

## LOCKING MECHANISM FOR A RESISTANCE SELECTION SYSTEM

### Field of the Invention

- 5 This invention relates to exercise apparatuses, and in particular a locking mechanism for resistance selection system that is suitable for use in exercise apparatuses.

### Background

- 10 Resistance devices are commonly used in gyms and other training facilities for a wide range of strength and training exercises. An example of a resistance device is a resistance band, which typically includes a length of elastic material with a handle at one or both of its ends. Resistance bands are lightweight and portable in comparison to weights such as dumbbells. However, they have limitations including providing a variable amount of resistance as the  
15 elastic is stretched during an exercise; the band can pull back violently during an exercise and strike the user; and resistance bands are typically perishable and tend to split/fray/weaken over time.

- Another example of a resistance device is a cable machine. Cable machines typically include  
20 one or more stacks of plate weights, one or more cables connected to the weights, and a series of pulleys connected to a frame. The free end of the cable includes an attachment point for handles and other gripable accessories. The level of resistance is selected using a pin to engage a chosen number of weights. Cable machines are large and bulky, heavy and difficult to transport, and the exposed pulleys and weights can cause injuries if used incorrectly.

- 25 Recently, compact resistance devices have been developed to overcome the limitations of resistance bands and cable machines. These devices are lightweight and transportable. They include a series of resistance elements (e.g. elastic bands, gas struts) contained within a housing, and a selection system for selecting one or more of the resistance elements to vary  
30 the resistance. Because of the compactness of these devices, internal components are designed to only work within small tolerances, which can lead to malfunctioning. For example, when a user selectively engages and disengages the resistance elements, internal

components may be subject to asymmetrical loading. This can lead to components becoming misaligned during use, which can ultimately prevent the device from functioning properly.

Therefore, there exists a need for a solution that increases the reliability and usability of compact resistance devices. The applicant has determined that it would be advantageous to  
5 provide a resistance device, or part thereof, which in its preferred embodiments, seeks to at least in part alleviate the above-identified problems or to offer the public with a useful choice.

## 10 Summary of the Invention

According to an aspect of the invention, there is provided a locking mechanism for a resistance selection system of an exercise apparatus, comprising: a hub having a plurality of selectable positions; a core seated within, and rotatable relative to, the hub, the core  
15 comprising two force transmission members for effecting movement of a resistance selector and a retractable pin that is biased to engage one of the plurality of selectable positions; a lock member being slidably moveable within a central cavity of the core between a raised state, in which the lock member abuts one end of the pin to prevent the pin from retracting so as to restrict relative movement between the core and the hub, and a depressed state, in  
20 which the lock member does not prevent the pin from retracting; and a key moveable relative to the central cavity, and configured to actuate the lock member into the depressed state when the exercise apparatus is in a rest position, thereby permitting rotation of the core relative to the hub to enable resistance selection.

25 In some embodiments, the key includes a cylindrical portion having a diameter that is less than a diameter of the lock member.

In some embodiments, the key includes a substantially frustoconical portion between the first and second cylindrical portions.

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In some embodiments, the key includes two flanged portions.

In some embodiments, a circumferential edge at a first end of the key is rounded.

In some embodiments, the radius of curvature of the rounded edge is between 0.001 mm and 1.000 mm.

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In some embodiments, the key is received in the central cavity of the core in use.

In some embodiments, the hub comprises a plurality of recesses, and the recesses define the plurality of selectable positions.

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In some embodiments, the recesses are configured to receive the pin.

In some embodiments, the hub is substantially annular.

15 In some embodiments, the core comprises a plurality of pins.

In some embodiments, the pins are equally spaced from each other.

20 In some embodiments, the force transmission members comprise projections which interface with corresponding apertures in a portion of the selection system.

In some embodiments, the central cavity includes a rounded rim.

25 In some embodiments, the locking mechanism further comprises a housing coupled to the core such that rotation of the housing rotates the core.

In some embodiments, the lock member is substantially cylindrical.

30 According to another aspect of the invention, there is provided an exercise apparatus, comprising: a plurality of resilient elements; an arrangement having a first portion moveable relative to a second portion, whereby resistance experienced by a user moving the first portion relative to the second portion is determined by the number of resilient elements

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engaged to travel with the first portion; a selection system for selecting any of the plurality of resilient elements to travel with the first portion, thereby varying the resistance of the exercise apparatus; and a locking mechanism as described above, wherein the locking mechanism prevents movement of the selection system while the first portion is moved away  
5 from the second portion.

In some embodiments, the selection system includes a selector plate, which is carried by the first portion when in use.

10 In some embodiments, there are three resilient elements, and the selection system has a plurality of configurations for engaging one or more of the resilient elements.

In some embodiments, the resilient elements are gas struts and/or gas spring struts.

15 Further aspects of the present invention and further embodiments of the aspects described in the preceding paragraphs will become apparent from the following description.

While components of the locking mechanism and selection system for an exercise apparatus will be described below for use in combination with each other in the preferred embodiments  
20 of the present invention, it is to be understood by a skilled person that some aspects of the present invention are equally suitable to be used interchangeably between one or more embodiments of the present invention and/or suitable for use as standalone inventions that can be individually incorporated into other devices and assemblies not described herein.

25 The word “about” or “approximately” when used in relation to a stated reference point for a quality, level, value, number, frequency, percentage, dimension, location, size, amount, weight or length may be understood to indicate that the reference point is capable of variation, and that the term may encompass proximal qualities on either side of the reference point.

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As used herein, the word "substantially" may be used merely to indicate an intention that the term it qualifies should not be read too literally and that the word could mean "sufficiently", "mostly" or "near enough" for the patentee's purposes.

## 5 Description of the Drawings

The invention will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a resistance selection system for an exercise  
10 apparatus in accordance with an embodiment of the present invention;

Figure 2 is an exploded perspective view of a the resistance selection system shown in Figure 1;

Figure 3 is a bottom perspective view of a central core of the selection system shown in Figure 1;

15 Figure 4 is a bottom perspective view of a hub of the selection system shown in Figure 1;

Figure 5 is a cutaway top view of the resistance selection system shown in Figure 1 with a portion of the central core partially removed to show internal components;

20 Figure 6 is a cutaway perspective view of the resistance selection system shown in Figure 1 in a locked position and with the central core partially removed;

Figure 7 is a sectional view of the resistance selection system shown in Figure 6 taken along line A-A illustrated in Figure 5;

Figure 8 is a cutaway perspective view of the resistance selection system shown in Figure 1 in a locked position and with the central core partially removed;

25 Figure 9 is a sectional view of the resistance selection system shown in Figure 4 taken along line A-A shown in Figure 5;

Figure 10 is a perspective view of a key of the resistance selection system in accordance with an embodiment of the present invention;

Figure 11 is a side view of the key shown in Figure 10;

30 Figure 12 is a schematic diagram of an exercise apparatus including a resistance selection system according to an embodiment of the present invention;

Figure 13 is a cutaway perspective view of an exercise apparatus including a

resistance selection system according to an embodiment of the present invention in a rest position;

Figure 14 is a cutaway perspective view of the exercise apparatus shown in Figure 13 in an active position;

5        Figure 15 is a zoom view of the resistance selection system and a carriage of the exercise apparatus shown in Figure 13;

Figure 16 is a partially exploded perspective view of the resistance selection system and the carriage of the exercise apparatus shown in Figure 13;

Figure 17 is a perspective view of a bevel gear of the resistance selection system;

10       Figure 18 is a perspective view of a selector plate of the resistance selection system;

Figure 19 is a perspective view of a retainer member of the resistance selection system;

Figure 20 is an exploded perspective view of the carriage of the exercise apparatus shown in Figure 13;

15       Figure 21 is a cutaway perspective view of the exercise apparatus according to an embodiment of the present invention with the selector plate in a first position and the exercise apparatus in a rest position;

Figure 22 is a cutaway perspective view of the exercise apparatus of Figure 21 in an active position;

20       Figure 23 is a cutaway perspective view of the exercise apparatus according to an embodiment of the present invention with the selector plate in a second position and the exercise apparatus in a rest position; and

Figure 24 is a cutaway perspective view of the exercise apparatus of Figure 23 in an active position.

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### Detailed Description

Figures 1 and 2 show a locking mechanism 100 for a resistance selection system of an exercise apparatus according to a preferred embodiment of the present invention. The  
30       locking mechanism 100 comprises a hub 110 having a plurality of selectable positions and a core 120 seated within, and rotatable relative to, the hub 110, the core 120 comprising two force transmission members 122 for effecting movement of a resistance selector 260 and a

retractable pin 124 that is biased to engage one of the plurality of selectable positions. The locking mechanism 100 also comprises a lock member 126 being slidably moveable within a central cavity 130 of the core 120 between a raised state, in which the lock member 126 abuts the pin 124 to prevent the pin from retracting so as to restrict relative movement  
5 between the core 120 and the hub 110, and a depressed state, in which the lock member does not prevent the pin 124 from retracting. The locking mechanism also comprises a key 140 moveable relative to the central cavity 130, and configured to actuate the lock member 126 into the depressed state when the exercise apparatus 200 is in a rest position, thereby permitting rotation of the core 120 relative to the hub 110 for resistance selection

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For the avoidance of doubt, 'upper' and 'lower' and similar terms are used herein with reference to the illustrated orientation of the device as an aid to the reader only. The invention is not limited to devices capable of operation in the illustrated orientation.

15 In some embodiments, the hub 110 is an annular shell, and the selectable positions are defined by a series of equispaced recesses 112 (also known as notches or teeth), in the shell. Each recess is configured to receive one of a plurality of pins 124a, 124b, 124c (also known as tongues), which are equally spaced from one another around a central axis. Each tongue has a corresponding spring 156a, 156b, 156c that biases the tongue 124 towards the recesses  
20 112. Together, the tongues 124 and springs 156 form spring-loaded detent members that cooperate with, and are biased towards, recesses 112. In use, the spring-loaded detent members, including the tongues 124 and the springs 156, in combination with the recesses 112 provide a user with desirable tactile qualities as the locking mechanism 100 is clicked from one selectable position to another.

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The core 120 includes slots 157 (as shown in Figure 3) to receive plates 158a, 158b, 158c thereby holding the plates in a fixed position relative to the core 120. A small projection 159 on each plate 158 locates a first end of each spring 156 on the plate, and each tongue 124 includes a corresponding slot for receiving a second end of each spring 156. The core 120  
30 includes a channel 131 for each tongue 124, each channel extends radially outwards from each of the plates 158, thereby allowing the tongues 124 to slide relative to the core 120 to engage/disengage from the recesses 112. The lock member 126 is substantially cylindrical

and is biased by lock member spring 127 towards a position in which it prevents movement of the tongues 124 when the exercise apparatus is in use. Lock member spring 127 is seated on seat 128 of core retaining plate 121. When the exercise apparatus is in a rest position, the key 140 pushes the lock member 126 to an unlocked position where the projecting portions  
5 129 of the tongues 124 can move radially inwards to disengage from the recesses 112. The key 140 moves slidingly through a central cavity 130 in the core 120.

The core 120 also includes force transmission members 122 which transfer torque applied to the selector ring 160 by a user to rotational motion of the selection system 300 in order to  
10 select between different resistance levels. The force transmission members 122 may comprise projections, or drive pins, that extend upwardly from the core 120.

To rotate the core 120, a user rotates selector ring 160. Torque applied to the selector ring 160 is transferred to the core 120 through coupling projections 162a, 162b, which are  
15 received in coupling apertures 164a, 164b of retaining plate 121. The retaining plate 121 is fixedly connected to the core 120 by a screw or similar.

The selector ring 160 may be moulded from plastic with a suitable form to be conveniently gripped and rotated. In this example, the selector ring has grooves to increase friction when  
20 gripped by a user. Preferably one of an outer surface of the housing 214 and the selector ring 160 carries a series of indicia corresponding to the available resistances whilst the other of those two things carries a suitable pointer whereby the user is provided with a visual indication of the selected resistance.

25 The core retaining plate 121 comprises a projection 134 that slides against a bottom annular surface 114 of the hub 110 as shown in Figure 4. A ridge 115 extends circumferentially around a portion of the bottom annular surface 114 and includes blocking portions 116 at each end. The projection 134 can slide between the ends of the ridge 115 and is prevented from rotating past the ends in either direction by the blocking portions 116. The core  
30 retaining plate 121 also comprises rails 123 to guide the movement of the tongues 124 in the radial direction.

Ring 166 is decorative, and also acts as a spacer between the locking mechanism 100 and the housing 214 when the exercise apparatus is assembled. It may also be formed integrally with the hub 110.

- 5 Figure 5 shows a top view of the locking mechanism 100 with the core 120 removed. Figure 5 also shows line A-A, which defines the cutting plane for the sectional views shown in Figures 7 and 9. In the engaged, or locked, position shown in Figure 5, the tongues 124a, 124b, 124c sit in register with respective ones of recesses 112.
- 10 Figures 6 and 7 show the locking mechanism 100 with the core 120 removed and in the locked position. In this position, the key 140 rests on the lock member 126 without pushing it to its unlocked position. As shown in Figure 7, the lock member 126 prevents the tongues 124 from moving radially towards the centre of the hub 110. In particular, the projecting portions 129 of the tongues 124 are in close facing relation with the lock member 126 and
- 15 are thus prevented from moving away from the engaged or locked position.

- As shown in Figures 8 and 9, in the unlocked position, the key 140 pushes the lock member 126 to its unlocked position thereby allowing the projecting portions 129 of the tongues 124 to move towards the centre of the hub 110 and out of engagement with the recesses 112. In
- 20 the unlocked position, the lock member spring 127 is compressed. The key 140 includes first and second cylindrical portions 142, 144. The diameter of the second cylindrical portion 144 is less than the diameter of the lock member 126 so that the tongues 124 can move away from the recesses 112 in order to permit rotation of the core 120. In alternative embodiments, the diameter of the second cylindrical portion 144 may be larger than the diameter of the
- 25 lock member 126.

- When a torque is applied to the selector ring 160 by a user, the angle of the teeth/recesses 112 and the angle of the corresponding engaging portion of the tongues 124, produces a resultant force that has a component in the radial direction. This radial force acts to push the
- 30 tongues 124 away from the engaged position to allow rotation of the selector ring 160.

Figures 10 and 11 show details of a preferred embodiment of the key 140. The key 140 comprises first and second cylindrical portions 142, 144, a frustoconical portion 146, first and second flanged portions 149, 150, an internal threaded portion 153, and a substantially flat face 149 between the first cylindrical portion 142 and the frustoconical portion 146. The first cylindrical portion 142, second cylindrical portion 144, and the flanged portions 149, 150 have diameters A2, A3 and A4, respectively. Diameter A2 may be approximately 11.8 mm; diameter A3 may be approximately 7.5 mm; and diameter A4 may be approximately 16.0 mm. The transitions between the respective portions R2, R3, and R4 are rounded with a radius of curvature of approximately 0.3 mm. Rounded edge 152 has a radius of curvature between 0.001 mm and 1.000 mm. The radius of curvature of rounded edge 152 is preferably approximately 0.6 mm. The angle of the frustoconical portion  $\theta_1$  may be approximately  $90^\circ$ ; and the angle of the second flanged portion  $\theta_2$  may be approximately  $132^\circ$ .

Rounded edge 152, in combination with a rounded rim at the opening of the central cavity 130 of the core 120, allows the locking mechanism 100 to function even if the key 140 is out of alignment with the central cavity 130. In other words, if the longitudinal axis of the key 140 is not parallel with the longitudinal axis of the cavity 130, the rounded edge 152 allows the key 140 to enter the central cavity 130 and engage with the lock member 126. This ensures that the key 140 can fully engage with and push the lock member 126 to the unlocked position to unlock the locking mechanism 100 and permit adjustment of the resistance even if the key 140 is misaligned. Small misalignment of the key 140 occurs frequently, and can be caused by uneven loading within the exercise apparatus when a user selects a resistance level that requires an asymmetrical arrangement of resistance members, for example.

Figure 12 shows an exercise apparatus 200 according to a second embodiment of the present invention. The exercise apparatus 200 includes a vertical rail 216. In this example, the rail is wall mounted. The exercise apparatus 200 is connected to the rail 216 at selected vertical locations via connecting arrangement 217. In a preferred variant of the exercise apparatus 200, the connection arrangement 217 is configured to slide along the rail 216 and incorporates a spring-loaded detent co-operable with detent-receiving features (e.g. holes) along the rail 216.

The exercise apparatus incorporates a housing 214 housing a transmission and a resilient arrangement. The housing 214 is elongate, i.e. is more than three times longer than it is wide and in this particular example is approximately cylindrical. A cable 210 emerges from a first  
5 end of the exercise apparatus 200, and the locking mechanism 100 is located at a second end of the housing 214.

The cable 210 of the exercise apparatus 200 carries a handle 212 whereby the apparatus 200 is configured for a variety of exercises. By way of example, the connection arrangement 217  
10 may be dropped towards the bottom of the rail 216 to configure the machine for bicep curls, used at the illustrated shoulder height for chest presses or raised higher for pull-down exercises.

In another variant of the exercise apparatus 200, the rail 216 may be replaced by a set of  
15 anchor points, e.g. wall-mounted ringbolts, arranged to be at differing heights. To suit such variants, the apparatus 200 may have an anchor engaging feature such as a snap hook by which the apparatus 200 is conveniently engageable with a selected one of the anchor points. Preferred forms of the apparatus 200 may be attached to any convenient anchor point, e.g. to existing racks/frames or other stable stationary object such as a tree.

20 As shown in Figures 13 to 15, the exercise apparatus 200 comprises a resilient arrangement having a first portion moveable relative to a second portion, and a plurality of resilient elements; a selection system 300 for selecting at least one of the resilient elements to vary the resistance of the exercise apparatus 200; and a locking mechanism 100 as described  
25 above, wherein the locking mechanism 100 prevents inadvertent movement of the selection system 300 while the exercise apparatus 200 is in use.

Figure 13 illustrates the exercise apparatus 200 in a rest position. In this position, the key  
140 pushes the lock member 126 to the unlocked position, where the projecting portions 129  
30 of the tongues 124 can move radially inwards to disengage from the recesses 112.

Figure 14 illustrates the exercise apparatus 200 in an active position. An active position may be any position where the key 140 is disengaged from the lock member 126, and the lock member 126 is in the locked position. In such a position, the tongues 124 are prevented from disengaging from the recesses 112, thereby preventing rotation of the selection system 300.

5 In the embodiment shown in Figures 13 to 15, the first portion comprises carriage 240 and the second portion comprises the locking mechanism 100. The exercise apparatus 200 incorporates three mutually identical gas struts 230, 231, 232. It is also contemplated that the gas struts may be mutually different, in which case the selection system 300 may be configured to select various permutations. By way of example, gas struts configured to  
10 individually present a user with 2.5 kilograms, 5 kilograms and 7.5 kilograms respectively may be individually selectable to give the user six selectable resistance options corresponding to 2.5 kilograms, 5 kilograms, 7.5 kilograms, 10 kilograms, 12.5 kilograms and 15 kilograms.

15 Gas struts are preferred because proprietary gas struts are economically available and provide resistance that is relatively uniform along their stroke length relative to other resistance devices such as typical springs and resistance bands, etc. Each of the struts 230, 231, 232 may have the following specifications:

- 15 mm diameter cylinder
- 20 - 6 mm diameter piston
- Cylinder length = 145 mm
- Strut max stroke = 120.5 mm
- Strut free length = 300 mm
- Strut force (max lifting force) = 470 N

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These specifications are provided as examples only, and other variants are also possible.

Whilst gas struts provide force that (relative to other resilient arrangements such as typical springs) is uniform, there is some variation in force along the stroke of the gas strut and  
30 between the extension and compression phases of the strut's operation. The 'strut force (max lifting force)' corresponds to the force during the extension phase measured 5 mm before the

complete extension of the piston. This is the typical operating point at which compression struts are characterised. It is almost the lowest force produced by the strut. Typically the lowest force is at the very end of the extension phase.

5 In addition to providing relatively uniform and controlled resistance, typical economically available gas struts also provide a slight degree of dampening which goes some way to addressing the problem of the violent release of energy that can be experienced with resistance bands. The reduction arrangement also goes some way to addressing these problems in that the friction inherent in the mechanism also goes some way to mitigating the  
10 potentially violent retraction of the cable 210 if it is inadvertently released from an extended state.

In this example, the resilient arrangement incorporates gas struts 230, 231, 232 although other variants are possible. By way of example, in a rudimentary form of the device the gas  
15 struts may be eliminated and a simple compression springs incorporated instead. In yet further embodiments, gas spring struts that include a compression spring within a gas strut may be used.

The gas struts 230, 231, 232 together form a resilient arrangement. The pulleys 222, 223 and  
20 the routing of the cable 210 thereabouts form a transmission by which the cable 210 is connected to the resilient arrangement such that pulling upon the cable 210 causes the carriage 240 to move towards a head portion 220 of the exercise apparatus 200.

The lock member spring 127 is selected to be relatively weaker than each of the gas struts  
25 whereby the gas struts overcome the spring 127 to drive the key 140 against the lock member 126 when the carriage is at the end of its stroke (in the resting position).

The selection system 300 can be usefully applied in the context of resistance elements other than gas struts and variants of the selection system are suited to resistance devices having a  
30 number of resistance elements other than three resistance elements.

The exercise apparatus 200 incorporates a user-manipulable portion in the form of selector

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ring 160 overlying a bottom end of the top housing 214. As shown in Figure 15, the selector ring 160 has a cylindrical exterior, which is suitably textured for gripping. The selector ring 160 is user rotatable relative to the rigid housing 214.

5 In this embodiment there are two sets of pulleys 222, 223, with each set of pulleys comprising two pulley wheels arranged coaxially. The cable 210 is laced about the pulleys 222, 223 to form the transmission connecting the cable 210 to the resilient arrangement. In this example the cable 210 is laced about each of the pulleys 222, 223, and is anchored  
10 relative to the carriage 240 whereby the transmission has a reduction ratio of, for example, 4:1. As a result of this reduction ratio, withdrawing a length of cable 210 from the exercise apparatus 200 moves the carriage 240 towards the upper pulleys 222 (and thus compresses the gas struts 230, 231, 232) only a proportion of that length. In this example, the proportion is 0.25.

15 In other examples, the reduction ratio may be 9 to 1 whereby withdrawing one metre of cable moves the carriage 240 about 11 cm towards the portion head portion 220. This reduction arrangement allows for a length of cable 210 to be withdrawn from the exercise apparatus 200 that is useful for performing exercises whilst the apparatus 200 remains conveniently compact.

20 The cable 210 is routed into the head portion 220 via the inlet 218, which includes guide wheels that route the cable 210 through a suitable penetration in the head portion and into the resilient arrangement.

25 In Figure 14, the cable 210 is withdrawn and the carriage is positioned at a top end of its stroke length. In this configuration, gas struts 231 and 232 are selected by the selection system 300, and gas strut 230 is not selected thereby strut rod 230b passes through an aperture in the carriage 240 and does not resist movement of the carriage 240 when the cable is withdrawn.

30 As shown in Figures 16 to 20, the exercise apparatus 200 incorporates a selection system 300 by which the resistance to the withdrawal of the cable 210 can be varied. The selection

system 300 comprises the locking mechanism 100, retainer plate 250, selector plate 260 bevel gear 270, pawl 274, and pawl spring 276.

The substantially flat face 149 of key 140 is adapted to bear against the bottom face of  
5 retainer plate 250 and thereby secure the retainer plate 250 to the carriage 240 during use. In this arrangement, the selector plate 260 and bevel gear 270 are housed in a cavity in the bottom surface of the carriage 240. Thus, the selector plate 260 is carried by the carriage 240 during operation of the exercise apparatus 200.

10 As shown in Figure 17, the bevel gear 270 includes a plurality of teeth 273 and a central aperture 272. The central aperture 272 has a larger diameter than the diameter of the first cylindrical portion 142 of the key 140. The teeth 273 define a number of discrete angular positions and are configured to receive pawl 274. The pawl 274 acts as a spring-loaded detent member co-operable with the depressions between neighbouring ones of the teeth 273. A  
15 bottom surface of the bevel gear includes a plurality of projections 277 for engagement with corresponding apertures in the selector plate 260.

As shown in Figure 18, the selector plate 260 includes apertures 261, 262 for receiving force transmission members 122, a central aperture 266 which has a larger diameter than the first  
20 cylindrical portion 142 of the key 140, a plurality of blocking portions 268 adapted to engage with the strut rods 230b, 231b, 232b of the gas struts, and a plurality of keyways 269 configured to not obstruct the strut rods 230b, 231b, 232b. The bevel gear 270 is rotationally fixed to the selector plate 260 when projections 277 are engaged in apertures 264.

25 As shown in Figure 19, the retainer plate 250 includes keyways 251a, 251b, 251c for strut rods 230b, 231b, 232b to pass through, notches 252a, 252b 252c for alignment and engagement with corresponding projections 244 on the carriage 240, two arcuate slots 254, 255 to allow movement of the force transmission members 122 therein, and a central aperture 256. The diameter of the central aperture 256 is larger than the diameter of the first  
30 cylindrical portion 142 of the key 140, but is smaller than the diameter the first flanged portion A4. As mentioned above, the notches 252 and corresponding projections 244 serve to rotationally fix the retainer plate 250 to the carriage 240. Selector plate 260 and bevel gear

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270 are also rotationally fixed with each other, but can rotate relative to the retainer plate 250 and the carriage 240.

When the gas struts are extended and the carriage 240 is at the end of its stroke, the force  
5 transmission members 122 are engaged with the apertures 261, 262 in the selector plate 260. Rotation of the selector ring 160 results in rotation of the selector plate 260 thereby allowing the user to adjust the resistance. When the user pulls on the cable 210 to move the carriage 240 away from the locking mechanism 100, the carriage 240 moves away from and thereby disengages the force transmission members 122. In addition, key 140 also moves away from  
10 lock member 126 thereby preventing rotation of the locking mechanism 100, as described above.

The lock member 126 serves to prevent the core 120 rotating during this mid-stroke phase of the apparatus' operation; that is, whilst the carriage 240 is disengaged from the pins 122.  
15 The locking mechanism 100 locks the selector ring 160 against rotation during this mid-stroke phase of operation so that the pins 122 remain in position to engage the apertures 261, 262 in selector plate 260 upon its return at the end of the housing (resting position).

Figures 21 and 22 illustrate a first configuration of the selector plate 260. In this  
20 configuration, blocking portions 268 overlie rods 230b and 323b, whilst a keyway 269 sits in register with rod 231b of the gas strut 231.

When the selector plate 260 is in the position of Figures 21 and 22 and the cable 210 pulled upon to move the carriage 240 upward, the blocking portions 268 act on the struts 230 and  
25 232 whereby the struts 230 and 232 resist the withdrawal of the cable 210. At the same time, the rod 231b passes through the opening 269 whereby the strut 231 does not resist the withdrawal of the cable 210. The selector plate 260 simply moves along the rod 231b of the strut 231. As such, as the wording is used herein, in this configuration the strut 231 is deselected.

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Rotating the selector plate 260 to another of the defined orientations, as shown in Figures 23 and 24, moves a blocking portion 268 into register with rod 231b. In this orientation, all

three struts 230, 231, 232 are selected and resist withdrawal of the cable 210.

In some embodiments, gas strut 230 remains engaged with the selector plate 260 for all angular positions of the selector plate 260 whereas the struts 231 and 232 are selected  
5 depending on the position of the selector plate 260. As such, as the wording is used herein, the struts 231 and 232 are selectable elements.

In embodiments with three gas struts, there may be six selectable configurations as illustrated in the following table. In the table, ticks indicate whether each strut is engaged in respective  
10 selectable configurations.

| Strut no. | Selection 1 | Selection 2 | Selection 3 | Selection 4 | Selection 5 | Selection 6 |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1         | ✓           |             |             | ✓           | ✓           | ✓           |
| 2         |             | ✓           |             | ✓           |             | ✓           |
| 3         |             |             | ✓           |             | ✓           | ✓           |

As above, when the cable is pulled out, each gas strut may produce a resistance of about 50 kilograms which, via the reduction arrangement, the user experiences as a resistance of about  
15 5 kilograms. As such, three selectable positions of the selector plate 260 give the user the choice of 5, 10 or 15 kilograms of resistance. The exercise apparatus 200 weighs about 1.4 kilograms, giving a resistance to weight ratio of better than 10:1.

In some embodiments, each gas strut may have a different pressure. For example, a first strut  
20 may have a pressure of 150 N, a second strut may have a pressure of 230 N, and a third strut may have a pressure of 470 N.

Many variants of the described technology are possible. By way of example, the selector plate 260 may be replaced by another suitable selector member. Likewise, the selector ring  
25 160 may be replaced by another suitable member such as a thumb slide. An electrically actuated selector mechanism and magnetic-style adjustment are also possibilities, e.g. a suitable actuator may be added to the system 300. Electrical actuation would enable actuation from a control remote from the housing 214, e.g. a control built into a handle could

enable the resistance to a chest press to be varied without removing the apparatus 200 or even releasing the handle. In some embodiments, the selection system can include motorised actuators.

- 5 Figure 20 shows an exploded view of the carriage 240 and various components from the selection system 300. The carriage comprises guide wheels 236 that interface with corresponding slots on an internal face of housing 214. The guide wheels 236 and slots prevent rotation of the carriage 240 relative to the housing 214 and assist in keeping the carriage 240 aligned within the housing 214. The carriage also comprises guides 234a, 234b,  
10 234c that are received in apertures in the carriage 240. Each guide 234a, 234b, 234c includes an aperture that allows respective strut rods 230a, 230b, 230c to pass through. The guides 234a, 234b, 234c include low friction material.

- Lower pulley wheels 223 are secured to bracket 280 by bracket bolt 282 and fastener 284.  
15 Bracket 280 is connected to key 140 by key connector bolt 141. Spacer 242 is housed in a central aperture in a lower portion of the carriage 240.

- Whilst variants of the disclosed devices may be used for purposes other than exercising, the described device may be used to achieve benefits related to back strength, core strength,  
20 upper and lower body strength, aerobic cardiovascular benefits, anaerobic cardiovascular benefits, postural improvements, muscular development (hypertrophy), endurance benefits, etc. The described device can be used for high performance sport, general fitness and strength, rehabilitation, posture correction, sports specific training, coaches and trainers for use with their clients, older adult exercise, injury rehab, in a group exercise class scenario  
25 and more, etc. Variants of the described device may be employed to assist special needs persons (e.g. the wheelchair-bound, amputees and those otherwise disabled).

- While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not by way of  
30 limitation. It will be apparent to a person skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. Thus, the present invention should not be limited by any of the above described

exemplary embodiments.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will  
5 be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

## Reference Numbers

|     |                                                                                 |     |                                          |
|-----|---------------------------------------------------------------------------------|-----|------------------------------------------|
| 100 | Locking mechanism                                                               |     | Apertures in the selector system (plate) |
| 300 | Selection system                                                                |     |                                          |
| 200 | Exercise apparatus                                                              | 200 | Exercise apparatus                       |
|     |                                                                                 |     |                                          |
| 110 | Hub / shell / annular shell                                                     | 210 | Cable                                    |
| 112 | Plurality of teeth / recesses / notches                                         | 212 | Handle                                   |
| 114 | Bottom annular surface of the hub                                               | 214 | Housing / Body portion                   |
| 115 | Ridge on hub                                                                    |     |                                          |
| 116 | Blocking portions at ends of ridge                                              |     |                                          |
| 120 | Core / carrier / body / hub / cartridge / wheel / spool                         | 216 | Mounting rail                            |
|     |                                                                                 | 217 | Connecting arrangement                   |
| 121 | Core retaining plate                                                            | 218 | Head pulleys                             |
| 122 | Force transmission members / drive pins                                         | 219 |                                          |
| 123 | Rails on retainer plate                                                         |     |                                          |
| 124 | Pin / tongue / pawl / spring loaded detent members / spring loaded latch member | 220 | Head of apparatus                        |
| 125 | Tooth portion of tongue/pawl                                                    | 222 | Top / upper pulleys                      |
| 126 | Lock member                                                                     | 223 | Bottom / lower pulleys                   |
| 127 | Lock member spring                                                              | 230 | Strut (strut body 230a, strut rod 230b)  |
| 128 | Lock member spring seat                                                         | 231 | Strut (strut body 231a, strut rod 231b)  |
| 129 | Projecting portion of tongue                                                    |     |                                          |
| 130 | Central cavity                                                                  | 232 | Strut (strut body 232a, strut rod 232b)  |
| 131 | Radial grooves in body                                                          |     |                                          |
| 132 | Rounded rim                                                                     | 234 | Strut rod guide                          |
| 134 | Stopper                                                                         | 236 | Guide wheels                             |
| 140 | Key / pin / striker                                                             |     |                                          |
| 141 | Key connector bolt                                                              | 240 | Carriage / moveable unit                 |
| 142 | First cylindrical portion                                                       | 242 | Spacer/guide                             |
| 144 | Second cylindrical portion                                                      | 244 | Notch on carriage                        |
| 146 | Frustoconical portion                                                           | 250 | Retainer plate                           |
| 148 | First flanged portion                                                           | 251 | keyways for struts to pass through       |
| 149 | Substantially flat face                                                         | 252 | Notch for alignment with carriage        |
| 150 | Second flanged portion                                                          | 254 | Slot (arcuate)                           |
| 152 | Rounded edge                                                                    | 255 | Slot (arcuate)                           |
| 153 | Internal thread                                                                 | 256 | Central aperture                         |
|     |                                                                                 | 259 | Bottom face of retainer plate            |
| 156 | Springs                                                                         |     |                                          |
| 157 | Slots for plates                                                                |     |                                          |
| 158 | Mounting plates                                                                 | 260 | Selector plate / member                  |

|            |                                     |     |                                                                |
|------------|-------------------------------------|-----|----------------------------------------------------------------|
| 159        | Projection on plate                 | 261 | Force transmission member aperture                             |
| 160        | Selector ring                       | 262 | Force transmission member aperture                             |
| 162        | Coupling projections                | 264 | Retaining apertures                                            |
| 164        | Coupling apertures                  | 266 | Central aperture                                               |
| 165        | Coupling apertures                  | 268 | Blocking portions / strut-engaging portion                     |
| 166        | Retaining ring                      | 269 | Apertures/slots for rods to pass / strut-accommodating regions |
|            |                                     |     |                                                                |
| $\theta_1$ | Angle of frustoconical section (90) |     |                                                                |
| $\theta_2$ | Angle of bottom flange (132)        | 270 | Tooth plate/bevel gear                                         |
| R2         | Radius of curvature                 | 272 | Central aperture in tooth plate                                |
| R3         | Radius of curvature                 | 273 | Tooth of tooth plate                                           |
| R4         | Radius of curvature                 | 274 | Tongue/pawl for selector member / spring loaded detent member  |
| R5         | Radius of curvature                 | 276 | Tongue/pawl spring                                             |
| A2         | Diameter                            |     |                                                                |
| A3         | Diameter                            | 280 | Bracket                                                        |
| A4         | Diameter                            | 282 | Bracket bolt                                                   |
|            |                                     | 284 | Bracket bolt fastener                                          |

## THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A locking mechanism for a resistance selection system of an exercise apparatus, comprising:
  - 5 a hub having a plurality of selectable positions;  
a core seated within, and rotatable relative to, the hub, the core comprising two force transmission members for effecting movement of a resistance selector and a retractable pin that is biased to engage one of the plurality of selectable positions;  
a lock member being slidably moveable within a central cavity of the core between  
10 a raised state, in which the lock member abuts one end of the pin to prevent the pin from retracting so as to restrict relative movement between the core and the hub, and a depressed state, in which the lock member does not prevent the pin from retracting; and  
a key moveable relative to the central cavity, and configured to actuate the lock member into the depressed state when the exercise apparatus is in a rest position, thereby  
15 permitting rotation of the core relative to the hub to enable resistance selection.
2. A locking mechanism according to claim 1, wherein the key includes a cylindrical portion having a diameter that is less than a diameter of the lock member.
- 20 3. A locking mechanism according to claim 2, wherein the key includes a substantially frustoconical portion between the first and second cylindrical portions.
4. A locking mechanism according to any one of the preceding claims, wherein the key includes two flanged portions.  
25
5. A locking mechanism according to any one of the preceding claims, wherein a circumferential edge at a first end of the key is rounded.
6. A locking mechanism according to claim 5, wherein the radius of curvature of the  
30 rounded edge is between 0.001 mm and 1.000 mm.

7. A locking mechanism according to any one of the preceding claims, wherein the key is received in the central cavity of the core in use.
8. A locking mechanism according to any one of the preceding claims, wherein the hub  
5 comprises a plurality of recesses, and wherein the recesses define the plurality of selectable positions.
9. A locking mechanism according to claim 8, wherein the recesses are configured to receive the pin.  
10
10. A locking mechanism according to any one of the preceding claims, wherein the hub is substantially annular.
11. A locking mechanism according to any one of the preceding claims, wherein the core  
15 comprises a plurality of pins.
12. A locking mechanism according to claim 11, wherein the pins are equally spaced from each other.
- 20 13. A locking mechanism according to any one of the preceding claims, wherein the force transmission members comprise projections which interface with corresponding apertures in a portion of the selection system.
14. A locking mechanism according to any one of the preceding claims, wherein the  
25 central cavity includes a rounded rim.
15. A locking mechanism according to any one of the preceding claims, further comprising a housing coupled to the core such that rotation of the housing rotates the core.
- 30 16. A locking mechanism according to any one of the preceding claims, wherein the lock member is substantially cylindrical.

17. An exercise apparatus, comprising:  
a plurality of resilient elements;  
an arrangement having a first portion moveable relative to a second portion, whereby  
resistance experienced by a user moving the first portion relative to the second portion is  
5 determined by the number of resilient elements engaged to travel with the first portion;  
a selection system for selecting any of the plurality of resilient elements to travel  
with the first portion, thereby varying the resistance of the exercise apparatus; and  
a locking mechanism according to any one of claims 1 to 16,  
wherein the locking mechanism prevents movement of the selection system while  
10 the first portion is moved away from the second portion.
18. An exercise apparatus according to claim 17, wherein the selection system includes  
a selector plate, which is carried by the first portion when in use.
- 15 19. An exercise apparatus according to claim 17 or claim 18, wherein there are three  
resilient elements, and the selection system has a plurality of configurations for engaging  
one or more of the resilient elements.
20. An exercise apparatus according to any one of claims 17 to 19, wherein the resilient  
20 elements are gas struts and/or gas spring struts.