism 112 that on rotation widens or narrows the heel area 113 between the foot rest 104 and the calf support 103. This ensures individual user specifications depending on the ankle range of movement of each user. In the embodiment shown the heel area 113 does not allow contact with the heel tissue of the user, this is to prevent pressure sores. The user pushes with their forefoot onto the foot rest 104 to propel the trolley 107 that the leg rest 102 is attached to forward along the rail 108 against the resistance of the resistance cords illustrated in figure 4. The resistance cords can be accessed through an access hatch 114 (shown with cover on) located on the rear upper surface of the elongate body 101.

[0042] In use, the trolley 107 is moved forwardly and backwardly by the extension and retraction respectively of a user's leg located in the leg rest 102. A contact sensor 115 located at the front of the friction-free rail 108 relays digital information regarding number of repetitions of full leg extension movements achieved by the user to the screen (403; figure 4) at the rear of the device.

[0043] The extent of movement of the user's knee and hip can be limited if

necessary by use of flexion block 116. The block being attached to the rail 108 behind the mobile trolley 107 and the leg rest 102 and being able to move longitudinally and be secured in place where appropriate for the individual user.

5 **[0044]** The apparatus is configured to be used by someone sitting in a chair, as illustrated by the supporting legs 117 being rotated outwardly from under the body 101 by way of pivoting struts 118. A non-slip material 119 is applied to the floor contacting area of the support legs 117 to avoid movement of the device when in use in the chair configuration.

10

[0045] The device further comprises a carry handle 120 located on the base of the elongate body 101.

[0046] Referring to figure 2 herein there is shown perspective view 200 of a first embodiment of the present invention shown attached to a chair 201 via the securing mechanism or brace 202. The bracing mechanism 202 attaches the device 101 securely to the chair 201. The elongate body 101 of the device having a leg rest 102 comprising a calf support 103 and foot support 104 is illustrated with like parts denoted by like reference numerals. Straps 105 and 106 are applied around the calf and the foot respectively to fasten a user's leg to the device. The leg rest 102 is attached to a trolley 107 mounted on a friction-free longitudinal rail 108 which runs the predominant length of the elongate body 101, such that the trolley can move forward and backward along said longitudinal rail 108 in the direction of the arrow.

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[0047] Attachment of the leg rest 102 to the friction-free rail 108 mounted within the elongate body 101 is via pivot joint 110. The leg rest 102 has an angle adjusting mechanism 111 to alter the angle between the foot rest 104 and the calf support 103. The angle adjuster 111 is connected to a mechanism (see figures 30 1:112) which upon rotation widens or narrows the heel area 113 between the foot rest 104 and the calf support 103. This ensures individual user specifications depending on the ankle range of movement of each user. In the embodiment shown the heel area 113 does not allow contact with the heel tissue of the user, this is to prevent pressure sores. The user pushes with their forefoot onto the foot

rest 104 to propel the trolley 107 that the leg rest 102 is attached to forward along the rail 108 against the resistance of the resistance cords illustrated in figure 4. The resistance cords can be accessed through an access hatch 114 (shown with cover on) located on the rear upper surface of the elongate body 101.

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[0048] The friction-free rail is affixed inside the device under a wipeable external cover 109. A groove 203 in the top surface of the outer wipeable cover 109 allows contact between the hinged pivot joint 110 of the leg rest 102 and the friction-free rail 108, such that the trolley 107 can be moveably mounted to the rail 108. The groove 203 has an enclosing flap e.g. a rubber or brush strip, to prevent skin cells and debris from falling into the device and onto the rail 108.

[0049] In use, the trolley 107 is moved forwardly and backwardly by the extension and retraction respectively of a user's leg located in the leg rest 102.

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[0050] Referring to figure 3 herein there is shown a side view 300 of the leg rest 102 comprising a foot 104 and calf support 103 in accordance with a first embodiment of the present invention. The arrow illustrates the direction that the leg rest can pivot and tilt when in use, due to the hinge joint 110. The ankle range of movement adjustment mechanism 111 and threaded insert 112 are also shown.

[0051] Referring to figure 4 herein there is shown a partial perspective rear view 400 of a first embodiment of the present invention in chair configuration. Like parts are shown by like reference numerals. The device is shown with access hatch 114 located on the rear upper surface of the elongate body 101 uncovered to expose 5 resistance cords 401 arranged in parallel with the elongate body 101 of the device. The resistance cords 401 are anchored at a first end to the trolley 107 and at a second end to anchor points 402 on the rear interior of the body of the device 101. The resistance cords 401 can be easily added in, i.e. attached or unhooked from the rear anchor points 402 depending upon the resistance required by the user.

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[0052] The contact sensor (115 figure 1) at the front of the rail 108 relays digital information regarding number of repetitions of full leg extension movements

achieved by the user to the screen 403 at the rear of the device.

[0053] Referring to figure 5 herein there is shown a side view 500 of a first embodiment of the present invention in use on a bed 501 by a patient in long sitting on the bed.

[0054] Referring to figure 6 herein there is shown is a perspective view 600 of a first embodiment of the present invention in use in a bed configuration. In the bed configuration, the supporting leg 117 at the first end are rotated out for use as the bed end stop whilst the leg at the second end is rotated under the device and an adjustable brace 601 can be set against the bed end to prevent forward movement of the device during use. The user is then able to perform the exercise by pushing with their forefoot so that the trolley 107 is moved longitudinally along the rail 108 away from the user, against the resistance of the resistance cords (401; figure 4). The user will have been set a number of repetitions of the movement to do and the repetitions can be tracked by user and therapist by looking at the digital rep counter 403.

[0055] Referring to figure 7 herein there is shown a perspective view of a second embodiment of the apparatus of the present invention. The apparatus 700 comprises an elongate body 701 having first 702 and second 703 ends. The apparatus is mounted on a pair of legs 704 in adjustable attachment to the body of the device 701 about pivot points 705. The legs have rubber stoppers 706 or rubber feet to increase friction between the apparatus and the device on which it is placed to prevent the apparatus from slipping. The legs may further comprise joining clips 707 which permit two individual apparatus 700 to be joined together or may assist in joining the device to an anchor point for stability e.g. a chair. The legs are foldable beneath the device so that it can be used folded flat for storage.

[0056] The upper surface of the elongate body 701 is a molded plastic shell of polyurethane or an aluminium extrusion 708 over which a nylon slide plate or trolley 709 is located. The nylon slide plate 709 provides a pivotal anchor point 710 for footplate 711, allowing the angle of the footplate to move freely relative

the longitudinal axis L of the device. The footplate 711 may further comprise a removable heel pad 712, by adjusting the point of contact between the foot and the footplate the precise position through which a user has to exert force and thus the area of the user's anatomy which experiences pressure can be adjusted.

5 Thus, when the removable heel pad 712 is absent, the device is driven by pressure through the ball of the user's foot and there is no pressure on the user's heel. Hence, the apparatus is operable without the need for a foot to be flat on the footplate i.e. it avoids pressure going through the heel portion. When the heel pad 712 is present, pressure is exerted through the user's heel via the

10 removable heel pad into the footplate 711 of the device.

[0057] A calf support 713 is adjustably connected to the footplate 711. The calf support is molded to reflect the anatomical shape of a user's calf to provide an ergonomic support to ensure that unsupervised patients maintain their leg in

15 the correct orientation when utilising the device. Both the footplate 711 and calf support 713 are lined in foam or soft material to aid the comfort of the user. The angle between the footplate 711 and calf support 713 is adjustable via knob 714 so that the angle of the ankle in said foot and calf support to account for the varying degree of flexibility each user has in their ankle joint. Counterclockwise

20 movement of knob 714 reduces the angle between the footplate and the calf support 713, whilst clockwise rotation of knob 714 increases the angle between the footplate and the calf support 713.

[0058] Anchor point 710 also joins the nylon slide plate or trolley 709 bearing the footplate 711 and calf support 713 to a connecting member in the

25 form of steel cable 715. Steel cable 715 runs along a part of the length of the body of the device 701 over and around a wheel (see W in figure 8) to anchor the cable to a plurality of springs which provide variable resistance and form the inner workings of the device discussed in detail in figure 9.

30 **[0059]** The resistance of the device and thus the energy requires to be exerted by a user pushing through the footplate 711 is adjusted through resistance switches 716 located on the upper surface of the first end 702 of the body of the device 701. A spring-loaded release lever 717 is also provided to

disengage the bed end stop (figure 8;803) when the device is no longer in use. The outer limit 720 of the bed end stop is visible in retracted position in figure 7.

5 **[0060]** The number of full leg extensions made is recorded by a digital or manual counter 718. Whilst an end stop clamp 719 is provided to limit the retraction of nylon slide plate or trolley 709 and thus restrict the extent of the user's movement when using the device.

10 **[0061]** Figure 8 illustrates a partial cross-sectional view 800 in accordance with the second embodiment of the present invention. Like numerals denote like parts. The elongate body of the device 701 having first 702 and second 703 ends houses steel cable 715 which is wound around wheel W and attached to a plurality of steel tension springs 801 naturally biased to retract and to pull the steel cable 715 towards themselves. The number of springs 801 engaged is
15 determined by the organ stop 716 engaged on the surface of the apparatus. When pressed down the organ stop engages the central aperture of the spring trapping it between the organ stop 716 and the lower surface 802 of the elongate body 701 in the direction of the arrow shown. In moving downwardly, the tension spring is in mechanical connection with the steel wire 715 increasing the
20 resistance required by the user to move the trolley 709 towards the first end 702 of the apparatus.

25 **[0062]** The legs of the apparatus 704 are moveable between first (1), second (2) and third (3) orientations as determined by the height of the ground level or surface the device is being used upon. In use, a bed end stop 803, which comprises a pole 804 extending along the inner length of the device provides stability allowing the device to rest against a bed footboard or headboard when used on a bed.

30 **[0063]** When not in use the adjustable calf support 713 can be folded forward in the direction of the arrow for storage. The device further comprises a carry handle 805 on its underside so that the device can be carried and a hanging loop 806 for hanging the device.

5 **[0064]** Figure 9 herein shows a cross section 900 of a partial perspective view of the second embodiment of the present invention. The elongate body 701 is shown in partial cut through. Multiple steel coiled tension springs 801 are shown. The outermost two springs 901 are the weakest tension springs. These are in permanent attachment to the steel cable 715. The inner 3 springs 902 are engaged by depressing the relevant organ stop 716 and each offer differing and graduated levels of resistance.

10 **[0065]** The organ stop structure 1000 is shown in vertical cross section in figure 10. The bed end pole 803 running through the device and the two outer springs 901 which are permanently attached to the trolley are visible in this cross section.

15 **[0066]** Each organ stop 716 is coupled to the loop end 1001 of a steel spring 801 so that when the corresponding knob, stop or plunger 716 is depressed and pushed downwardly a lower end of the knob, stop or plunger engaged with the central aperture of the loop end of the spring(s) so that the springs are engaged thus increasing the tension experienced by the sliding
20 element, increasing the resistance required by a user to move the footplate of the device in a forward motion.

[0067] Referring to figure 11 herein there is shown a representative illustration to demonstrate the folding nature of the apparatus in accordance with a
25 second embodiment of the present invention. The apparatus 1100 has two legs 704 folded upwardly into the underside 802 of the device 1100. A carry handle 805 on the underside of the device allows the device to be carried once said legs 704 are in a folded configuration.

30 **[0068]** Referring to figure 12 herein there is shown a representative illustration in accordance with a second embodiment to demonstrate the portable nature of the apparatus. The apparatus 1200 is carried by handle 805 located on the underside of the apparatus and the calf and footplate have been folded inwardly into the body of the apparatus for ease of transport.

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[0069] Referring to figure 13 herein there is shown a representative perspective illustration of a device 1300 in accordance with a second embodiment of the present invention in use on a bed 1301. The device 1300 has pivotal legs 704 folded inwardly so that the outer limit of the device in contact with the bed 1301 is the curved underside 1302 of the device 1300 to which the legs 704 are pivotally mounted. The curved underside may be coated in rubber to enhance friction and prevent the device from slipping. A bed stop 803 extends from a first end of the device 1300 and prevents the device from moving forward when a user extends the footplate and calf support forming the 'leg rest' 1303 forward towards the bed stop end of the device.

[0070] Referring to figure 14 herein there is shown a representative side illustration of a device 1400 in accordance with a second embodiment of the present invention in use on a bed 1301. The device 1400 has pivotal legs 704 folded inwardly so that the outer limit of the device and the carrying handle 805 are both in contact with the bed 1301 as is the curved underside 1302 of the device 1400 to which the legs 704 are pivotally mounted. The curved underside may be coated in rubber to enhance friction and prevent the device from slipping. An adjustable bed stop 803 extends from a first end of the device towards the bed footboard 1401 at variable distance D as required by the user. The bed stop 803 prevents the device from moving forward when a user extends the footplate and calf support of the device 1400 in a forward direction.

[0071] Referring to figure 15 herein there is shown a representative perspective illustration of a single device 1500 in accordance with a second embodiment of the present invention for use by a seated individual. A first end 702 of the device 1500 is shown strapped to a chair 1501 by belt anchor 1502. The pivotal legs 704 are fully extended so that the device is raised from floor level.

[0072] Referring to figure 16 herein there is shown a representative perspective illustration of two conjoined devices 1600 in accordance with a second embodiment of the present invention for use by a seated individual. First ends 702 of the respective devices 1600 are shown strapped to a chair

1501 by belt anchors 1502. The pivotal legs 704 of each device 1600 are fully extended so that the devices are raised from floor level. The devices 1600 are connected by plastic joining clips 1601 to allow the devices to be operated simultaneously without separating.

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[0073] Referring to figure 17 herein there is shown a perspective view of a third embodiment of the apparatus in accordance with the present invention. The apparatus 1700 comprises an elongate body 1701 having first 1702 and second 1703 ends. The apparatus is mounted on a pair of legs 1704 in adjustable attachment to the body of the device 1701 about pivot points 1705. The legs have stoppers or feet 1706 made from a thermoplastic elastomer (TPE) plastic to increase friction between the apparatus and the device on which it is placed to prevent the apparatus from slipping. The legs may further comprise joining clips 1707 which permit two individual apparatus 1700 to be joined together or may assist in joining the device to an anchor point for stability e.g. a chair. The legs are foldable beneath the device so that it can be used folded flat for storage.

[0074] The upper surface of the elongate body 1701 is an aluminium extruded body 1708 over which an aluminium slide plate or trolley 1709 is located. The aluminium slide plate 1709 provides a pivotal anchor point 1710 for footplate 1711, allowing the angle of the footplate to move freely relative the longitudinal axis L of the device. The footplate 1711 may further comprise a removable heel pad 1712, by adjusting the point of contact between the foot and the footplate the precise position through which a user has to exert force and thus the area of the user's anatomy which experiences pressure can be adjusted. Thus, when the removable heel pad 1712 is absent, the device is driven by pressure through the ball of the user's foot and there is no pressure on the user's heel. Hence, the apparatus is operable without the need for a foot to be flat on the footplate i.e. it avoids pressure going through the heel portion. When the heel pad 1712 is present, pressure is exerted through the user's heel via the removable heel pad into the footplate 1711 of the device.

[0075] A calf support 1713 is adjustably connected to the footplate 1711. The calf support is molded to reflect the anatomical shape of a user's calf to

provide an ergonomic support to ensure that unsupervised patients maintain their leg in the correct orientation when utilising the device. Both the footplate 1711 and calf support 1713 are lined in foam or soft material to aid the comfort of the user. The angle between the footplate 1711 and calf support 1713 is adjustable via adjusting means 1714 so that the angle of the ankle in said foot and calf support to account for the varying degree of flexibility each user has in their ankle joint. Counterclockwise movement of adjusting means 1714 reduces the angle between the footplate and the calf support 1713, whilst clockwise rotation of knob 1714 increases the angle between the footplate and the calf support 1713. The user's foot and leg are held in position by silicone straps 'S' attached to the footplate 1711 and calf support 1713 respectively. The strap bindings 'S' are adjusted by a CAM locks 'C' to ensure the user's foot and leg are held in place in the device.

[0076] Anchor point 1710 also joins the aluminium slide plate or trolley 1709 bearing the footplate 1711 and calf support 1713 to a connecting member in the form of steel cable 1715. Steel cable 1715 runs along a part of the length of the body of the device 1701 over and around a wheel (see W in figure 19) to anchor the cable to a plurality of springs which provide variable resistance and form the inner workings of the device discussed in detail in figure 18.

[0077] The resistance of the device and thus the energy required to be exerted by a user pushing through the footplate 1711 is adjusted through resistance switches 1716 located on the upper surface of the first end 1702 of the body of the device 1701. A spring-loaded release lever 1717 is also provided to disengage the bed end stop when the device is no longer in use.

[0078] The number of full leg extensions made is recorded by a digital counter 1718. Whilst an end stop clamp 1719 is provided to limit the retraction of aluminium slide plate or trolley 1709 and thus restrict the extent of the user's movement when using the device. The device 1700 further includes a start line 1720 to denote the beginning position for the aluminium trolley 1709 when in use by a patient.

[0079] In contrast to embodiment two, the device has a substantially rectangular flat end piece which forms an elongate bed stop 1721 and is shown in retracted configuration in figure 17. A further difference in third embodiment of the invention is that the foldable leg 1704 also provides a carry handle when the device is being transported.

[0080] Figure 18 herein shows a cross section 1800 of a partial perspective view of the device in accordance with a third embodiment of the present invention. The elongate body 1701 is shown in partial cut through. Multiple steel coiled tension springs 1801 are shown. The outermost two springs 1802 are the weakest tension springs. These are in permanent attachment to the steel cable 1715. The inner 3 springs 1801 are engaged by depressing the relevant organ stop 1716 and each offer differing and graduated levels of resistance.

[0081] The bed end stop 1721 comprises two elongate poles 1803 which run through the body of the device 1701. Having two supports for the end stop provide greater stability to the device in use and also prevent the device from twisting. A spring-loaded release lever 1804 is operable to disengage the bed end stop and allow the rods 1803 to retract within the body of the device. The trolley 1709 must be at the start line 1720 before adjusting the resistance.

[0082] Greater details of the organ stop arrangement of the third embodiment is illustrated in figures 19a-c, 1900. Each organ stop 1706 is located in a vertical orientation protruding from the longitudinal body 1701 of the device. The organ stops comprise standard plungers as shown in figure 19b having a threaded portion 1901 and an enlarged flat portion 1902 which provides a gripping region. Referring to figure 19c the threaded portion 1901 of the plungers are operable to engage with a correspondingly threaded screw 1903 located within the device body. The plungers are pushed downwardly to engage the corresponding spring 1904 beneath, a loop end 1906 of steel spring 1904, so that when the corresponding plunger 1716 is depressed and pushed downwardly a lower end of the knob, stop or plunger engaged with the central aperture of the loop end of the spring(s) so that the springs are engaged. The spring 1904 which is engaged determines the tension and force required by the user to operate the

device. To disengage the plunger, the knob-like gripping portion 1902, which may have undulations on it to aid gripping, is lifted upwardly and rotated 90 degrees to latch the plunger in a disengaged position in which the narrow-tapered end of the plunger 1905 sits above the screw 1903.

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[0083] Referring to figure 20 herein there is shown a partial cross-sectional view 2000 in accordance with the third embodiment of the present invention. Like numerals denote like parts. The elongate body of the device 1701 has first 1702 and second 1703 ends and the body 1701 houses steel cable 1715 which is wound around wheel W and attached to a plurality of steel tension springs 1801 naturally biased to retract and to pull the steel cable 1715 towards themselves. The number of springs 1801 engaged is determined by the organ stop 1716 engaged on the surface of the apparatus. When pressed down the organ stop engages with the central aperture of the loop end 1906 of the spring to increase the resistance required by the user to move the trolley 1709 towards the first end 1702 of the apparatus.

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[0084] Referring to figure 21 herein there is shown a representative perspective view 2100 of a device in accordance with a third embodiment of the present invention in use on a bed 2101. The device has pivotal legs 1704 folded inwardly so that the outer limit of the device in contact with the bed 2101 is the curved underside 2102 of the device to which the legs 1704 are pivotally mounted.

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[0085] The legs have stoppers or feet 1706 shown in figure 17 made from a thermoplastic elastomer (TPE) plastic to increase friction between the apparatus and the device on which it is placed to prevent the apparatus from slipping. The legs may further comprise joining clips 1707 which permit two individual apparatus 1700 to be joined together or may assist in joining the device to an anchor point for stability e.g. a chair. The legs are foldable beneath the device so that it can be used folded flat for storage.

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[0086] Referring to figure 21 the curved underside 2102 is coated in rubber to enhance friction and prevent the device from slipping. The bed stop 1721

extends from a first end of the device 2100 and prevents the device from moving forward when a user extends the footplate 1711 and calf support 1713 which form a 'leg rest' towards the bed stop end of the device.

5 **[0087]** Referring to figure 22 herein there is shown a representative side illustration 2200 of a device in accordance with a third embodiment of the present invention in use on a bed 2101. The device has pivotal legs 1704 folded inwardly so that the curved underside 2102 of the device to which the legs 1704 are pivotally mounted is in contact with the bed 2101. The curved underside is to
10 be coated in rubber to enhance friction and prevent the device from slipping. An adjustable bed stop 1803 extends from a first end of the device towards the bed footboard 2201 at variable distance D as required by the user. The bed stop 1803 prevents the device from moving forward when a user extends the footplate 1711 and calf support 1713 of the device in a forward direction.

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[0088] Referring to figure 23 herein there is shown a device in accordance with a third embodiment of the present invention in folded configuration for storage and transport 2300. The apparatus has two legs 1704 folded upwardly into the underside of the device. One of the legs 1704 has a coating 2301 of thermoplastic
20 elastomer (TPE) plastic to increase friction between the apparatus and to provide a gripping area and handle for carrying the device once the legs 1704 are in a folded configuration.

[0089] Referring to figures 23 and 24 herein there is shown a device in
25 accordance with a third embodiment of the invention. The apparatus is carried by handle 2301 which is a region of one of the supporting legs 1704. The calf 1713 and footplate 1711 have been folded inwardly into the body of the apparatus for ease of transport. An anchor strap 2302 is shown which can be used to secure the device to a chair when used in an upright position. A hanging
30 loop 2303 can be used to aid hung storage of the device.

[0090] Referring to figures 25a and b there are shown perspective illustrations of a single device in accordance with a third embodiment of the

present invention for use by a seated individual. An end 1703 of the device is shown strapped to a chair 2501 by belt anchor 2502. The pivotal legs 1704 are fully extended so that the device is raised from floor level. An extra-long belt anchor, approximately 2-3 meters in length 2503 may be used to secure the device around a large comfortable chair or may be 1-2 meters for securing a single device to an upright sturdy chair e.g. a dining chair. The belt anchor is made of hygienic gloss thermoplastic polyurethane.

[0091] Referring to figure 25c there is shown a perspective illustration of two conjoined devices in accordance with a third embodiment of the present invention for use by a seated individual. Ends 1703 of the respective devices are shown strapped to a chair 2501 by belt anchors 2502. The pivotal legs 1704 of each device are fully extended so that the devices are raised from floor level. The devices are connected by plastic joining clips 1707n the illustration shown to allow the devices to be operated simultaneously without separating. Alternatively, the devices may be joined by Velcro strapping 2503.

[0092] It will be understood that various modifications will be apparent to those skilled in the art. For example the nylon slide plate or trolley may be replaced by any other form of moveable mechanism anchorable to the base of the footplate. The steel cable may be replaced with an alternative reinforced connecting means e.g. a chain or reinforced fibers.

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Claims

1. A portable therapeutic leg strengthening apparatus comprising:
 - 5 a longitudinal body having first and second ends;

a guide member moveable between said first and second ends of the longitudinal body of the device;
 - 10 one or a plurality of resiliently of biased means; and

a connecting means for connecting said plurality of resiliently biased means to the guide member;
 - 15 a footplate for receiving a portion of a user's leg or foot therein; and

a calf support; and

said plurality of resiliently biased means provide variable resistance to the
20 connecting means to increase or decrease the force required by the user to move said guide member between said first and second ends of the longitudinal body of the apparatus.
2. An apparatus according to claim 1 wherein said footplate and calf
25 support are pivotally connected to the guide member.
3. An apparatus according to any preceding claim wherein the angle between the footplate and the calf support is adjustable.
- 30 4. An apparatus according to claim 3 wherein the footplate and calf support are joined by a hinge.
5. An apparatus according to any preceding claim wherein plurality of resiliently biased means are elastic or rubber cords.

6. An apparatus according to any preceding claim wherein plurality of resiliently biased means are springs.

5 7. An apparatus according to any preceding claim wherein the footplate is a two-part assembly.

8. An apparatus according to any preceding claim further comprising a
10 removable heel support.

9. An apparatus according to any preceding claim further comprising a removable liner.

15 10. An apparatus according to claim 6 wherein the removable liners are magnetically aligned with the footplate and calf support.

11. An apparatus according to any preceding claim wherein the footplate and calf support are replaceable with a gripping portion to allow the
20 device to be used to exercise the upper body and/or arms.

12. An apparatus according to any preceding claim further comprising a manual or electronic counter

25 13. An apparatus according to any preceding claim wherein the connecting means is a steel cable.

14. An apparatus according to any preceding claim further comprising a
30 bed end stop to stabilize the device in use on a bed.

15. An apparatus according to claim 14 wherein the bed end stop comprises two elongate support rods.

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Examiner: Dr David Palmer

Claims searched: 1-15

Date of search: 24 September 2018

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-15	US 2011/112455 A1 (ROCKLIN) See whole document especially the figures.
X	1-15	US 3717144 A (BIMLER) See whole document especially the figures.
X	1-15	US 7137936 B1 (SHAW et al.) See whole document especially figures 10-13.
X	1-15	US 6416448 B1 (HASSLER) See whole document especially the figures.
X	1-15	US2015/119204 A1 (LOANE et al.) See whole document especially the figures.
X	1-15	DE 3037619 A1 (CALLEHN) See the figures and WPI Abstract Accession No. 1982-F7101E.
X	1-15	US 4229001 A (ROMAN) See whole document especially the figures.
X	1-15	US 2014/088466 A1 (HANSEN) See whole document especially the figures.
X	1-15	US 2010/016131 A1 (HOFFMAN) See whole document especially the figures.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.



Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

A63B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
A63B	0023/035	01/01/2006
A63B	0021/055	01/01/2006
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