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PERSON SUPPORT APPARATUS HAVING EXERCISE THERAPY FEATURES

Abstract

A person support apparatus includes a support surface having a patient facing surface and includes a head section, a seat section, and a foot section, the head section and the foot section being rotatable with respect to the seat section. One or more actuators are provided to rotate the head section and the foot section with respect to the seat section. At least one strain gauge is provided proximate the patient facing surface of the support surface to detect a change in pressure against at least one of the head section and the foot section. A controller is configured to transmit a signal to one or more of the actuators to rotate a corresponding one of the head section or the foot section in response to receiving data from the at least one strain gauge indicating a change in pressure that exceeds a predetermined reduction in pressure.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation application of co-pending U.S. Nonprovisional patent application Ser. No. 17/061,925, filed Oct. 2, 2020, entitled “Person Support Apparatus Having Exercise Therapy Features,” which claims priority to U.S. Provisional Patent Application No. 62/912,932, filed Oct. 9, 2019, entitled “Person Support Apparatus Having Exercise Therapy Features” and U.S. Provisional Patent Application No. 62/940,492, filed Nov. 26, 2019, entitled “Person Support Apparatus Having Exercise Therapy Features,” each of which are hereby incorporated by reference in their respective entireties including the drawings.

TECHNICAL FIELD
[0002] The present specification generally relates to person support apparatuses and, more particularly, to person support apparatuses having exercise therapy features.
BACKGROUND
[0003] Long periods of bed rest that are sometimes necessary for recovery of subjects often lead to deterioration of muscle strength and a corresponding inability of the subject to support his or her full body weight upon standing. It can be challenging for rehabilitation specialists to help these subjects regain the ability to stand and begin ambulation, and the challenge is especially great for obese subjects. A common technique in conventional practice is to summon as many personnel as practical to lift and maneuver the weakened subject to a standing position while he or she attempts to bear full weight through the lower extremities. This technique is not only dangerous, because of the risk of a fall, but it is also psychologically degrading for the subject as the activity reinforces the subject's dependence on others.
[0004] Hospital beds have evolved over the years from conventional beds that lie flat to beds that convert into a chair position, allowing subjects to begin standing from a sitting position at the foot of the bed. However, the sitting position does not improve a subject's leg strength and does little for preparing a subject for upright standing. Subjects are still required to be lifted by hospital staff as the subject's leg muscles do not have adequate strength to support his or her weight. Additionally, these beds typically do not include various exercise devices incorporated into the bed for allowing the subject to perform exercises to strengthen their muscles while in the bed. As such, this requires separate devices to be brought to the bed so that the exercises may be performed. However, these devices may not be specifically configured for the bed and, thus, may not be appropriately fitted to the bed or, at a minimum, require installation and setup.
SUMMARY
[0005] In one aspect, a person support apparatus includes a support surface having a patient facing surface and includes a head section, a seat section, and a foot section, the head section and the foot section being rotatable with respect to the seat section. A head section actuator is coupled between

the head section and the seat section to rotate the head section with respect to the seat section. A foot section actuator is coupled between the foot section and the seat section to rotate the foot section with respect to the seat section. At least one strain gauge is provided proximate the patient facing surface of the support surface to detect a change in pressure against at least one of the head section and the foot section. A controller is configured to transmit a signal to one or more of the head section actuator or the foot section actuator to rotate a corresponding one of the head section or the foot section in response to receiving data from the at least one strain gauge indicating a change in pressure that exceeds a predetermined reduction in pressure.
[0006] In another aspect, a person support apparatus includes a base frame, an upper frame, and a plurality of lift members extending between the base frame and the upper frame for moving the upper frame with respect to the base frame. The person support apparatus further includes a support surface having a patient facing surface and includes a head section, a seat section, and a foot section, the head section and the foot section being rotatable with respect to the seat section. One or more actuators are coupled between one or more of the head section and the seat section to rotate a corresponding one of the head section and the foot section with respect to the seat section. At least one strain gauge is provided proximate the patient facing surface of the support surface to detect a change in pressure against at least one of the head section and the foot section. A controller is configured to transmit a signal to the one or more actuators to rotate a corresponding one of the head section and the foot section in response to receiving data from the at least one strain gauge indicating a change in pressure that exceeds a predetermined reduction in pressure.
[0007] In yet another aspect, a method for performing exercises in a person support apparatus includes receiving, at a user interface, a maximum angle of rotation and a predetermined reduction in pressure, monitoring, by a strain gauge, a change in pressure applied against a head section of the person support apparatus, and responsive to a change in pressure against the head section detected by the strain gauge exceeding the predetermined reduction in pressure, rotating the head section in a first direction with respect to a seat section of the person support apparatus toward the maximum angle of rotation.
[0008] These and additional features provided by the embodiments described herein will be more fully understood in view of the following detailed description, in conjunction with the drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0009] The embodiments set forth in the drawings are illustrative and exemplary in nature and not intended to limit the subject matter defined by the claims. The following detailed description of the illustrative embodiments can be understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:
[0010] FIG. **1** schematically depicts a side view of an illustrative person support apparatus, according to one or more embodiments shown and described herein;
[0011] FIG. **2** schematically depicts a perspective view of the person support apparatus of FIG. **1**, including an upper frame in a partially inclined position and supporting a subject thereon, according to one or more embodiments shown and described herein;
[0012] FIG. **3** schematically depicts a perspective view of the person support apparatus of FIG. **1** having a movable seat accessory that is usable by a subject, according to one or more embodiments shown and described herein;
[0013] FIG. **4** schematically depicts a block diagram of an illustrative electronic control system of a person support apparatus providing control of various features, according to one or more embodiments shown and described herein;
[0014] FIG. **5** schematically depicts a perspective view of the person support apparatus of FIGS. **1-**

3 including a head section in a partially inclined position and supporting a subject thereon, according to one or more embodiments shown and described herein;
[0015] FIG. **6** schematically depicts a perspective view of the person support apparatus of FIGS. **1-3** with the head section in a fully inclined position and supporting a subject thereon, according to one or more embodiments shown and described herein;
[0016] FIG. **7** schematically depicts a perspective view of the person support apparatus of FIGS. **1-3** in a sitting configuration with the head section in the fully inclined position and a foot section in a fully lowered position and supporting a subject thereon, according to one or more embodiments shown and described herein;
[0017] FIG. **8** schematically depicts a perspective view of an illustrative mattress of the person support apparatus of FIGS. **1-3**, the mattress including a plurality of inflatable bladders, according to one or more embodiments shown and described herein;
[0018] FIG. **9** schematically depicts a perspective view of another illustrative mattress of the person support apparatus of FIGS. **1-3**, the mattress including a pair of inflatable bladders, according to one or more embodiments shown and described herein;
[0019] FIG. **10** schematically depicts a perspective view of an illustrative mattress of the person support apparatus of FIGS. **1-3**, the mattress including a single inflatable bladder, according to one or more embodiments shown and described herein;
[0020] FIG. **11** schematically depicts a partially transparent perspective view of an illustrative subject helper system of the person support apparatus of FIGS. **1-3**, according to one or more embodiments shown and described herein;
[0021] FIG. **12** schematically depicts an enlarged perspective view of an illustrative tensioning assembly of the subject helper system of FIG. **11** as shown in circle A of FIG. **11**, according to one or more embodiments shown and described herein;
[0022] FIG. **13** schematically depicts a perspective view of another illustrative subject helper system including a pair of tensioning assemblies, according to one or more embodiments shown and described herein;
[0023] FIG. **14** schematically depicts a partial perspective view of an illustrative friction mechanism of a subject helper system during an extension operation, according to one or more embodiments shown and described herein;
[0024] FIG. **15** schematically depicts a partial perspective view the friction mechanism of FIG. **14** during a retraction operation, according to one or more embodiments shown and described herein; and
[0025] FIG. **16** schematically depicts an exploded perspective view of an illustrative attachment device including a rotational potentiometer, according to one or more embodiments shown and described herein.

DETAILED DESCRIPTION

[0026] The present disclosure generally relates to person support apparatuses including various systems and components for use in allowing a subject to perform various muscle strengthening exercises, muscle stretching exercises, rehabilitation exercises, as well as other potential uses which are contemplated herein. The person support apparatus depicted in FIGS. **1-3** include a base frame, a plurality of lift members coupled to the base frame, and an upper frame movably supported by the plurality of lift members above the base frame. In some embodiments, the person support apparatus includes a rotatable head section that assists a subject in performing sit up exercises. In some embodiments, the person support apparatus includes a rotatable foot section that assists a subject in performing leg raise and leg curl exercises. In some embodiments, the person support apparatus includes at least one inflatable bladder for performing knee flexion exercises. Additionally, various accessories and straps may be utilized to assist in performing other upper body and lower body exercises while on the person support apparatus. Various embodiments of the person support apparatus and methods for performing exercises will be described in more detail herein with specific reference to the appended drawings.

Person Support Apparatus

[0027] Referring now to FIGS. **1-3**, a person support apparatus **10** according to various embodiments is depicted. The person support apparatus **10** can be, for example, a hospital bed, a stretcher, a subject lift, a chair, an operating table, or similar support apparatuses commonly found in hospitals, nursing homes, rehabilitation centers or the like. As shown in FIG. **1**, the person support apparatus **10** includes a base frame **12** including a plurality of wheels or casters **29** that are movable along a ground surface G. A plurality of lift members **14** extend from the base frame **12** and support an upper frame **16** above the base frame **12**. A first end lift member **14** is coupled to the base frame **12** and an opposite end of each lift member **14** is coupled to the upper frame **16**. Thus, the upper frame **16** is supported by the plurality of lift members **14** above the base frame **12** such that the upper frame **16** is movable relative to the base frame **12**. In embodiments, the ends of the lift members **14** may be rotatably attached to the base frame **12** and the upper frame **16** to allow the ends of the lift members **14** to rotate relative to the base frame **12** and the upper frame **16** as the upper frame **16** is raised. In various embodiments, the person support apparatus **10** includes a support surface **18** supported by the upper frame **16**. The support surface **18** supports a mattress **23** thereon. The support surface **18** has a head section **32**, a seat section **34**, and a foot section **36**, with the seat section **34** located between the head section **32** and the foot section **36**. As discussed herein, the head section **32** and the foot section **36** are rotatable relative to the seat section **34** and, in some embodiments, each of the head section **32**, the seat section **34**, and the foot section **36** are movable relative to the upper frame **16**. As such, the head section **32** rotates between a horizontal position, in which the head section **32** is substantially parallel to the seat section **34**, and a vertical position, in which the head section **32** is substantially perpendicular to the seat section **34**. The foot section **36** also rotates between a horizontal position, in which the foot section **36** is substantially parallel to the seat section **34**, and a vertical position, in which the foot section **36** is substantially perpendicular to the seat section **34**. As discussed in more detail herein, one or more strain gauges **203**, as shown in FIG. **3**, may be positioned in or on one of the mattress **23** or the head section **32** of the support surface **18** for detecting a force applied against the head section **32** of the support surface **18**. Similarly, one or more strain gauges **211** may also be positioned in or on one of the mattress **23** or the foot section **36** of the support surface **18** for detecting a force applied against the foot section **36** of the support surface **18**. When the strain gauges **203**, **211** are positioned in the support surface **18**, the strain gauges **203**, **211** are located proximate a subject facing surface **21** of the support surface **18**. The strain gauges **203**, **211** may be any suitable sensor for converting a force applied against the strain gauge **203**, **211** into a change in electrical resistance which can then be measured.

[0028] As used herein, “upper” and “above” are defined as the +Z direction of the coordinate axes shown in the drawings. “Lower” and “below” are defined as the −Z direction of the coordinate axes shown in the drawings. Similarly, it should be appreciated that when referring to the upper frame **16** being “raised,” the upper frame **16** is moving in the +Z direction of the coordinate axes shown in the drawings. Similarly, when the upper frame **16** is being “lowered,” the upper frame **16** is moving in the −Z direction of the coordinate axes shown in the drawings.

[0029] In embodiments, the lift members **14** include various linear actuators **13** (such as jack motors and the like) and related mechanical and electrical components extending between the upper frame **16** and the lift members **14** to facilitate extension of the lift members **14** and raising, lowering, and tilting of the upper frame **16**, and thus the support surface **18**, with respect to the base frame **12**. In other embodiments, the various linear actuators **13** may be provided entirely on the lifting members **14** to facilitate extension of the lift members **14**. Tilting of the support surface **18** relative to the base frame **12** may also be referred to herein as orienting the support surface **18** in a Trendelenburg orientation or a reverse Trendelenburg orientation. In a Trendelenburg orientation, the head section **32** of the support surface **18** is lower than the foot section **36** of the support surface

18 along the +/−Z axis depicted in the coordinate axes of the drawings. In other words, the head section **32** is closer to the ground surface G than the foot section **36** when in the Trendelenburg orientation. In a reverse Trendelenburg orientation, the foot section **36** of the support surface **18** is lower than the head section **32** of the support surface **18** such that the foot section **36** is closer to the ground surface G than the head section **32**.

[0030] At noted above, the head section **32** and the foot section **36** are each movable relative to the seat section **34**, which may also be movable relative to the upper frame **16**. For example, the head section **32** and the foot section **36** rotate to raise and lower between the respective horizontal positions and the vertical positions relative to the seat section **34**. The mattress **23** is flexible such that it can be articulated along with the support surface **18**. In some embodiments, the person support apparatus **10** includes one or more actuators or motors such as a head section actuator **43***a*, a seat section actuator **43***b*, and a foot section actuator **43***c* (FIG. **4**), which, in some embodiments, include linear actuators with electric motors to move the head section **32**, the seat section **34**, and the foot section **36**, respectively. It should be appreciated that these actuators **43***a*, **43***b*, **43***c* that operate the head section **32**, the seat section **34**, and the foot section **36** may be separate and distinct from the actuators that form the lift members **14** provided between the base frame **12** and the upper frame **16** for moving the upper frame **16** relative to the base frame **12**. Further, the actuators **43***a*, **43***b*, **43***c* operate to adjust the position of the support surface **18** with respect to the base frame **12** greater than that provided by the lift members **14** alone. Specifically, as shown in FIG. **1**, the head section actuator **43***a* may be provided between the head section **32** and the seat section **34** to facilitate rotation of the head section **32** relative to the seat section **34**. Also shown in FIG. **1**, the foot section actuator **43***c* may be provided between the foot section **36** and the seat section **34** to facilitate rotation of the foot section **36** relative to the seat section **34**. The actuators **43***a*, **43***b*, **43***c* are well-known in the hospital bed art and, thus, are not described in more detail herein. Alternative actuators or motors contemplated by this disclosure include hydraulic cylinders and pneumatic cylinders, for example. In the illustrative embodiment, the orientation of the seat section **34** may be fixed relative to the upper frame **16** as the support surface **18** moves between its various subject supporting positions including a horizontal position in which the head section **32** and the foot section **36** are both in the horizontal position, as shown in FIG. **1**, to support the subject in a supine position, and a chair position in which the head section **32** and the foot section **36** are both in the vertical position, as shown in FIG. **7**, to support the subject in a sitting up position.

[0031] In some embodiments, the foot section **36** is movable between an extended position and a retracted position with respect to the seat section **34**. For example, a linear actuator **44** may be coupled to the foot section **36** to enable the length of the person support apparatus **10**, particularly the support surface **18**, to be adjusted. For example, the foot section **36**, when extendable, may be retracted to decrease the length of the person support apparatus **10**, and may be extended to increase the length of the person support apparatus **10**. In embodiments, automatic (i.e., active) extension and retraction of the foot section **36** may be accomplished in response to actuation of the linear actuator **44**, which may automatically extend and retract the foot section **36** in response to signals received from a control unit. In embodiments, the foot section **36** may also be slidable with respect to the upper frame **16** such that the linear actuator **44** provides a passive assist in facilitating leg presses. As such, linear actuator **44** slides the foot section **36** away from the seat section **34** in response to receiving a force, such as a subject pressing against the foot section **36**.

[0032] The person support apparatus **10** may further include side rails **24**, a headboard **25**, and a footboard **26**. The headboard **25** may be coupled to the upper frame **16** proximate the head section **32** of the support surface **18**. The side rails **24** and the footboard **26** may be coupled to the support surface **18**, with the footboard **26** at an end of the foot section **36** and the side rails **24** located between the headboard **25** and the footboard **26**.

[0033] In some embodiments, the side rails **24** may include a plurality of sections. For example, the side rails **24** may each include a head side rail **28** positioned at the head section **32** of the support surface **18**, and an intermediate side rail **30** positioned at the seat section **34** of the support surface **18** between the head side rail **28** and the foot section **36**. The head side rail **28** includes a head side rail body **38** and a head side rail movement assembly **40**. The head side rail movement assembly **40** movably couples the head side rail body **38** to the head section **32** of the support surface **18** and permits movement of the head side rail **28** between a deployed position and a stowed position. When the head side rail **28** is in the deployed position, at least a portion of the head side rail body **38** is positioned above the support surface **18**. When the head side rail **28** is in the stowed position, the head side rail body **38** is positioned below at least the mattress **23**. In embodiments, the head side rail body **38** may also be positioned below the support surface **18** when in the stowed position. In some embodiments, the head side rail movement assembly **40** includes a locking mechanism (not shown) that maintains the head side rail **28** in the deployed position and/or the stowed position.

[0034] The intermediate side rail **30** includes an intermediate side rail body **39** and an intermediate side rail movement assembly **41**. The intermediate side rail movement assembly **41** movably couples the intermediate side rail body **39** to the seat section **34** of the support surface **18** and permits movement of the intermediate side rail **30** between a deployed position and a stowed position, as shown in FIG. **3**. When the intermediate side rail **30** is in the deployed position, at least a portion of the intermediate side rail **30** is positioned above the support surface **18**. When the intermediate side rail **30** is in the stowed position, the intermediate side rail body **39** is positioned below at least the mattress **23**. In embodiments, the intermediate side rail **30** may also be positioned below the support surface **18** when in the stowed position. In some embodiments, the intermediate side rail movement assembly **41** includes a locking mechanism (not shown) that maintains the intermediate side rail **30** in the deployed position and/or the stowed position.

[0035] The person support apparatus **10** further includes at least one exterior user interface **50**A located on an outer surface of one of the intermediate side rails **30**, at least one interior user interface **50**B located on the opposite inner or mattress facing surface of one of the intermediate side rails **30**, and at least one foot user interface **50**C located on a mattress facing surface of the footboard **26**. The exterior user interface **50**A, the interior user interface **50**B, and the foot user interface **50**C may be referred to generally herein as user interfaces **50**. It should be understood that the user interfaces **50** may be located elsewhere on the person support apparatus **10**. The user interfaces **50** may each be configured for control and/or display of the features of the person support apparatus **10**. As such, each of the user interfaces **50** includes user interface hardware components such as, for example, buttons, joysticks, touchscreens, and other suitable user controls for operating the user interfaces **50** and, thus, the person support apparatus **10**.

[0036] As noted hereinabove, the user interfaces **50** may be in the form of or include a display **202**. The display **202** may be a touchscreen, LCD screen, or other suitable display. In addition, the user interfaces **50** display information about a subject's use of the pressure surface **60** for therapeutic strength training and/or monitoring. For example, the user interfaces **50** can display the number of applications of force to the pressure surface **60**, the length of time that the pressure surface **60** was used by the subject, a stroke length, a percent of completion of an exercise or therapy routine, and/or the amount of force that the subject applied to the pressure surface **60**. Additionally, the user interfaces **50** may display historical trends indicative of changes over time, for example, by hour, by day, or by week. Moreover, the user interfaces **50**, particularly the interior user interface **50**B and/or the foot user interface **50**C, may display words of encouragement regarding the use of the pressure surface **60** (e.g., “Keep It Up”, “Almost Done”, “Just One More”, “You Can Do It”, “Great Job”, etc.) In some embodiments, the user interfaces **50** may include a speaker **201**. The speaker **201** can be used for providing audible signaling to a subject positioned in the person support apparatus **10**. For example, in one embodiment, the user interfaces **50** may play audible words of encouragement through the speaker **201**. In other embodiments, the user interfaces **50** may give audible indicators related to exercise progress to a subject.

[0037] In some embodiments, the person support apparatus **10** includes a subject helper system **400** for facilitating pull down stretches. The subject helper system **400** generally includes a tube **402** having a first end **404** and a second end **406**. As shown, the first end **404** of the tube **402** is mounted to the headboard **25** and extends above and over the head section **32** of the support surface **18**. However, the tube **402** may be coupled to the person support apparatus **10** proximate the first end **404** of the tube **402** at any other suitable location such as, for example, the base frame **12** or the upper frame **16**. The subject helper system **400** includes at least one belt **408** extending through the tube **402** and out of the tube proximate the second end **406** of the tube **402**. A pair of handles **410** is attached to an end of the belt **408** to facilitate gripping by the subject. The subject helper system **400** includes a tensioning assembly, as described in more detail herein, for providing resistance when performing exercises using the subject helper system **400**.

[0038] As the person support apparatus **10** is positioned into a reverse Trendelenburg orientation, the foot section **36** of the support surface **18** may come into close contact with the ground surface G. Thus, in some embodiments, the person support apparatus **10** includes a support component **310** to further stabilize the person support apparatus **10** and prevent the footboard **26** from being damaged upon contact with the ground surface G. In some embodiments, the support component **310** is provided on a lower edge of the footboard **26** at a medial location of the footboard **26** along the +/−Y axis of the coordinate axes depicted in the drawings to prevent the footboard **26** from directly contacting the ground surface G when the foot section **36** is rotated to the vertical position or the person support apparatus **10** is in the reverse Trendelenburg orientation. In other embodiments, the support component **310** is provided on a lower surface of the upper frame **16** to prevent the upper frame **16** from contacting the ground surface G in instances in which the footboard **26** is removed or in a retracted position in which the upper frame **16** would contact the ground surface G prior to the footboard **26**. In some embodiments, the support component **310** is a support caster similar to casters **29**. Although only a single support component **310** is illustrated, a plurality of support components **310** may be provided on the lower edge of the footboard **26**.

[0039] In some embodiments, as shown in FIG. **2**, the person support apparatus **10** includes at least one restraint strap **312**. As shown, the person support apparatus **10** includes a pair of restraint straps **312** with one of the restraint straps **312** positioned proximate a torso of the subject and the other of the restraint straps **312** positioned proximate the knees of the subject. Specifically, one of the restraint straps **312** is provided proximate a location of the mattress **23** where the seat section **34** meets the foot section **36** as this is where the subject's knees will be located. Additionally, the other one of the restraint straps **312** is provided proximate a location of the mattress **23** where the seat section **34** meets the head section **32** as this is where the subject's waist will be located. Each restraint strap **312** is secured at opposite ends thereof to the person support apparatus **10**. In some embodiments, opposite ends of the restraint strap **312** are secured to adjacent sides or an underside surface of the mattress **23**. In other embodiments, opposite ends of the restraint strap **312** are secured to adjacent sides of the support surface **18**, an upper surface of the support surface **18** facing the mattress **23**, or a lower surface of the support surface **18** facing the upper frame **16**. It is to be understood that opposite ends of the restraint strap **312** may be secured using any suitable means, such as mechanical fasteners. As such, each end of the restraint strap **312** may be removably attachable to the mattress **23** or the support surface **18** by detaching the mechanical fasteners or other securing mechanism. This allows for the restraint strap **312** to be moved between the different positions shown in FIG. **2** to be located at either the torso or the knees of the subject. Permitting the restraint strap **312** to be detached from the person support apparatus **10** also allows for different restraint straps having varying sizes to be used, for the restraint strap **312** to be removed when not necessary, or for attaching multiple restraint straps **312** to the person support apparatus **10**, particularly one located at the knees of the subject and one located at the waist of the subject.

[0040] Alternatively, the ends of the restraint strap **312** may be permanently fixed to the mattress

23 by being sewn thereto. When the restraint strap **312** is positioned at the subject's knees, the restraint strap **312** has a length defined by a distance between opposite ends of the restraint strap **312**. To provide the correct length for the restraint strap **312**, the subject may attach a particular restraint strap **312** that is appropriate for the size and needs of the subject. Alternatively, in some embodiments, the length of the restraint strap **312** itself may be adjustable. The length of the restraint strap **312** may be adjusted by reattaching one or both ends of the restraint strap **312** to the person support apparatus **10** at different positions along the restraint strap **312** or adjusting a mechanism, such as a buckle, to increase or decrease the length of the restraint strap **312**. In embodiments, the restraint strap **312** has an elasticity to allow a subject to perform shallow knee bends and restrict the subject from over bending at the knee. In some embodiments, the restraint strap **312** is formed from an inelastic material to prevent stretching as the subject performs the shallow knee bend. In other embodiments, the restraint strap **312** is formed from an elastic material to permit limited stretching while preventing overextending of the subject's knees.
[0041] As shown in FIG. **3**, in some embodiments, the person support apparatus **10** includes an exercise pad **260** for facilitating shallow knee bends and allowing the subject to move atop the mattress **23** along the +/−X axis of the coordinate axes depicted in the drawings. The exercise pad **260** may be used in combination with the restraint strap **312**, which is shown in transparency and attached to the mattress **23**. Thus, the exercise pad **260** is positioned on the mattress **23** proximate the seat section **34** and/or the foot section **36** based on a degree of bending in the subject's knees. The exercise pad **260** has a width extending along the +/−Y axis of the coordinate axes depicted in the drawings. The width of the exercise pad **260** is equal to or less than a width of the mattress **23** such that the exercise pad **260** does not interfere with the side rails **24** when the exercise pad **260** moves along the mattress **23**.
[0042] In this embodiment, the exercise pad **260** includes a base **262** and a seat **264** affixed to an upper surface **266** of the base **262**. A bottom surface **268** of the base **262**, opposite the upper surface **266**, is formed from a low friction material such as, for example, nylon, satin, silk, and the like, to easily allow the exercise pad **260** to slide across the mattress **23**. The seat **264** may include a foam body for providing comfort to the subject while sitting on the seat **264**. As shown, opposite ends of at least one strap **270** may be attachable to the seat **264** to secure the subject to the exercise pad **260**. However, in some embodiments, the strap **270** may extend from the base **262**. It is to be understood that the exercise pad **260** is an accessory device that may be easily removable from the person support apparatus **10** such that the person support apparatus **10** can be used for any of the other exercises described herein without being limited to being used with the exercise pad **260**.
[0043] In other embodiments, the exercise pad **260** may include only one of the base **262** or the seat **264**. When only the base **262** is provided, the subject sits on the upper surface **266** of the base **262** and slides along the mattress **23**. Alternatively, when only the seat **264** is provided, the seat **264** itself slides along the mattress **23** instead of the base **262**.
Electronic Control Unit
[0044] FIG. **4** is a block diagram of an embodiment of an electronic control system **110** that provides control of various functions of the person support apparatus **10** described herein. In embodiments including an extendible foot section **36**, the electronic control system **110** operates and monitors the linear actuator **44** to extend and retract the extendible foot section **36**. The electronic control system **110** may further operate and monitor the lift members **14** to move the upper frame **16** relative to the base frame **12**. Foot pedal controls **56** may be provided on the base frame **12**, as shown in FIG. **1**, at any suitable location for an operator to depress with his or her foot. The foot pedal controls **56**, when provided, are communicatively coupled to the lift members **14** and/or the linear actuators **13** for operating the lift members **14** and raising and lowering the upper frame **16** relative to the base frame **12**. In various embodiments, the electronic control system **110** further operates and monitors the head section actuator **43***a*, the seat section actuator **43***b*, and the foot section actuator **43***c* to pivot the head section **32**, the seat section **34**, and the foot section

36, respectively, relative to the upper frame **16**.

[0045] In embodiments, the foot user interface **50**C may be communicatively coupled to a pressure surface **60** which is mounted to the footboard **26** of the person support apparatus **10**. The pressure surface **60** may include a sensor **59**, such as a flexing force pressure sensor, which measures the amount of force applied to the sensor **59**. The sensor **59** may be, for example, an integrated load cell sensor such as those that measure weight. However, other force-sensing technologies may be utilized, such as pressure-sensitive resistors, capacitive force sensors, and piezoelectric transducers, for example.

[0046] In various embodiments, a subject positioned on the person support apparatus **10** can push upon the pressure surface **60** and the amount of force imparted to the pressure surface **60** is detected by the sensor **59**. The resulting force, the number of applications of force (i.e., repetitions), and other data detected with the sensor **59** may be communicated to the foot user interface **50**C, processed and/or displayed, as well as stored in memory of the electronic control system **110**.

[0047] A controller area network system **222** may execute a control program **224** to control the various actuators and components. Such a system can include one or more controller area network (CAN) controller nodes to control the various actuators. If multiple controller nodes are utilized, the nodes can communicate with one another via serial bus connections. The control program **224** may further include additional control software or other logic that indicates desired control logic for the person support apparatus **10** such as, for example, to control which actuators to operate in response to which user inputs, what displays on the user interfaces **50** at what times, how to convert data from the sensor **59** into a subject's weight, and what alarms to sound via the speaker **201** and/or the user interfaces **50** in response to inputs (side rails up/down detected by side rail position detectors **57**, brakes set/notset, bed low/notlow, person position). The control program **224** may be stored in the electronic control system **110**, or may be stored remotely and accessed by the electronic control system **110** via a network connection.

[0048] A microprocessor **200** communicates with the controller area network system **222** via a CAN interface circuit **220**. Accordingly, the microprocessor **200** can receive inputs indicating the force provided by the person on the therapy mechanisms described herein, and allow for feedback to be provided to the subject during such therapy. The microprocessor **200** includes processing components operable to receive and execute machine-readable instructions, such as those stored in a non-volatile memory component **204** and/or a volatile memory component **209**.

[0049] The CAN interface circuit **220** allows the microprocessor **200** to deliver input commands to the controller area network system **222** to perform a variety of functions, such as to move an actuator or set an alarm signal. The CAN interface circuit **220** further enables the controller area network system **222** to deliver actuator status information and other information to the microprocessor **200**, which may be displayed on at least one of the user interfaces **50**. The CAN interface circuit **220** includes appropriate circuitry or integrated circuitry that allows the microprocessor **200** to communicate with the controller area network system **222**. The CAN interface circuit **220** may be, for example, a high speed CAN transceiver.

[0050] The microprocessor **200** communicates with and drives the display **202** of a corresponding one of the user interfaces **50**. The display **202** includes appropriate driver or interface circuitry for driving displays. Additionally, the microprocessor **200** may drive a speaker amplifier **205**, via an audio interface **207**, to permit audio through the speaker **201**. Accordingly, alarms, music, nature sounds and other sounds can be driven by the microprocessor **200** through the speaker **201** and/or the user interfaces **50**.

[0051] The electronic control system **110** of the person support apparatus **10** may include a Wi-Fi interface **208**. The Wi-Fi interface **208** allows the microprocessor **200** to communicate with a hospital server **111** (and/or to other equipment) via a wireless local area network communication protocol.

[0052] In some embodiments, the electronic control system **110** may further include a power supply **135**. The power supply **135** may be, for example, a battery or connection to an alternating current power source. The power supply **135** may provide power to various components of the electronic control system **110**. Additionally, the power supply **135** may provide power to an inductive power transmitter **139**. The inductive power transmitter **139** can provide power to an inductive power receiver **137** incorporated into one or more features described herein. For example, an inductive power transmitter **139** may be supported by the upper frame **16**, and an inductive power receiver **137** may be supported by the footboard **26**. The inductive power transmitter **139** is connected with the power supply **135** and induces power in the inductive power receiver **137** to operate the foot user interface **50**C of the footboard **26**. Accordingly, a variety of footboards **26** having electronics may be attached to the person support apparatus **10**, and interchanged therewith without need for physically plugging in the footboards **26** or having them connect directly with the electronic control system **110**. Rather, the power to the footboard **26** may be provided wirelessly through the inductive power transmitter **139** and the inductive power receiver **137**, and the footboard **26** may operate as a standalone module.

[0053] Other components or parts of the person support apparatus **10** may be powered by such power transmitter/receiver arrangements, such as the headboard **25**, the side rails **24**, the user interfaces **50**, and the like. Examples of wireless power transmitters and receivers are those having transmit and receive coils respectively, such as those provided by Wurth Electronics and having Texas Instruments inductive transmitter and receiver manager integrated circuits.

[0054] Having described an exemplary person support apparatus in general, various features of the person support apparatus **10** including exercise therapy configurations in accordance with one or more embodiments and methods of using the person support apparatus **10** will now be described.

Handles

[0055] As shown in FIGS. **5-7**, in some embodiments, the person support apparatus **10** includes one or more side handles **316**. The side handles **316** are generally positioned at opposite sides of the mattress **23** in a location that is accessible to a subject when positioned on the mattress **23**. That is, the side handles **316** are generally positioned in a location to be reachable by a subject when the subject is positioned on the mattress **23**. The side handles **316** may be positioned between the head section **32** and the foot section **36**. For example, the side handles **316** may be attached or affixed to the side rails **24**, the support surface **18**, or the upper frame **16**. In some embodiments, the side handles **316** may be molded as an extension of one or more components, such as, for example, the side rails **24**, the support surface **18**, or the upper frame **16**.

[0056] In some embodiments, the side handles **316** may be fixed in position such that the side handles **316** are not movable. In other embodiments, the side handles **316** may be adjustable such that they may be moved to a position suited to a particular subject (e.g., moved toward to the head section **32** or toward to the foot section **36** such that the subject can reach the side handles **316**). In some embodiments, the side handles **316** may be coupled to one or more link arms that are coupled to one or more actuators or motors that facilitate movement of the side handles **316** (e.g., to facilitate movement of the side handles **316** such that a subject moves in a rowing type motion).

[0057] The present disclosure is not limited to any particular shape, size, or configuration or the side handles **316**. Thus, various shapes, sizes, and configurations are contemplated. In some embodiments, the side handles **316** may be shaped, sized, configured, and arranged such that a subject can grasp the side handles **316** for support and/or stabilization. In some embodiments, the side handles **316** may be shaped, sized, configured, and arranged such that, when the person support apparatus **10** is in a reverse Trendelenburg position, the subject may grasp the side handles **316** to complete dip exercises by lowering his/her body slightly via knee bending and using tricep and bicep muscles to push back upwards. In some embodiments, the side handles **316** may be fitted with one or more accessories, such as, for example, a grip or the like.

[0058] In some embodiments, the person support apparatus **10** also includes one or more head handles **318**. The head handles **318** are generally positioned proximate an end of the mattress **23** proximate the headboard **25**. For example, the head handles **318** may be attached or affixed to the head section **32** of the support surface **18**, the headboard **25**, or the upper frame **16**. When the head handles **318** are attached or affixed to the head section **32** of the support surface **18**, the head handles **318** remain reachable when the head section **32** rotates toward a raised position relative to the seat section **34**. In some embodiments, the head handles **318** may be molded as an extension of one or more components, such as, for example, the headboard **25**, the support surface **18**, or the upper frame **16**.

[0059] In some embodiments, the head handles **318** may be fixed in position such that the head handles **318** are not movable. As such, the head handles **318** may be useful in pushing or otherwise maneuvering the person support apparatus **10** by someone other than the subject on the mattress **23**. In other embodiments, the head handles **318** may be adjustable such that they can be moved to a position suited to a particular subject (e.g., moved across the head section **32** in a direction toward the foot section **36** such that subjects of different heights can reach the head handles **318**). In some embodiments, the head handles **318** may be coupled to one or more link arms that are coupled to one or more actuators or motors that facilitate movement of the head handles **318** (e.g., to facilitate movement of the head handles **318** such that a subject moves in a pulling type motion).

[0060] As with the side handles **316**, the head handles **318** are not limited to any particular shape, size, or configuration. Thus, various shapes, sizes, and configurations are contemplated. In some embodiments, the head handles **318** may be shaped, sized, configured, and arranged such that a use can grasp the head handles **318** for support and/or stabilization. In some embodiments, the head handles **318** may be shaped, sized, configured, and arranged such that, when the person support apparatus **10** is in a reverse Trendelenburg position, the subject may grasp the head handles **318** to complete pull up exercises by using tricep and bicep muscles to pull upwards. In some embodiments, the head handles **318** may be fitted with one or more accessories, such as, for example, a grip or the like.

Sit up Assistance

[0061] As illustrated in FIG. **5**, the person support apparatus **10** is illustrated during a sit up assistance exercise in which the head section **32** assists the subject in performing sit ups in some embodiments. In such embodiments, one or more strain gauges **203** may be positioned in or on one of the mattress **23** or the head section **32** of the support surface **18**. The strain gauge **203** is in communication with the controller area network system **222** and monitors a pressure applied against the head section **32** of the support surface **18** by the subject. Initially, the strain gauge **203** detects a baseline pressure. As the subject lifts his or her upper body away from the head section **32** during a sit up, the strain gauge **203** detects a change or reduction in pressure relative to the baseline pressure. When a change in pressure exceeding a predetermined threshold or reduction in pressure is detected (e.g., due to the subject attempting a sit up motion under his or her own strength), the head section actuator **43***a* is activated in a first direction to rotate the head section **32** toward the vertical position. Specifically, the predetermined threshold may be a percentage of the baseline pressure or a particular magnitude of a change in pressure relative to the baseline pressure. As such, the change in pressure is determined by identifying a pressure detected by the strain gauge **203** at a particular time and comparing that pressure to the baseline pressure. In the illustrative embodiment, the head section **32** raises between 30 degrees and 50 degrees to assist the subject in performing the sit up. It should be noted that other ranges of head section movement are contemplated to assist the subject. For example, the range may be any range between 0 degrees and 90 degrees. As discussed herein, the head section actuator **43***a* is only activated to rotate the head section **32** toward the vertical position and away from the upper frame **16** when the strain gauge **203** detects the change in pressure against the support surface **18** exceeds the predetermined reduction in pressure. As such, the head section actuator **43***a* may be operated as long as the predetermined reduction in pressure is detected or until a predetermined maximum predetermined angle is reached. If the subject begins to rest back on the head section **32** of the support surface **18**, such that the strain gauge **203** does not detect the predetermined reduction in pressure applied against the head section **32** of the support surface **18** prior to reaching the predetermined maximum angle, the head section actuator **43***a* may be slowed or stopped to slow or stop the rotation of the head section **32**.

[0062] The amount of assistance provided by the person support apparatus **10** during the subject's sit up exercise may be altered by adjusting the predetermined reduction in pressure necessary to activate the head section actuator **43***a*. For example, the head section actuator **43***a* may be activated at the detection of any reduction in pressure. In other embodiments, the predetermined reduction in pressure may be set by a caregiver or the subject to any value or percentage, e.g. 10% reduction in pressure, 15% reduction in pressure, 20% reduction in pressure, etc. In other embodiments, one or more force sensitive resistors (FSRs) or other types of sensors are provided on or in the mattress **23** or the head section **32** in addition to, or in lieu of, the one or more strain gauges **203**.

[0063] In some embodiments, the head section **32** may also assist the subject with performing a second half of the sit up in the reverse direction as the subject moves back toward a horizontal position. In doing so, a predetermined maximum angle for the sit up is selected, such as 45 degrees when performing a partial sit up or 90 degrees when performing a full sit up. The predetermined maximum angle may be selected by operating any one of the user interfaces **50** or any other suitable user controls. Once the head section **32** reaches the predetermined maximum angle, the head section actuator **43***a* is deactivated to stop the head section **32** from rotating toward the vertical position. Thereafter, the head section actuator **43***a* is activated in an opposite second direction to rotate the head section **32** in the opposite direction toward the horizontal position to lower the head section **32** when the strain gauge **203** or the FSRs detect the predetermined reduction in pressure.

[0064] If the subject does not wish to move back toward the horizontal position after each sit up, a predetermined minimum angle may be selected in the same manner in which the predetermined maximum angle was selected. When the head section **32** reaches the predetermined minimum angle, the head section **32** will stop rotating toward the horizontal position. If the subject begins to rest back on the head section **32** prior to reaching the predetermined minimum angle so that the predetermined reduction in pressure is no longer detected, the head section actuator **43***a* may be slowed or stopped to slow or stop the rotation of the head section **32**. Once the predetermined minimum angle is reached, further rotation of the head section **32** toward the horizontal position is prevented and the head section **32** will begin to rotate back toward the vertical position when the strain gauge **203** or the FSRs detect the predetermined reduction in pressure. The subject is also able to operate any one of the user interfaces **50** to select the number of repetitions, the length of time, the amount of assistance, the predetermined maximum and minimum angles, and any other parameters at which the head section **32** will operate during a sit up exercise. Data related to the subject's core exercise may be displayed on at least one of the user interfaces **50**.

[0065] With more particularity, as noted herein, a subject's exercise regimen may be entered into any of the user interfaces **50**. The exercise regimen may include a number of sets and a number of repetitions per set. The exercise regimen may also include the predetermined reduction in pressure. It is to be appreciated that the subject's exercise regimen may also be remotely set and transmitted to the person support apparatus **10** from any suitable wired or wireless device, such as the hospital server **111**, a central computer, or a caregiver's mobile device. It is to be understood that the exercise regimen may also be programmed by a caregiver using any other suitable operating controls.

Leg Lift/Curl Assistance

[0066] As described above, the head section **32** and the foot section **36** of the support surface **18** each rotate with respect to the seat section **34** via the head section actuator **43***a* and the foot section actuator **43***c*, respectively. Referring now to FIGS. **6** and **7**, in various embodiments, the foot section **36** may be configured to assist a subject in performing leg raise and/or leg curl exercises in a similar manner to that described above with respect to the head section **32** assisting in performing sit up exercises. Thus, the foot section **36** may assist the subject in performing leg raises in which the subject raises his or her legs off of the foot section **36** and/or leg curls in which the subject lowers, by curling and/or pressing, his or her legs onto the foot section **36**. In this embodiment, one or more strain gauges **211** may be positioned on or in one of the mattress **23** or the foot section **36** of the support surface **18**. Each strain gauge **211** monitors a pressure applied by the subject against the foot section **36**. Initially, the strain gauge **211** detects a baseline pressure. With the person support apparatus **10** initially in the chair configuration, as shown in FIG. **10**, the subject raises his or her legs and the strain gauge **211** detects a reduction in pressure against the foot section **36** relative to the baseline pressure. When a predetermined reduction in pressure is detected (e.g. due to the subject attempting to raise his or her legs under his or her own strength), the foot section actuator **43***c* is activated in a first direction to raise the foot section **36** toward the horizontal position, thereby assisting the subject in performing the leg raise exercise. Specifically, the predetermined threshold may be a percentage of the baseline pressure or a particular magnitude of a change in pressure relative to the baseline pressure. As such, the change in pressure is determined by identifying a pressure detected by the strain gauge **211** at a particular time and comparing that pressure to the baseline pressure. In the illustrative embodiment, the foot section **36** rotates from 90 degrees or the vertical position (FIG. **10**) to 180 degrees or the horizontal position (FIG. **9**) during the leg raise exercise. It should be noted that other ranges of foot section movement are contemplated to assist the subject. For example, the range may be any range between 90 degrees and 180 degrees such as when the subject is not capable of fully extending or bending his or her legs. As discussed herein, the foot section actuator **43***c* is only operated to rotate the foot section **36** when the strain gauge **211** detects the predetermined reduction in pressure. As such, the foot section actuator **43***c* may be operated as long as the predetermined reduction in pressure detected.

[0067] The assistance provided by the person support apparatus **10** during the leg raise exercise may be altered by adjusting the predetermined reduction in pressure. For example, the foot section actuator **43***c* may be activated to rotate the foot section **36** toward the horizontal position once any reduction in pressure is detected. In other embodiments, the predetermined reduction in pressure may be set by the caregiver or the subject to any value or percentage, e.g. 10% reduction in pressure, 15% reduction in pressure, 20% reduction in pressure, etc. In other embodiments, one or more force sensitive resistors (FSRs) or other types of sensors are provided on or in the mattress **23** or the foot section **36** in addition to, or in lieu of, the one or more strain gauges **211**.

[0068] In addition to assisting the subject with performing a leg raise exercise, in some embodiments, the foot section **36** also assists the subject with performing a leg curl exercise as the subject rotates his or her legs toward the bent position, thereby rotating the foot section **36** toward the vertical position. In doing so, a predetermined maximum angle between 90 degrees and 180 degrees is selected such as, for example, 180 degrees when rotating the foot section **36** to the horizontal position. In addition, a predetermined minimum angle between 90 degrees and 180 degrees is selected such as, for example, 90 degrees when rotating the foot section **36** to the vertical position. The predetermined maximum and minimum angles may be selected by operating any one of the user interfaces **50** or any other suitable user controls. Once the foot section **36** reaches the predetermined maximum angle, the foot section actuator **43***c* is deactivated from rotating the foot section **36** toward the horizontal position. Thereafter, the foot section actuator **43***c* is operated in a reverse direction to rotate the foot section **36** toward the vertical position when the at least one strain gauge **211** or the FSRs detect a change in pressure exceeding a predetermined threshold or increase in pressure. The subject is able to operate any one of the user interfaces **50** to select the frequency, the length of time, the amount of assistance during the leg raise/curl exercises, the predetermined maximum and minimum angles of incline and decline, the predetermined reduction or increase in pressure, and any other parameters at which the foot section **36** will operate during the leg raise/curl exercise. Thus, based on the selected number of repetitions or length of time for the leg raise/leg curl exercises, when the foot section **36** reaches the predetermined minimum angle, the foot section actuator **43***c* will deactivate and return to rotate the foot section **36** toward the horizontal position when the at least one strain gauge **211** or the FSRs detect the predetermined reduction in pressure.

[0069] Control of the foot section actuator **43***c* may operate continuously. For example, the foot section actuator **43***c* may be operated as long as the predetermined reduction or increase in pressure is detected. If the subject begins to lower his or her legs onto the foot section **36** prior to reaching the maximum angle so that the predetermined reduction in pressure is no longer detected, the foot section actuator **43***c* may be slowed or stopped to slow or stop the rotation of the foot section **36** toward the horizontal position. Similarly, if the strain gauge **211** fails to detect a change in pressure exceeding a predetermined increase in pressure applied against the foot section **36** prior to reaching the predetermined minimum angle, the foot section actuator **43***c* may be slowed or stopped to slow or stop the rotation of the foot section **36** toward the vertical position. Data related to the subject's core exercise may be displayed on at least one of the user interfaces **50**. Additionally, as set forth above, at least one of the user interfaces **50** may communicate with the subject throughout the exercise to encourage the subject and notify the subject of progress.

[0070] With more particularity, the subject's exercise regimen may be entered into the user interfaces **50**. The exercise regimen may include a number of sets and a number of repetitions per set. The exercise regimen may also include the predetermined reduction in pressure for leg lifts and for leg curls. It is to be appreciated that the subject's exercise regimen may also be remotely set and transmitted to the person support apparatus **10** from any suitable wired or wireless device, such as the hospital server **111**, a central computer, or a caregiver's mobile device. It is to be understood that the exercise regimen may also be programmed by a caregiver using any suitable operating controls. The exercise regimen is communicated to the electronic control system **110**, which monitors the strain gauge **211**.

Bladder

[0071] Referring now to FIG. **8**, in various embodiments, the mattress **23** of the person support apparatus **10** has a top surface **23**A, an opposite bottom surface **23**B, a head end **23**C, a foot end **23**D, and a pair of sides **23**E, **23**F. When the mattress **23** is positioned on the support surface **18**, as shown in FIG. **1**, the head end **23**C of the mattress **23** is positioned proximate the head section **32** of the support surface **18** and the foot end **23**D of the mattress **23** is positioned proximate the foot section **36** of the support surface **18**. The mattress **23** has a knee support area **81** located at a position that aligns with the knees of the subject when laying on the mattress **23**. Thus, the knee support area **81** is located closer to the foot end **23**D of the mattress **23** than the head end **23**C of the mattress **23**.

[0072] In some embodiments, the mattress **23** includes at least one bladder **82** provided on or within the mattress **23** and located at the knee support area **81** for receiving a subject's legs to ensure that the person is properly positioned on the person support apparatus **10**, as well as providing passive stretching. As shown in FIG. **8**, three bladders **82** are provided in the mattress **23** and operable between an inflated state in which the bladders **82** extend above the top surface **23**A of the mattress **23**, as shown, and a deflated state in which the bladders **82** do not extend above the top surface **23**A of the mattress **23**. Together, when the bladders **82** are in the inflated state, the bladders **82** form a recess **80** in the top surface **23**A of the mattress **23** between each adjacent pair of bladders **82**. The recesses **80** have a depth defined by a height of the bladders **82** when in the inflated state. Thus, as the bladders **82** are inflated to a greater height, the depth of the recess **80** between adjacent bladders **82** becomes greater. Each of the recesses **80** receive and guide a subject's legs. More particularly, the recesses **80** may be formed to fit the subject's calves. When the subject's legs are placed between adjacent bladders **82** and within in the recesses **80**, the bladders **82** maintain the subject's legs in longitudinal position while exercising/pushing against the footboard **26**. Accordingly, the mattress **23** may provide passive guidance to the subject to enable the subject to utilize the footboard **26** or another exercise therapy feature described herein with proper form.

[0073] In some embodiments, the bladders **82** may be coupled to a bladder inflator **223** such as, for example, a pneumatic pump, in communication with the electronic control system **110**. The bladder inflator **223** is configured to selectively inflate and deflate the bladders **82** by providing a fluid, such as a liquid or a gas, into the bladders **82** to cause the bladders **82** to inflate. As a non-limiting example, when the person support apparatus **10** is being used to perform exercises, such as the leg press exercise described herein above, the bladders **82** may be inflated to provide passive guidance to the subject. However, when the person support apparatus **10** is not being used for exercises (such as when the person support apparatus **10** is being used conventionally as a bed) the bladders **82** may be deflated, thereby providing a more conventional support surface. Moreover, even when the person support apparatus **10** is not being used for exercises, the bladders **82** may be inflated by activating the bladder inflator **223**. This keeps the subject's legs in a fixed position or the knees in a slightly bent position when the subject's legs are positioned between adjacent bladders **82** and within respective recesses **80**.

[0074] In another embodiment, as shown in FIG. **9**, a mattress **23**′ is shown including a pair of bladders **82** in which each bladder **82** is to be positioned directly under a corresponding knee of the subject as opposed to opposite sides of the subject's legs. In this embodiment, the bladders **82** are utilized to provide passive exercise to bend one or both of the subject's legs at the knee. This is beneficial for subjects that are unable to get out of bed to stretch, bend, or otherwise move his or her legs to ensure adequate blood circulation. In addition, providing this stretching/bending exercise to the subject's legs ensures that the tendons behind the knee do not become stiff which can lead to further complications. In doing so, the bladders **82** may be repeatedly inflated and deflated. When one of the bladders **82** are inflated, the bladder **82** applies a force against the subject's leg causing the subject's knee to bend at the respective bladder **82** in a direction away from the mattress **23**. Alternatively, when the bladder **82** is deflated, the bladder reduces the force against the subject's leg and permits the subject's knee to straighten and the leg to return to its initial horizontal position. It is to be appreciated that each bladder **82** may be continuously circulated between the inflated state and the deflated state either in unison or independently of the other bladder **82**.

[0075] As stated above, each of the bladders **82** may alternate between the inflated state and the deflated state in opposition of one another, thereby alternating between stretching the subject's right and left legs. In this case, the bladder **82** under each leg may be repeatedly inflated and deflated for a specified number of repetitions or for a specified period of time. Alternatively, employing the pair of bladders **82** allows for different stretching routines to be provided to each leg. The subject is able to utilize any suitable controls, such as the user interfaces **50**, to set either one or both of the bladders **82** to inflate and deflate for any number of repetitions and for a predetermined period of time to provide the necessary stretching the subject's legs. In addition, each bladder **82** may be set to inflate and deflate at various intervals to provide a desired resting period between inflation and deflation. Further, the subject may set the rate at which the bladders **82** will inflate to prevent too quick of an inflation or deflation, thereby straining the subject's legs. Even further, the subject may also set the degree of inflation to cause the bladders **82** to inflate to a greater or lesser height. As noted above, it is to be understood that each of the bladders **82** can be assigned a specific set of bladder operating parameters, thereby providing different stretches to each leg based on the specific injury and the rehabilitation needs of the subject. For example, it may be desired that the bladder **82** below the right leg inflates to a higher degree, at twice the rate, or for twice as long as the bladder **82** below the left leg.

[0076] In some embodiments, as illustrated in FIG. **10**, a mattress **23**″ may include only a single bladder **82** at the knee support area **81** and extending in a direction transverse to a longitudinal axis of the mattress **23**″. Thus, as the bladder **82** is inflated, the bladder **82** raises both legs of the subject at the knee causing the subject's knees to bend. As the bladder **82** deflates, the subject's legs straighten to stretch the muscles behind the knee of each leg. As with the embodiments of the bladders **82** discussed herein, the inflation and deflation of the bladder **82** is controlled by utilizing any of the user interfaces **50** or any other suitable user controls, for example, to automatically inflate the bladder **82** for any number of repetitions and for a predetermined period of time. For example, the subject may set the bladder **82** to inflate 10, 20, or 30 times, or repeatedly for a period of 1, 2, or 3 minutes. In addition, the subject can set the rate at which the bladder **82** will inflate to prevent too quick of an inflation or deflation, thereby straining the subject's legs. Furthermore, the subject may also set the degree of inflation to cause the bladder **82** to inflate to a greater or lesser height. When the bladder **82** inflates to a greater height, this results in a greater bend being formed in the subject's legs as opposed to a lesser inflation, provides only a slight bend formed therein.

Subject Helper System

[0077] Referring now to FIGS. **11** and **12**, the subject helper system **400** discussed herein is shown separate from the rest of the person support apparatus **10**. As discussed above, the subject helper system **400** includes a tube **402** having a first end **404** and a second end **406**. At least one belt **408** extends through an interior of the tube **402** and extends out of the second end **406** of the tube **402**. As shown, a pair of belts **408** are provided. Each belt **408** has a first end **411** and an opposite second end **412**. The belts **408** may generally be constructed of any material. For example, in some embodiments, the belts **408** may be automotive grade belts and encapsulated in vinyl. A tensioning assembly **414** is coupled to the first end **411** of the belts **408** for adding resistance and a handle **410** is attached to the second end **412** of each belt **408** to facilitate gripping and pulling of the belts **408** in a first direction toward the subject to perform an upper body exercise. As the handles **410** are released and the force pulling the handles in the first direction is reduced, the belts **408** retract back into the tube **402** in an opposite second direction due to the resistance provided by the tensioning assembly **414**, as described in more detail herein.

[0078] The handles **410** may be any suitable geometry to facilitate gripping by the subject. As shown, the handles **410** are triangular shaped, but may be circular, curved bars, or any other shape. Additionally, the handles **410** may be disengaged from the second end **412** of each belt **408** using any suitable releasable fastening mechanism, such as clips, hooks, or the like, to attach different handles **410** to the belts **408**. In some embodiments, the handles **410** are attachable to one another using any suitable means to prevent independent movement when not in use. In some embodiments, an inner surface of each handle **410** includes a magnet for attracting an opposite handle **410**. Thus, when not in use, the handles **410** may be attached to one another. Other suitable means for fastening the handles **410** when not in use are contemplated such as snaps, hook and loop fasteners, and the like.

[0079] The first end **411** of each belt **408** is attached to a mount **418** to ensure that the belts **408** move in unison with one another. As such, it is understood that, in this embodiment, the belts **408** are not capable of moving through the tube **402** independently of one another when pulled by a corresponding handle **410**. Although not shown, it is to be understood that some embodiments of the subject helper system **400** may include a single belt **408** that separates into two distinct belt sections at some point along the length of the belt **408**, thereby forming a Y-configuration proximate the second end **412** of the belt **408**. Thus, the first end **411** of the belt **408** is secured to the mount **418** and splits into the two distinct belt sections proximate the second end **412** of the belt **408** to attach to the two separate handles **410**. It is worth noting that this embodiment of the belt **408** may be utilized so long as the distance between an end of each separated belt section is far enough from the point of separation along the belt **408**, for example, a shoulder width from the point of separation, to permit the subject to pull the handles **410** in the desired direction without restriction.

[0080] As shown in FIG. **12**, the tensioning assembly **414** of the subject helper system **400** coupled to the first end **411** of the belt **408** is illustrated in greater detail. In some embodiments, the tensioning assembly **414** includes a shock **420** and a biasing member **422** positioned in a side-by-side arrangement. The shock **420** has a first end **420***a* and a second end **420***b*. The shock **420** such as, for example, a damper or a gas shock, includes a cylinder **424** and a piston **426** extendable within the cylinder **424** to increase and decrease the length of the shock **420** between the first end **420***a* and the second end **420***b*. The cylinder **424** of the shock **420** is fixed to a bracket **428** disposed within and fixed to the tube **402** in any suitable manner, such as a fastener, welding, or the like, for securing the cylinder **424** in position relative to the tube **402**. Further, the first end **420***a* of the shock **420** is fixed to the mount **418** for drawing the piston **426** out of the cylinder **424** as the belts **408** are pulled in the first direction and out of the second end **406** of the tube **402**.

[0081] The biasing member **422** such as, for example, a spring, has a first end **422***a* and a second end **422***b*. The first end **422***a* of the biasing member **422** is secured to the bracket **428**, and the second end **422***b* of the biasing member **422** is secured to the mount **418**. The biasing member **422** may be secured to the bracket **428** and the mount **418** in any suitable manner such, as by using a fastener, hook and loop, welding, or the like. Thus, as the belts **408** are pulled in the first direction and out of the second end **406** of the tube **402**, the second end **420***b* of the shock **420** and the second end **422***b* of the biasing member **422** are pulled therewith by virtue of being connected to the mount **418** secured to the first ends of the belts **408**. As such, the biasing member **422** adds resistance to the belts **408** when pulled in the first direction. As the force pulling the belts **408** in the first direction is reduced, the biasing member **422** pulls the belts **408** back toward the first end **404** of the tube **402** in the second direction. The shock **420** provides controlled recoil of the biasing member **422** to prevent the belts **408** from quickly returning to an initial position (e.g., a rest position). Although not shown, it is to be understood that the shock **420** and the biasing member **422** may be formed as a single unit, such as a shock absorber or linear damper.

[0082] In some embodiments, a monitoring device **430** is positioned within the tube **402** proximate the first end **420***a* of the biasing member **422**. The monitoring device **430** includes a force sensing gauge **431** mechanically coupled to the biasing member **422** to detect a pulling force and a switch **433** configured to count the number of repetitions that the belts **408** are pulled in the first direction and returned to the original position. The force sensing gauge **431** may be configured to detect the pulling force by monitoring tension of the biasing member **422**. The switch **433** may be configured to detect the number of repetitions by detecting extension and retraction of the biasing member **422**. In some embodiments, the force sensing gauge **431** and the switch **433** may be fixed to the second end **422**B of the biasing member or the mount **418** to translate with the biasing member **422** as the belts **408** are pulled. The monitoring device **430**, specifically the force sensing gauge **431** and the switch **433**, are in electrical communication with the electronic control system **110**. As such, data from the monitoring device **430** is transmitted to the electronic control system **110** to track an exercise routine of the subject in the person support apparatus **10**. This data may be displayed on any of the user interfaces **50** to provide feedback to the subject. As a result, data pertaining to the exercise routines may be logged in the electronic control system **110**. This allows for progress of the subject to be tracked, as with any of the exercises discussed herein, which may be necessary for insurance reimbursement purposes.

[0083] Referring now to FIG. **13**, an embodiment of a subject helper system **400′** may be provided including a pair of tensioning assemblies **414** allowing for the belts **408** to extend through the tube **402** independently of one another. It should be appreciated that the tensioning assemblies **414** may be identical to one another and, as such, each tensioning assembly **414** includes a shock **420** and a biasing member **422** coupled to a corresponding belt **408** via a mount **418**. At least one belt **408** extends from a corresponding mount **418** and to a corresponding handle **410**. The tensioning assemblies **414** are provided in a side by side arrangement within a bracket **428**, which may have an increased width to house both tensioning assemblies **414**. Further, the subject helper system **400′** may include a pair of monitoring devices **430** with each monitoring device **430** connected to an associated tensioning assembly **414** to measure the force and number of repetitions exhibited by each tensioning assembly **414**.

[0084] In some embodiments, as shown in FIGS. **14** and **15**, a friction mechanism **432** may be provided to adjust the amount of resistance against the belt **408** without adjusting the tensioning assembly **414** itself. It should be appreciated that when a pair of tensioning assemblies are provided, such as the pair of tensioning assemblies **414** of the subject helper system **400′**, a friction mechanism **432** may be associated with each belt **408** coupled to a corresponding tensioning assembly **414**. The friction mechanism **432** discussed herein is just one illustrative example of providing friction on the belts **408**, however, other friction assemblies are contemplated.

[0085] In embodiments, the friction mechanism **432** includes a housing **434** positioned within and fixed to the tube **402** of the subject helper system **400** by any suitable fastening mechanism. For example, the housing **434** may be secured to the tube **402** by a mounting bolt **436** extending through the tube **402**. In some embodiments, the housing **434** may be a one piece monolithic structure integrally formed with the tube **402**. The friction mechanism **432** includes an adjusting knob **438** accessible from an exterior of the subject helper system **400**. The adjusting knob **438** is fixed to a spacer **456** positioned between a pair of walls **458**, **460** of the housing **434**. A threaded pin **440** extends through and threadedly engages the spacer **456**. The friction mechanism **432** further includes a shaft **442** pivotally attached to an end of the threaded pin **440** opposite the spacer **456**. The shaft **442** may be pivotally attached to the threaded pin **440** in any suitable manner such that the shaft **442** is configured to pivot **442** with respect to the threaded pin **440**. As discussed herein, rotation of the adjusting knob **438** rotates the spacer **456**, which causes the threaded pin **440** to further engage or retract out of the spacer **456** based on a direction of rotation of the adjusting knob **438**.

[0086] The housing **434** further includes a side wall **448** having an arcuate aperture **450** formed therein and a corresponding elongated aperture **452** is formed in the shaft **442**. A sliding pivot **454** extends through the arcuate aperture **450** in the side wall **448** and the elongated aperture **452** in the shaft **442** to facilitate pivoting of the shaft **442** with respect to the threaded pin **440**. The shaft **442** is permitted to move toward and away from the belt **408** since the elongated aperture **452** is larger than a diameter of the sliding pivot **454**. Thus, as described in more detail herein, the shaft **442** may pivot relative to the threaded pin **440** between an unpivoted position, as shown in FIG. **14** when the belt **408** is being pulled out of the tube **402** in the first direction, and a pivoted position, as shown in FIG. **15** when the belt **408** is being retracted back into the tube **402** in the second direction. In some embodiments, the housing **434** includes a partition wall **462** extending perpendicular to the side wall **448** and includes a cutout **464** formed therein. The shaft **442** extends through the cutout **464** in the partition wall **462** from the threaded pin **440** toward the belt **408**. The cutout **464** permits limited movement of the shaft **442** between the unpivoted position and the pivoted position as the shaft **442** contacts an edge of the cutout **464**.

[0087] A first pad **444** is attached to an end of the shaft **442** opposite the threaded pin **440** for frictionally pressing against the belt **408**. In some embodiments, the first pad **444** is formed from highly frictional materials. In some embodiments, as shown, the first pad **444** is a delrin pad having an arcuate belt surface **445** that pivots in and out of engagement with the belt **408** based on a moving direction of the belt **408**. In other embodiments, the first pad **444** may be a wheel having a high or variable resistance mode.

[0088] A second pad **446** may be fixed to the housing **434** opposite the adjusting knob **438** such that the belt **408** is positioned to extend between the first pad **444** and the second pad **446**. In some embodiments, the second pad **446** is formed from a highly frictional material. In some embodiments, the second pad **446** may be a delrin pad. Alternatively, when the second pad **446** is not provided, the belt **408** may extend between the first pad **444** and a wall of the housing **434** or, alternatively, an interior surface of the tube **402** itself. Although not shown, a biasing member, such as a spring, may be provided within the housing **434** or within the shaft **442** itself to bias the shaft **442** relative to the threaded pin **440** and toward the unpivoted position.

[0089] In use, rotation of the adjusting knob **438** in a first direction translates the threaded pin **440**, the shaft **442**, and the first pad **444** closer to the belt **408**, thereby increasing tension against the belt **408** between the first pad **444** and the second pad **446**, if provided. Similarly, rotation of the adjusting knob **438** in an opposite second direction translates the threaded pin **440**, the shaft **442**, and the first pad **444** away from the belt **408**, thereby decreasing tension against the belt **408** between the first pad **444** and the second pad **446**, if provided. As noted above, the shaft **442** is permitted to move toward and away from the belt **408** since the elongated aperture **452** formed in the shaft **442** is larger than the diameter of the sliding pivot **454**.
[0090] As the belt **408** moves in the first direction to extend out of the tube **402**, as shown in FIG. **14**, an upward pivoting force is applied against the first pad **444** by the belt **408** and the sliding pivot **454** abuts against an upper end of the arcuate aperture **450** formed in the side wall **448** of the housing **434**. This maintains the shaft **442** in the unpivoted position. It should be appreciated that the cutout **464** formed in the partition wall **462** of the housing **434** also limits the amount of pivoting of the shaft **442** relative to the threaded pin **440**. With the shaft **442** in the unpivoted position, friction on the belt **408** by the first pad **444** is increased, thereby adding resistance against the belt **408** when pulled in the first direction.
[0091] When the belt **408** moves in the second direction and retracts back into the tube **402**, as shown in FIG. **15**, movement of the belt **408** causes the first pad **444** and the shaft **442** to pivot downwardly with respect to the threaded pin **440** into the pivoted position. In doing so, the sliding pivot **454** moves to an opposite end of the arcuate aperture **450** in the side wall **448** of the housing **434**. Thus, the amount of contact on the belt **408** by the first pad **444** is reduced, thereby reducing the amount of friction against the belt **408** and allowing the belt **408** to more freely retract back into the tube **402** in the second direction.
[0092] It is to be understood that the friction mechanism **432** may be manually operated to adjust the position of the shaft **442** and the first pad **444** within the tube **402** by rotating the adjusting knob **438**. In some embodiments, the friction mechanism **432** may be automatically adjusted by controlling rotation of the adjusting knob **438** or the axial position of the threaded pin **440** itself, such as by using a motor or the like to operate the adjusting knob **438** or the shaft **442** directly. When the friction mechanism **432** is automatically operated, the friction mechanism **432** is in electronic communication with a power supply, such as power supply **135** (FIG. **4**). It should further be appreciated that, when a pair of friction mechanisms **432** are provided, such as when the pair of tensioning assemblies **414** are provided, each friction mechanism **432** may be adjusted, manually or automatically, independently of the other friction mechanism **432**.
[0093] The friction mechanism **432** may be provided within the tube **402** at any suitable location to control an amount of friction against the belt **408** and which may be accessible by the subject or some other operator. As such, the friction mechanism **432** may be located proximate the first end **404** of the tube **402**, proximate the second end **406** of the tube **402**, or at any location therebetween along which the belts **408** extend.
[0094] When the friction mechanism **432** is utilized on the subject helper system **400** depicted in FIG. **12**, the monitoring device **430** of the subject helper system **400** may detect the friction force applied against the belt **408** by the friction mechanism **432** to determine an actual force being performed by the subject during an exercise routine. Such a functionality may be added via a friction detection device **435** (FIG. **4**) provided within the friction mechanism **432**. For example, in some embodiments, the spacer **456** is a linear position sensor and functions as the friction detection device **435** to detect the amount of displacement of the threaded pin **440** and, thus, the amount of friction on the belt **408**. In this embodiment, the spacer **456** is in electronic communication with the monitoring device **430** or the electronic control system **110** directly. Thus, a force reading provided by the monitoring device **430** may be adjusted to account for a force reading provided by the spacer **456**.
[0095] The friction detection device **435** may be any suitable mechanism for measuring friction

imparted on the belt **408** by the friction mechanism **432**. In some embodiments, the friction detection device **435** is a sensor or imaging device configured to measure a position of the first pad **444** relative to the spacer **456** and, thus, how much friction is imparted on the belt **408** by the first pad **444**. In other embodiments, the second pad **446**, if provided, may include a force pressure pad provided on a surface thereof to abut against the belt **408** opposite the first pad **444** and configured to measure a force applied on the belt **408** by the first pad **444**. Alternatively, the force pressure pad may be provided directly on the tube **402** itself and opposite the first pad **444** if the second pad **446** is not provided.

[0096] In any event, the measured position or force detected by the friction detection device **435** may then be converted to a value stored within one of the memory components **204**, **209** of the electronic control system **110** or the monitoring device **430** to determine how much friction is applied onto the belt **408**. Thereafter, the amount of force initially determined by the monitoring device **430** is adjusted, i.e., increased, by the converted value to determine an adjusted force performed by the subject. Thus, despite the monitoring device **430** detecting an amount of resistance at the tension assembly **414**, the monitoring device **430** takes into account the friction on the belt **408** imparted by the friction mechanism **432**.

Exercise Band Tie Down

[0097] As noted above and illustrated in FIGS. **2** and **3**, the person support apparatus **10** includes a pair of side rails **24**, which may include a head side rail **28** and an intermediate side rail **30**. Each intermediate side rail **30** includes an attachment device **500** for attaching an associated exercise band. As shown in FIG. **16**, the attachment device **500** is shown in an exploded view with the attachment device **500** partially removed from the intermediate side rail **30**. However, it is to be understood that the attachment device **500** lies flush with the intermediate side rail **30** when in use to avoid inadvertent contact by a subject. More particularly, the intermediate side rail **30** includes a recessed portion **508** and an aperture **506** formed therein. The recessed portion **508** and the aperture **506** cooperate to receive the attachment device **500** and permit the attachment device **500** to lie flush with the intermediate side rail **30**. The attachment device **500** may be secured within the recessed portion **508** and the aperture **506** using any suitable fastening mechanism such as, for example, threaded fasteners, clasps, and the like.

[0098] The attachment device **500** includes a potentiometer **510** having a channel **512** extending axially therethrough. The potentiometer **510** may be a 3-axis load cell or any other suitable device for recognizing rotation and directional force of an object engaging the channel **512**, as discussed in more detail herein. The attachment device **500** includes a shaft **514** having a first end **514***a* and a second end **514***b*. A plate **516** is attached to the first end **514***a* of the shaft **514**, and a ring **518** is pivotally attached to the plate **516** opposite the shaft **514**. Thus, the ring **518** is pivotable between an unfolded position, as shown, and a folded position. More particularly, the plate **516** has a first surface **520** attached to the first end **514***a* of the shaft **514** and an opposite second surface **522** having a groove **524** formed therein for receiving the ring **518** when in the folded position.

[0099] In some embodiments, the ring **518** has a hinge end **526** and an opposite distal end **528**. The ring **518** is pivotally connected to the second surface **522** of the plate **516** at the hinge end **526** and may include a biasing member (not shown), such as a spring, for biasing the ring **518** toward the folded position when not in use. The ring **518** allows an exercise band **504** to be secured to the attachment device **500** to permit a subject to perform exercise routines using the exercise band **504**, such as curls, presses, lifts, and the like, by pulling the exercise band **504** away from the attachment device **500**. The exercise band **504** is a stretchable band that provides resistance as a subject grips the exercise band **504** and pulls the exercise band **504** away from the attachment device **500**. The exercise band **504** is attached to the distal end **528** of the ring **518** in any suitable manner, such as by tying the exercise band **504** to the ring **518**, to provide consistent readings as opposed to the exercise band **504** moving freely between the distal end **528** and the hinge end **526**.

[0100] The second end **514***b* of the shaft **514** is inserted into and engages the channel **512** of the potentiometer **510**. Although not shown, in some embodiments, the shaft **514** includes teeth for engaging internal grooves of the channel **512**. Thus, rotation of the shaft **514** results in rotation of the channel **512** within the potentiometer **510**. The potentiometer **510** is configured to rotate of the plate **516**, as shown by arrows R, in response to rotation of the channel **512**. In addition, as noted above, the potentiometer **510** is configured to sense directional force by recognizing a force applied against the channel **512** by the shaft **514**. Potentiometers are well-known in the art and, thus, description of the manner in which the potentiometer **510** detects a directional force is not discussed in more detail herein.

[0101] The potentiometer **510** is in electrical communication with the electronic control system **110** discussed herein. As such, data from the potentiometer **510**, including rotational direction data and force data at the channel **512**, is transmitted to the electronic control system **110**. As described herein, the electronic control system **110** is configured to process the rotational direction data to determine what specific exercise routine is being performed. In making this determination, the electronic control system **110** also takes into account the position of the support surface **18** to identify the orientation of the subject, i.e., the upper frame **16** (FIG. **1**), when the exercises are being performed. Examples of particular exercises that may be determined are described below with reference to the support apparatus **10** in FIGS. **2** and **16**.

[0102] In one non-limiting example, a subject in a supine position with the head section **32** of the support surface **18** in a horizontal position may perform a curl exercise by gripping the exercise band **504** and pulling the exercise band **504** toward his or her chest. By performing this motion, the ring **518** will orient itself in a first position, thereby rotating the channel **512** of the potentiometer **510** accordingly. The potentiometer **510** will detect this rotation of the channel **512** and transmit the rotation direction data to the electronic control system **110**. The electronic control system **110** determines that, based on the channel **512** of the potentiometer **510** being rotated to the first position and the head section **32** of the support surface **18** being reclined, the exercise being performed is a curl exercise. Specifically, the electronic control system **110** identifies that the direction in which the exercise band **504** is being pulled is substantially parallel to the head section **32** of the support surface **18**, which indicates a curl exercise is being performed. It should be appreciated that, without identifying the position of the head section **32** during this exercise, the electronic control system **110** may alternatively determine that a different exercise, such as a chest pull, was being performed.

[0103] In another non-limiting example, if the head section **32** of the support surface **18** is inclined to, for example, 90 degrees from the upper frame **16** and the subject performs the same curl exercise, the plate **516** will be rotated to a second position in which the exercise band **504** is pulled in a direction substantially perpendicular to the first direction due to the direction of the pulling force being directed in a vertical direction perpendicular to the longitudinal axis of the person support apparatus **10**. However, the electronic control system **110** is configured to determine that the pulling force applied by the exercise band **504** against the channel **512** is still directed in a direction substantially parallel to the head section **32** of the support surface **18** and, therefore, the same curl exercise is being performed. A gain, without identifying the position of the head section **32** during this exercise, the electronic control system **110** may alternatively determine that a different exercise, such as a bench press, was being performed.

[0104] In another non-limiting example, the head section **32** is in the horizontal position and the subject is performing a bench press exercise by pulling the exercise band **504** in an upward direction away from the subject's chest. Pulling the exercise band **504** in the upward or vertical direction orients the plate **516** in the second direction. The potentiometer **510** transmits this rotation direction data to the electronic control system **110**, which determines that, based on the head section **32** being in the horizontal position and the exercise band **504** resulting in a force against the channel **512** substantially perpendicular to the direction of the head section **32**, a bench press exercise is being performed. Without identifying the position of the head section **32** during this exercise, the electronic control system **110** may alternatively determine that a different exercise, such as a tricep and bicep lift exercise, was being performed.

[0105] In another non-limiting example, if the head section **32** is inclined to, for example, 90 degrees from the upper frame **16**, i.e., in the vertical position, and the subject performs the same arm movement by pulling the exercise band **504** away from the subject's chest, the subject may perform a sitting press or pectoral fly exercise. In doing so, the plate **516** will be rotated to a third direction opposite the first direction and roughly perpendicular to the second direction due to the direction of the pulling force being directed in a direction parallel to the longitudinal axis of the person support apparatus **10** and toward the foot section **36** of the support surface **18**. However, it is understood that the electronic control system **110** is configured to determine that, the exercise being performed when the exercise band **504** exerts a force on the channel **512** substantially perpendicular and away from the head section **32** a sitting press or pectoral fly exercise is being performed. It should be appreciated that, without identifying the head section **32** is inclined during this exercise, the electronic control system **110** may alternatively determine that a different exercise, such as a leg press, was being performed.

[0106] In some embodiments, the electronic control system **110** may be configured to continuously recognize changes in direction of the potentiometer **510** during an exercise. In doing so, the electronic control system **110** may determine that certain exercises, such as a rowing exercise, are being performed when the potentiometer **510** is rotated to more than one position during a single repetition.

[0107] In any event, the potentiometer **510** also transmits force data to the electronic control system **110**. Thus, the identified exercise routine and the force data may be displayed on any of the user interfaces **50** to provide feedback to the subject. As a result, data on the exercise routines may be logged in the electronic control system **110**. As noted above, this allows for progress of the subject to be tracked, which may be necessary for insurance reimbursement purposes.

[0108] In addition, in some embodiments, user input may be provided on the user interfaces **50** allowing the subject to confirm or deny the determination of the exercise routine by the electronic control system **110**. For example, if the electronic control system **110** makes a determination that a curl exercise is being performed when in fact a bench press exercise is being performed, a user, such as the subject or the caregiver, may operate the user interfaces **50** to indicate the correct exercise routine. The electronic control system **110** then stores the data transmitted from the potentiometer **510** and the position of the support surface **18** as being associated with the exercise routine indicated by the user. Thus, the next time similar parameters are identified by the electronic control system **110**, the correct exercise routine will be determined and displayed. The electronic control system **110** may use a machine learning algorithm to make more accurate determinations of the exercise routine being performed based on these confirmations or denials of the determined exercise routine by the user.

[0109] Although the person support apparatus **10** discussed herein is disclosed as including an attachment device **500** on each intermediate side rail **30**, it is to be understood that the attachment devices **500** may be located in any suitable location on the person support apparatus **10**. In some embodiments, the attachment devices **500** may be provided on each of the head side rails **24** to permit additional exercise routines to be performed. In other embodiments, the attachment devices **500** may be provided on the footboard **26** to permit leg exercises, such as knee bends, to be performed.

[0110] In addition, although not shown, it is to be understood that the attachment devices **500** may be detachable from the person support apparatus **10** and positionable on or within arms of a chair separate from the person support apparatus **10**. As such, each attachment device **500** may be secured in any suitable manner, such as straps, clips, mechanical fasteners, or the like. Further, the attachment devices **500** may be provided on a movable frame member positionable on opposite sides of a bed without arms. In either instance, the attachment devices **500** communicate, either via a wired connection or wirelessly, with the electronic control system **110** to transmit the data in the same manner as discussed herein.

[0111] It should now be understood that the person support apparatuses described herein offer early mobility exercise to a subject that is bedridden. Specifically, the features discussed herein, such as the alternating inflatable bladders, sit up assist, leg raise/curl assist, in addition to the waist and knee straps, allow the subject to perform exercises necessary to adequately address muscle groups to those that are bedridden. By addressing these additional muscle groups the subject's chances of benefitting from early mobility therapies are greatly increased. This translates to lower morbidity rates for subjects confirmed by many early mobility studies. For care institutions, this concept translates to quicker recovery times for subjects and all the revenue benefits that are associated. The person support apparatus offers a safe and efficient solution to the hassles physical therapists face on a regular basis while trying to move highly acute subjects to other devices or areas of the hospitals. Because the person support apparatus offers mobility therapies incorporated into the subject platform, caregivers are more likely to use them. In addition, the availability of these exercises also allows the subject access to therapeutic exercises that can be done on his or her own. This could lead to a sense of empowerment allowing for better subject outcomes.

[0112] The advantages that arise from the software of the exercise devices are a unique way to track and display subject physical therapy data on a subject platform equipped with physical therapy capability. In addition, the ability of the software to capture, store, and then transmit the data to the subject's electronic medical record allows for a better awareness of the subject's progress. Furthermore, capturing the data and transmitting it to the electronic medical record can reduce charting errors and allow for more accurate subject charting. This ability in turn can lead to earlier interventions if the subject's progress is flat or even negative. Finally, the ability to better monitor the subject's physical therapy state may lead to better subject outcomes.

[0113] Embodiments can be described with reference to the following clauses, with preferred features laid out in the dependent clauses. [0114] 1. A person support apparatus comprising: a support surface having a patient facing surface and including a head section, a seat section, and a foot section, the head section and the foot section being rotatable with respect to the seat section; a head section actuator coupled between the head section and the seat section to rotate the head section with respect to the seat section; a foot section actuator coupled between the foot section and the seat section to rotate the foot section with respect to the seat section; at least one strain gauge provided proximate the patient facing surface of the support surface to detect a change in pressure against at least one of the head section and the foot section; and a controller configured to transmit a signal to one or more of the head section actuator or the foot section actuator to rotate a corresponding one of the head section or the foot section in response to receiving data from the at least one strain gauge indicating a change in pressure that exceeds a predetermined reduction in pressure. [0115] 2. The person support apparatus of clause 1, further comprising: a first strain gauge positioned at the head section of the support surface; and a user interface configured to receive a maximum angle and a minimum angle between which the head section rotates with respect to the seat section, and the predetermined reduction in pressure. [0116] 3. The person support apparatus of clause 2, wherein, in response to the change in pressure against the head section detected by the first strain gauge exceeds the predetermined reduction in pressure, the head section actuator rotates the head section in a first direction with respect to the seat section toward the maximum angle. [0117] 4. The person support apparatus of clause 3, wherein, in response to the head section reaching the maximum angle and the change in pressure against the head section detected by the first strain gauge exceeds the predetermined reduction in pressure, the head section actuator rotates the head section in an opposite second direction with respect to the seat section toward the minimum angle. [0118] 5. The person support apparatus of any of clauses 1-4, further comprising: a second strain gauge positioned at the foot section of the support surface; and a user interface configured to receive a maximum angle and a minimum angle at which the foot section rotates with respect to the seat section, the predetermined reduction in pressure, and a predetermined increase in pressure. [0119] 6. The person support apparatus of clause 5, wherein, in response to the change in pressure against the foot section detected by the second strain gauge exceeds the predetermined reduction in pressure, the foot section actuator rotates the foot section in a first direction with respect to the seat section toward the minimum angle. [0120] 7. The person support apparatus of clause 6, wherein, in response to the change in pressure against the foot section detected by the second strain gauge exceeds the predetermined increase in pressure, the foot section actuator rotates the foot section in an opposite second direction with respect to the seat section toward the maximum angle. [0121] 8. The person support apparatus of any of clauses 1-7, further comprising: a mattress supported on the subject facing surface of the support surface, the mattress including a pair of inflatable bladders inflatable in a direction opposite the subject facing surface of the support surface; and a user interface configured to receive at least one bladder operating parameter for each inflatable bladder of the pair of inflatable bladders, the at least one bladder operating parameter including at least one of a number of repetitions, an inflation height, a deflation height, a rate of inflation, and a time of inflation. [0122] 9. The person support apparatus of clause 8, wherein the pair of inflatable bladders are configured to inflate and deflate independent of one another as instructed by the at least one bladder operating parameter. [0123] 10. The person support apparatus of any of clauses 1-9, further comprising: a padded seat supported by the subject facing surface of the support surface; an exercise pad including a bottom surface formed from a low friction material, the padded seat removably coupled to the exercise pad; and a strap for securing a person to the padded seat. [0124] 11. The person support apparatus of clause 10, further comprising a restraint strap having a first end and a second end coupled to the support surface, wherein the restraint strap extends from opposite sides of the support surface. [0125] 12. A person support apparatus comprising: a base frame; an upper frame; a plurality of lift members extending between the base frame and the upper frame for moving the upper frame with respect to the base frame; a support surface having a patient facing surface and including a head section, a seat section, and a foot section, the head section and the foot section being rotatable with respect to the seat section; one or more actuators coupled between one or more of the head section and the seat section to rotate a corresponding one of the head section and the foot section with respect to the seat section; at least one strain gauge provided proximate the patient facing surface of the support surface to detect a change in pressure against at least one of the head section and the foot section; and a controller configured to transmit a signal to the one or more actuators to rotate a corresponding one of the head section and the foot section in response to receiving data from the at least one strain gauge indicating a change in pressure that exceeds a predetermined reduction in pressure. [0126] 13. The person support apparatus of clause 12, further comprising: a subject helper system comprising: a tube having a first end and an opposite second end, the first end of the tube coupled to the upper frame proximate the head section of the support surface; at least one belt having a first end and an opposite second end, the at least one belt movable through the tube in a first direction to extend out of the tube proximate the second end and an opposite second direction to retract back into the tube proximate the second end; a pair of handles provided at the second end of the at least one belt; and a tensioning assembly coupled to a first end of the at least one belt, the tensioning assembly being moveable toward the at least one belt to apply a pressure against the at least one belt. [0127] 14. The person support apparatus of clause 13, wherein the tensioning assembly further comprises: a biasing member having a first end fixed to the tube and a second end coupled to the first end of the at least one belt, the biasing member increasing tension on the at least one belt when moving in the first direction; and a shock having a first end fixed to the tube and a second end coupled to the first end of the at least one belt, the shock damping movement of the at least one belt when moving in the second direction. [0128] 15. The person support apparatus of clause 13 or clause 14, further comprising: a pair of belts, each belt including a corresponding one of the pair of handles provided at a second end of the pair of belts; a pair of tensioning assemblies, each of the pair of tensioning assemblies coupled to a corresponding one of the pair of belts for independently adding resistance to the pair of belts when moving in the first direction. [0129] 16. The person support apparatus of any of clauses 13-15, further comprising a friction mechanism comprising: a pad provided within the tube on a side of the at least one belt, the at least one belt extending between the pad and the tube, wherein: the pad is movable in a first direction toward the at least one belt to increase force by the pad against the at least one belt; and the pad is movable in a second direction away from the at least one belt to decrease force by the pad against the at least one belt. [0130] 17. The person support apparatus of any of clauses 12-16, further comprising a pair of attachment devices provided in opposite side rails of the upper frame, each of the pair of attachment devices comprising: a potentiometer; a shaft rotatably connected to the potentiometer; a plate fixed to an end of the shaft opposite the potentiometer; and a ring pivotally attached to the plate opposite the shaft for receiving an exercise band, wherein the potentiometer detects directional rotation and force when the shaft engages the potentiometer and the plate is pulled by the exercise band. [0131] 18. A method for performing exercises in a person support apparatus, the method comprising: receiving, at a user interface, a maximum angle of rotation and a predetermined reduction in pressure; monitoring, by a strain gauge, a change in pressure applied against a head section of the person support apparatus; and responsive to a change in pressure against the head section detected by the strain gauge exceeding the predetermined reduction in pressure, rotating the head section in a first direction with respect to a seat section of the person support apparatus toward the maximum angle of rotation. [0132] 19. The method of clause 18, further comprising: translating a pad in a first direction toward a belt to increase pressure against the belt extending between the pad and a tube; and translating the pad in a second direction away from the belt to decrease pressure against the belt. [0133] 20. The method of clause 18 or clause 19, further comprising: detecting, by a potentiometer provided in a side rail of the person support apparatus, a direction and a force of an exercise band being pulled by a subject; determining a position of the head section of the person support apparatus with respect to the seat section of the person support apparatus; determining an exercise routine being performed by the subject based on the direction in which the exercise band is being pulled and the position of the head section; and displaying the determined exercise routine on the user interface of the person support apparatus. [0134] 21. A person support apparatus comprising: a base frame; an upper frame having a lower edge, a support caster mounted to the lower edge; a support surface including a head section, a seat section, and a foot section, the head section and the seat section being pivotable with respect to the seat section; and a plurality of lift members for moving the upper frame with respect to the base frame. [0135] 22. The person support apparatus of clause 21 further comprising: a strain gauge positioned within or on the head section; and a user interface for inputting a maximum angle and a minimum angle at which the head section rotates with respect to the seat section, and a predetermined threshold. [0136] 23. The person support apparatus of clause 22, wherein the strain gauge monitors a force and wherein the head section rotates in a first direction with respect to the seat section to the maximum angle when the force is less than the predetermined threshold. [0137] 24. The person support apparatus of clause 22, wherein the strain gauge monitors a force and wherein the head section rotates in a second direction with respect to the seat section to the minimum angle when the force is less than the predetermined threshold. [0138] 25. The person support apparatus of clause 21 further comprising: a strain gauge positioned within the foot section; and a user interface for inputting a maximum angle and a minimum angle at which the foot section rotates with respect to the seat section, a first predetermined threshold, and a second predetermined threshold. [0139] 26. The person support apparatus of clause 25, wherein the strain gauge monitors a force and wherein the foot section rotates in a first direction with respect to the seat section to the maximum angle when the force is less than the first predetermined threshold. [0140] 27. The person support apparatus of clause 25 or clause 26, wherein the strain gauge monitors a force and wherein the foot section rotates in a second direction with respect to the seat section to the minimum angle when the force is greater than the second predetermined threshold. [0141] 28. The person support apparatus of any of clauses 21-27 further comprising: at least one inflatable bladder; and a user interface for inputting at least one bladder operation parameter, the bladder operation parameter selected from the group consisting of number of repetitions, inflation height, deflation height, rate of inflation, and time of inflation. [0142] 29. The person support apparatus of clause 28, wherein the at least one inflatable bladder extends transverse to a longitudinal axis of the support surface. [0143] 30. The person support apparatus of any of clauses 28-29, wherein the at least one inflatable bladder comprises a first inflatable bladder and a second inflatable bladder. [0144] 31. The person support apparatus of clause 30, wherein the first inflatable bladder and the second inflatable bladder are operable independent of one another. [0145] 32. The person support apparatus of any of clauses 30-31, wherein the first inflatable bladder and the second inflatable bladder alternatively inflate and deflate in opposition of one another. [0146] 33. The person support apparatus of clause 21 further comprising: a knee strap having a first end and a second end, the knee strap permitting a person to perform shallow knee bend exercises, the knee strap having an adjustable length, the first and second ends of the knee strap are attachable to the support surface. [0147] 34. The person support apparatus of clause 33, wherein the knee strap is formed from an inelastic material. [0148] 35. The person support apparatus of any of clause 34 further comprising: a padded seat; an exercise pad including a bottom surface formed from a low friction material, the padded seat removably coupled to the exercise pad; and a strap for securing a person to the padded seat. [0149] 36. The person support apparatus of any of clauses 21-35 further comprising: a waist strap having a first end and a second end, the waist strap formed from an inelastic material and securing a waist of a person against the support surface, the waist strap having an adjustable length, the first and second ends of the waist strap are attachable to the support surface. [0150] 37. The person support apparatus of any of clauses 21-36 further comprising a tube fixed to the base frame and a belt assembly extending through the tube, the belt assembly including a pair of belts having a first end and a second end, the first end of the belts coupled to a biasing member and a shock, the second end of the belts attached to a respective handle, the belt assembly further including a friction mechanism for adjusting tension on the belts. [0151] 38. The person support apparatus of any of clauses 21-37 further comprising a pair of attachment devices provided in opposite sides of the upper frame, each pair of attachment devices including a potentiometer, a shaft rotatably connected to the potentiometer, a plate fixed to the shaft, and a ring for receiving an exercise band, the potentiometer identifying directional rotation and force based on movement of the ring. [0152] 39. A method for performing sit up exercises in a person support apparatus comprising the steps of: receiving, at a user interface, a maximum angle of rotation, a minimum angle of rotation, and a predetermined threshold; monitoring a force against a head section; rotating the head section in a first direction with respect to a seat section of the person support apparatus to the maximum angle of rotation when the force against the head section is less than the predetermined threshold; and rotating the head section in a second direction with respect to the seat section to the minimum angle of rotation when the force against the head section is less than the predetermined threshold. [0153] 40. A method of performing leg raise and leg curl exercises in a person support apparatus comprising the steps of: receiving at a user interface a maximum angle, a minimum angle, a first predetermined threshold, and a second predetermined threshold; monitoring a force against a foot section; rotating the foot section in a first direction with respect to a seat section of the person support apparatus to the maximum angle of rotation when the force against the head section is less than the first predetermined threshold; and rotating the head section in a second direction with respect to the seat section to the minimum angle of rotation when the force against the foot section is greater than the second predetermined threshold.

[0154] Any theory, mechanism of operation, proof, or finding stated herein is meant to further enhance understanding of principles of the present disclosure and is not intended to make the present disclosure in any way dependent upon such theory, mechanism of operation, illustrative embodiment, proof, or finding. It should be understood that while the use of the word preferable, preferably or preferred in the description above indicates that the feature so described can be more desirable, it nonetheless cannot be necessary and embodiments lacking the same can be contemplated as within the scope of the disclosure, that scope being defined by the claims that follow.

[0155] In reading the claims it is intended that when words such as “a,” “an,” “at least one,” “at least a portion” are used there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. When the language “at least a portion” and/or “a portion” is used the item can include a portion and/or the entire item unless specifically stated to the contrary.

[0156] It should be understood that only selected embodiments have been shown and described and that all possible alternatives, modifications, aspects, combinations, principles, variations, and equivalents that come within the spirit of the disclosure as defined herein or by any of the following claims are desired to be protected. While embodiments of the disclosure have been illustrated and described in detail in the drawings and foregoing description, the same are to be considered as illustrative and not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Additional alternatives, modifications and variations can be apparent to those skilled in the art. Also, while multiple inventive aspects and principles can have been presented, they need not be utilized in combination, and many combinations of aspects and principles are possible in light of the various embodiments provided above.

Claims

1. A person support apparatus comprising: a base frame; an upper frame supported by the base frame; a deck supported by the upper frame and having sections movable to a plurality of articulated positions including a chair configuration; a mattress supported by the deck; a pair of side rails adjacent sides of the mattress, each side rail of the pair of side rails including a section configured to be grasped by a hand of a user; a footboard adjacent an end of the mattress, the footboard configured to engage feet of the user; a reduced friction mechanism configured to be positioned on the mattress and under a buttocks of the user and permit sliding of the buttocks relative to the deck when the user pushes off the footboard with the feet; and a restraint strap extending across the mattress and configured to engage knees of the user.

2. The person support apparatus of claim 1, wherein the reduced friction mechanism comprises an exercise pad.

3. The person support apparatus of claim 2, wherein the exercise pad comprises: a base; and a seat affixed to an upper surface of the base.

4. The person support apparatus of claim 3, wherein: a bottom surface of the base opposite the upper surface is formed from a low friction material; and the low friction material includes nylon, satin, or silk.

5. The person support apparatus of claim 3, wherein the exercise pad includes a strap attachable to the seat.

6. The person support apparatus of claim 1, wherein: the restraint strap has a length that is adjustable; opposite ends of the restraint strap are removably attached to sides of the deck; and the restraint strap is formed from an elastic material.

7. A method for exercising in a person support apparatus, the method comprising: providing a reduced friction mechanism for a mattress of a person support apparatus, wherein the mattress is supported by a frame of the person support apparatus; sitting, by a user, on the mattress such that a buttocks of the user is positioned on the reduced friction mechanism; sitting up, by the user, on the mattress; grasping, by the user, a portion of a first side rail of the person support apparatus with one hand of the user; grasping, by the user, a portion of a second side rail of the person support apparatus with a second hand of the user; placing, by the user, feet of the user against a footboard of the person support apparatus; positioning a restraint strap across the mattress and engage knees of the user; bending, by the user, the knees of the user while positioned against the footboard of the person support apparatus; pushing, by the user, off the footboard with the feet; and sliding, by the user, the buttocks relative to the frame using the reduced friction mechanism until the knees are straightened.

8. The method of claim 7, wherein: the reduced friction mechanism comprises an exercise pad; a bottom surface of the reduced friction mechanism is formed from a low friction material; and the low friction material includes nylon, satin, or silk.

9. The method of claim 8, wherein the exercise pad comprises: a base; a seat affixed to an upper surface of the base; and a strap attachable to the seat.

10. The method of claim 7, wherein: the restraint strap has a length that is adjustable; opposite ends of the restraint strap are removably attached to sides of the deck; and the restraint strap is formed from an elastic material.

11. A person support apparatus comprising: an upper frame; a support surface provided on the upper frame and including a patient facing surface defining a head section, a seat section, and a foot section; and a subject helper system comprising: a tube having a first end and an opposite second end, the first end of the tube coupled to the upper frame proximate the head section of the support surface; a belt having a first end and an opposite second end, the belt extending through the second end of the tube and movable through the tube in a first direction to extend further out of the tube and an opposite second direction to retract back into the tube; a pair of handles provided at the second end of the belt; and a tensioning assembly coupled to a first end of the belt.

12. The person support apparatus of claim 11, wherein the tensioning assembly further comprises: a biasing member having a first end fixed to the tube and a second end coupled to the first end of the belt, the biasing member increasing tension on the belt when moving in the first direction; and a shock having a first end fixed to the tube and a second end coupled to the first end of the belt, the shock damping movement of the belt when moving in the second direction.

13. The person support apparatus of claim 12, wherein: the belt comprises a pair of belts, each belt including a corresponding one of the pair of handles provided at a second end of the pair of belts; and the tensioning assembly comprises a pair of tensioning assemblies, each of the pair of tensioning assemblies coupled to a corresponding one of the pair of belts for independently adding resistance to the pair of belts when moving in the first direction.

14. The person support apparatus of claim 13, further comprising a friction mechanism being moveable relative to the belt to apply a pressure against the belt.

15. The person support apparatus of claim 13, further comprising a friction mechanism being moveable relative to the belt to apply a pressure against the belt, the friction mechanism comprising: a first pad provided within the tube on a side of the belt, the belt extending between the first pad and the tube, wherein: the first pad is movable in a first pivoting direction toward belt to increase force by the first pad against the belt; and the first pad is movable in a second pivoting direction away from the belt to decrease force by the first pad against the belt.

16. The person support apparatus of claim 15, wherein: movement of the belt in the first direction causes the first pad to move in the first pivoting direction; and movement of the belt in the second direction causes the first pad to move in the second pivoting direction.

17. The person support apparatus of claim 15, wherein the friction mechanism comprises: an adjusting knob; a spacer extending from the adjusting knob; a threaded pin threadedly engaging the spacer; a shaft pivotally coupled to an end of the threaded pin opposite the spacer; and the first pad provided on an end of the shaft opposite the threaded pin.

18. The person support apparatus of claim 17, wherein: rotation of the adjusting knob in a first rotation direction results in rotation of the spacer in the first rotation direction and the threaded pin retracting out of the spacer; and rotation of the adjusting knob in a second rotation direction opposite the first rotation direction results in rotation of the spacer in the second rotation direction and the threaded pin further engaging the spacer.

19. The person support apparatus of claim 17, wherein: the tube includes a partition wall defining a cutout; and the shaft extends through the cutout such that pivoting of the shaft is limited by the cutout.

20. The person support apparatus of claim 17, wherein: the tube includes a side wall defining an arcuate aperture; an elongated aperture is formed in the shaft; and a sliding pivot extends through the arcuate aperture formed in the side wall and the elongated aperture formed in the shaft to facilitate pivoting of the shaft.