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(54) LINEAR ACTUATOR FOR PATIENT LIFT

(57) A lift assembly for a patient lift system 1 and a patient lift system having a lift assembly comprising: a frame 102 having a proximal end 104 and a distal end 106 and a longitudinal axis extending from the proximal end to the distal end; a carriage 120 movable relative to the frame substantially in the direction of the longitudinal axis; an actuator 108 secured to the frame at or around the proximal end 104 of the frame, the actuator being coupled to the carriage for moving the carriage relative to the frame substantially in the direction of the longitudinal axis; and a line 140 having a first end 142 and a second end 144, the first end of the line being secured to the frame. The carriage comprises a first carriage line guide 130a and the line is arranged to extend from the first end 142 over and around the first carriage line guide 130a and away from the frame 102 to the second end 144. The line is coupled to the carriage at least at the first carriage line guide 130a such that movement of the carriage 120 substantially along the longitudinal axis of the frame 102 draws the line 140 with the carriage and moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage.

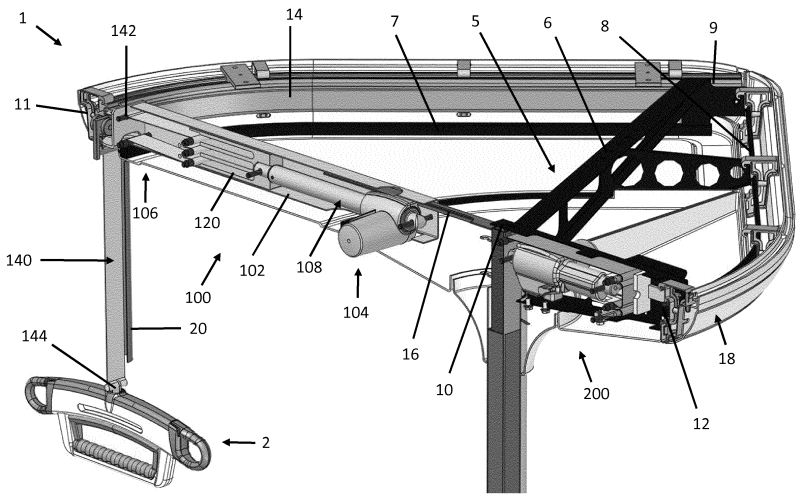

Figure 4

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Description

[0001] This disclosure relates to lift assemblies for patient lift systems and patient lift systems comprising lift assemblies. In particular, but not exclusively, this disclosure relates to overhead patient lift systems.

[0002] Caregivers may need to move patients from one location to another in a care facility. Sometimes, caregivers may need to use patient lift systems to assist with lifting and/or moving a patient. Various types of patient lift systems have been developed. One type of patient lift system that has been developed comprises a lift assembly mounted to a carriage or a trolley that is slidably mounted to a fixed rail. This type of patient lift system is often referred to as an overhead patient lift system, since the frame or rail of the system is generally mounted to a celling or a wall above a patient's head. Overhead patient lift systems are typically configured to move a patient within in a defined area, such as in the vicinity of a patient support apparatus, such as a hospital bed, a long term care (LTC) bed or a chair.

[0003] While various patient lift systems have been developed, there is still room for improvement. Thus, a need persists for further contributions in this area of technology.

[0004] In addition, patients on a patient support apparatus, such as a hospital bed, LTC bed or chair, and their caregivers may require access to a number of different functionalities in the vicinity of the support apparatus for comfort, entertainment and/or care. For example a patient in an LTC bed and a caregiver may require access to one or more of the following:

- a patient lift system to life the patient into and out of the bed
- a display screen
- an over bed table
- a bedside cabinet with storage space
- an egress bar to help the patient move in the bed, and/or egress from the bed
- a bedside light
- an intravenous (IV) drip pole
- an electrical socket.

[0005] Conventionally, most of these functionalities are provided by separate units located near the bed. A long term care (LTC) or hospital bed may be surrounded by at least the following separate units: a wall-mounted screen, a patient lifting cradle, a zimmer frame or other walking and bed egress aid, a drug storage and dispensing trolley, an IV (intravenous) pole and a bedside cabinet for the patient to store his/her possessions. This takes up significant amounts of space and therefore has clear cost, convenience and accessibility implications. Space is at a premium and often expensive in a hospital or other care facility; the provision of a number of different units takes up space and increases cost as well as making it awkward for a care giver to access the patient and clean around the various units.

[0006] While various units providing combinations of functionalities have been developed, there is still room for improvement. Thus, a need persists for further contributions in this area of technology.

[0007] According to a first aspect of the present invention, there is provided a lift assembly for a patient lift system, the lift assembly comprising: a frame having a proximal end and a distal end and a longitudinal axis extending from the proximal end to the distal end; a carriage movable relative to the frame substantially in the direction of the longitudinal axis; an actuator secured to the frame at or around the proximal end of the frame, the actuator being coupled to the carriage for moving the carriage relative to the frame substantially in the direction of the longitudinal axis; and a line having a first end and a second end, the first end of the line being secured to the frame. The carriage comprises a first carriage line guide and the line is arranged to extend from the first end over and around the first carriage line guide and away from the frame to the second end. The line is coupled to the carriage at least at the first carriage line guide such that movement of the carriage substantially along the longitudinal axis of the frame draws the line with the carriage and moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage.

[0008] The lift assembly of the present invention comprises an actuator and a carriage which are arranged to move a second end of a line towards and away from the frame. The movement of the second end of the line towards and away from the frame provides the lifting or lowering action of the lift assembly.

[0009] Typically, the second end of the line is configured for lifting a load.

[0010] In preferred embodiments, the second end of the line may be configured for lifting a patient. In some preferred embodiments, the second end of the line may comprise a patient lifting device. The patient lifting device may be any suitable patient lifting device. For example, the second end of the line may comprise a sling bar. In some preferred embodiments, the second end of the line may comprise attachment means for attaching a patient lifting device to the lift assembly. The attachment means may be any suitable attachment means. For example, the attachment means may comprise a loop for receiving a hook of a patient lifting device.

[0011] In some embodiments, the second end of the line may be configured for lifting one or more patient service elements of a patient service unit for providing assistance and/or services to a patient in or on a patient support apparatus. The second end of the line may comprise one or more patient service elements of a patient service unit. The second end of the line may comprise attachment means for attaching one or more patient service elements of a patient service unit.

[0012] The one or more patient service elements for providing assistance and/or services may include or com-

prises one or more of a patient transporting or lift system, a patient or care-giver screen, an over bed table, an egress bar for aiding egress from or movement on the patient support apparatus, a bedside cabinet, a drawer unit, an intravenous drip support pole and/or an electrical power supply socket.

[0013] The actuator and carriage of the lift assembly have a stroke length, which corresponds to the distance along the longitudinal axis of the frame that the carriage may be moved by the actuator. The lift assembly also has a stroke length, which corresponds to the distance the second end of the line may be moved towards and away from the frame by the actuator and carriage. The particular arrangement of the line on the frame and the carriage enables the stroke length of the actuator and carriage to be amplified, such that the movement of the second end of the line towards and away from the frame is greater than the movement of the actuator and carriage. In other words, the arrangement of the line on the frame and the carriage enables the stroke length of the lift assembly to be greater than the stroke length of the actuator and carriage. Advantageously, amplifying the stroke length of the actuator and carriage enables the lift assembly of the present invention to have a large stroke length relative to the size of the lift assembly. In other words, for a given lift assembly stroke length, the lift assembly of the present invention may be relatively small and compact.

[0014] In addition, the line arrangement of the line on the frame and carriage results in a low number of contact points between the line and the frame and carriage at which the line is required to move over the frame and/or carriage. In particular, securing one end of the line on the frame and arranging the opposite end of the line away from the frame enables the number of such contact points between the line and the frame and carriage to be low. Advantageously, minimising the number of contact points between the line and the frame and carriage at which the line is required to move over the frame and/or carriage reduces the friction between the line and the frame and carriage and improves the efficiency of the assembly.

[0015] It is envisaged that the carriage may comprise more than one carriage line guide. It is also envisaged that in embodiments comprising more than one carriage line guide, the frame may also comprise one or more frame line guides. In these embodiments, the line may pass alternatingly over and around a carriage line guide and over and around a frame line guide or over and around a frame line guide and over and around a carriage line guide.

[0016] Providing additional carriage line guides and additional frame line guides over and around which the line extends may further amplify the stroke of the actuator and carriage, increasing the stroke length of the lift assembly. In other words, extending the line over and around additional carriage line guides and additional frame line guides may increase the distance that the second end of the line is moved by movement of the carriage.

[0017] In some embodiments, the frame may further comprise a first frame line guide and the carriage may further comprise a second carriage line guide. In these embodiments, the line may be arranged to extend from the first end over and around the first carriage line guide, over and around the first frame line guide, over and around the second carriage line guide and away from the frame to the second end.

[0018] In some embodiments, the frame may further comprises first, second and third frame line guides and the carriage may further comprises a second carriage line guide. In these embodiments, the line may be arranged to extend from the first end over and around the first frame line guide, over and around the first carriage line guide, over and around the second frame line guide, over and around the second carriage line guide, over and around the third frame line guide and away from the frame to the second end.

[0019] In some embodiments, the frame may further comprises at least one additional frame line guide and the carriage may further comprises at least one additional carriage line guide. In these embodiments, the line may be further arranged to extend alternatingly over and around an additional frame line guide and over and around an additional carriage line guide or over and around an additional carriage line guide and over and around an additional frame line guide.

[0020] As used herein, the term "line guide" means an aspect, feature or group of features that directs or influences the direction of the line. A line guide may comprise any suitable type of line guide. In some embodiments, a line guide may comprise a fixed feature, such as a notch or groove, across or through which the line is drawn. In some embodiments, a line guide may comprise a moveable feature, such as a bearing or roller, that is configured to move with movement of the line. Preferably, each line guide comprises one or more moveable features configured to move with movement of the line. Advantageously, line guides comprising movable features configured to move with movement of the line may provide a low friction contact region between the line and the frame and/or carriage.

[0021] Ideally, each line guide comprises at least one roller. Each line guide may comprise a single roller. Each line guide may comprise a plurality of rollers. A roller of a carriage line guide may be pivotally secured to the carriage. A roller of a frame line guide may be pivotally secured to the frame. Each roller may be configured to rotate about an axis on movement of the line over the roller. In embodiments comprising more than one roller, the axes of the rollers may be oriented such that they are substantially parallel to each other. Typically the axes of the rollers are oriented substantially perpendicular to the longitudinal axis of the frame.

[0022] As used herein the term "carriage line guide" is used to mean a line guide that forms part of the carriage or is provided or arranged on the carriage. Similarly, as

used herein the term "frame line guide" is used to mean a line guide that forms part of the frame or is provided or arranged on the frame.

[0023] The line extends over and around some of the line guides. As used herein, the term "over and around" is used to mean that the line follows a path that extends generally towards the line guide in a first direction and extends generally away from the line guide in a second direction, substantially opposite to the first direction. Where the line extends over and around a first line guide and over and around a second line guide, the line generally extends in a serpentine or zigzag path around the line guides.

[0024] In preferred embodiments, the carriage comprises at least one carriage line guide, and each carriage line guide comprises at least one roller pivotally secured to the carriage. In some preferred embodiments, a carriage line guide may comprise two or more rollers pivotally secured to the carriage.

[0025] In preferred embodiments, the frame comprises at least one frame line guide, and each frame line guide comprises at least one roller pivotally secured to the frame. In some preferred embodiments, a frame line guide may comprise two or more rollers pivotally secured to the frame.

[0026] In embodiments comprising two or more frame line guides, the frame line guides may be arranged on the frame substantially in a line. The line may be oriented substantially perpendicular to the longitudinal axis of the frame. In other words, the frame line guides may be arranged on the frame substantially on a transverse axis of the frame.

[0027] In embodiments comprising two or more carriage line guides, the carriage line guides may be arranged on the carriage substantially in a line. The line may be oriented substantially perpendicular to the longitudinal axis of the frame when the carriage is coupled to the frame. In other words, the carriage line guides may be arranged on the carriage substantially in a line perpendicular to the direction of movement of the carriage along the frame.

[0028] The frame is required to support the actuator, the carriage, the line and a load supported at the second end of the line. The frame may be any suitable type of frame for supporting the required loads. The frame may be formed from one or more frame members. The frame may be formed from any suitable material. For example, the frame may be formed from metals, alloys, ceramic materials, plastic materials or wood. Preferably, the frame is formed from metal or a metal alloy. Typically, the frame is formed from one or more beams or sections of a metal, such as steel or aluminium.

[0029] The frame may be any suitable shape and size. Typically the frame is elongate. In other words, the frame has a length that is greater than the other dimensions of the frame. The frame may comprise a beam or a section having any suitable cross-section. For example, the frame may have a square cross-section of a circular cross-section.

[0030] As mentioned above, the frame may comprise one or more frame line guides. Preferably, the frame line guides comprise one or more rollers pivotally secured to the frame. The one or more frame line guides may be arranged on the frame in any suitable arrangement.

[0031] The first end of the line is fixed or secured to the frame. The first end of the line may be secured to the frame by any suitable means. Suitable means to secure the first end of the line to the frame include adhesive and tying the line to the frame. In some embodiments, the frame may comprise an attachment point for the first end of the line. The attachment point may comprise a pin or a ring around which the first end of the line may be looped and secured to itself.

[0032] The first end of the line may be secured to the frame at any suitable location on the frame. In some embodiments, the first end of the line is fixed or secured to the frame at or around the proximal end of the frame. However, in preferred embodiments the first end of the line is fixed or secured to the frame at or around the distal end of the frame.

[0033] The line extends away from the frame to the second end. In some embodiments, the frame may comprise one or more openings for the line to extend through and out of the fame to the second end. In some embodiments, the line may extend away from the frame at or around the distal end of the frame. In these embodiments, the frame may comprise a distal line guide. The line may extend over the distal line guide before extending away from the frame to the second end. In some embodiments, the line may extend away from the frame at or around the proximal end of the frame. In these embodiments, the frame may comprise a proximal line guide. The line may extend over the proximal line guide before extending away from the frame to the second end.

[0034] The frame may be configured to be mounted directly to a wall, a ceiling or a post or column. However, preferably the frame is configured to be mounted to a support frame of a patient lift system, as described in more detail later on.

[0035] The frame may be configured to be mounted or arranged in any suitable orientation. The frame may be configured to be mounted or arranged such that the longitudinal axis of the frame is substantially vertical. However, in preferred embodiments the frame is configured to be mounted or arranged such that the longitudinal axis of the frame is substantially horizontal.

[0036] As used herein, the terms "horizontal" and "vertical" refer to the orientation and/or relative positions of elements of the assembly when it is arranged for use.

[0037] In some embodiments, the line may extend away from the frame in a substantially vertical direction to the second end. In preferred embodiments, where the longitudinal axis of the frame is oriented substantially horizontally, the direction of the line may be required to change from a horizontal orientation to a vertical orientation where the line extends away from the frame in a

substantially vertical direction. In these preferred embodiments, a line guide may be provided on the frame at the location at which the line changes direction and extends away from the frame. Providing a line guide on the frame at the location at which the line extends away from the frame may reduce the friction between the line and the frame at the location at which the line extends away from the frame to the second end.

[0038] The frame may be configured to slidably couple with the carriage such that the carriage may slidably move along the frame along the frame in the direction of the longitudinal axis. In preferred embodiments, the frame comprises one or more rails or guides for slidably receiving the carriage. The rails may extend substantially in the direction of the longitudinal axis of the frame.

[0039] The carriage may be slidably coupled to the frame by any suitable means. Where the frame comprises one or more rails or guides, the carriage may comprise one or more wheels or rollers arranged to couple with the rails or guides such that the carriage may slide along the rails or guides.

[0040] The carriage is provided with one or more carriage line guides. The carriage is coupled to the line at least at the one or more carriage line guides such that the carriage may the line to draw the line with the carriage along the longitudinal axis of the frame and move the second end of the line towards and away from the frame.

[0041] The carriage may be any suitable size and shape and may be formed from any suitable material. Typically, the carriage is formed from the same material as the frame.

[0042] In some preferred embodiments, the carriage further comprises: a body portion coupled to the actuator and two or more finger portions extending from the body portion substantially in the direction of the distal end of the frame. In these embodiments, neighbouring ones of the finger portions may be spaced apart to define a cavity for receiving a frame line guide of the frame. The carriage may be arranged on the frame such that each cavity defined by neighbouring ones of the finger portions receives a frame line guide at least when the carriage is positioned at or around the distal end of the frame.

[0043] Advantageously, providing the carriage with one or more cavities for receiving the one or more frame line guides may enable the size of the frame to be reduced. The size of the frame may be reduced, as the one or more frame line guides may be arranged in the path of the carriage, such that the one or more frame line guides may be received in the one or more cavities of the carriage as the carriage is moved along the longitudinal axis of the frame. Providing one or more cavities in the carriage may also enable the one or more carriage line guides and the one or more frame line guides to be aligned along a transverse axis, substantially perpendicular to the longitudinal axis of the frame. Aligning adjacent carriage line guides and frame line guides substantially on a transverse axis may reduce the distance between the adjacent carriage line guides and frame line guides, reducing the length of the line extending between the adjacent line guides and increasing the maximum distance of the second end of the line from the frame. In other words, enabling adjacent carriage line guides and frame line guides to align along a transvers axis may increasing the stroke length of the lift assembly.

[0044] In the preferred embodiments, the or each carriage line guide may be arranged at a finger portion of the carriage. Particularly, each carriage line guide may be arranged at or around a distal end of the finger portions of the carriage. Where a carriage line guide comprises one or more rollers, each roller may be pivotally secured to a finger portion of the carriage at or around the distal end of the finger portion.

[0045] The actuator is secured to the frame. The actuator may be secured or fixed to the frame at or around the proximal end of the frame. The actuator may be secured or fixed to the frame by any suitable means.

[0046] The actuator is required to support at least the lifting load of the lift assembly. In other words, the actuator is required to support and move at least the weight of a load supported at the second end of the line. Accordingly, where the load supported at the second end of the line is a person, the actuator may be configured to support and move at least about 50 Kg, at least about 100 Kg and preferably at least about 200 Kg. However, generally the linear actuator is required to support and move a load greater than the lifting load of the lift assembly. This is because the load of the patient supported at the second end of the line is amplified at the carriage and actuator as a result of the path of the line around the carriage and frame line guides. Accordingly, the linear actuator is typically configured to support and move at least about 200 Kg, at least about 400 Kg or preferably at least about 800 Kg. In some embodiments, the actuator may be configured to support and move at least about 1000 Kg.

[0047] The actuator may be any suitable type of actuator capable of moving the carriage in both directions along the longitudinal axis of the frame when a load is supported at the second end of the line. Preferably, the actuator is a linear actuator. The linear actuator may be any suitable type of linear actuator. For example, the linear actuator may be a pneumatic or hydraulic linear actuator. However, preferably the linear actuator is an electric linear actuator.

[0048] The linear actuator may be any suitable type of linear actuator. Suitable types of linear may include screw-driven linear actuators, belt-driven linear actuators, hydraulic actuators and pneumatic actuators.

[0049] In preferred embodiments, the actuator is a linear actuator comprising a reversible electric motor arranged to drive a shaft in the direction of the longitudinal axis of the frame. In some embodiments the carriage may be integrally formed with the distal end of the shaft of the linear actuator. However, preferably the carriage is coupled to a distal end of the shaft of the linear actuator. The linear actuator may be arranged to impart a force on the carriage, via the shaft, in either direction along the lon-

gitudinal axis of the frame to move the carriage along the longitudinal axis of the frame.

[0050] The linear actuator may be a screw-driven linear actuator. A screw-driven linear actuator may include a reversible electric motor having a motor shaft rotatably coupled to a threaded shaft. Some screw-driven linear actuators may comprise a threaded nut arranged on the threaded shaft, and may further comprise one or more or ball bearings and rollers arranged between the threads of the shaft and nut. Such screw-driven linear actuators are typically referred to as ball screw actuators or roller-screw actuators.

[0051] The actuator may be configured to freewheel under certain conditions. In other words, the actuator may be configured to enable movement of the actuator without movement of the carriage under certain conditions. Freewheeling may substantially protect the actuator from damage when the second end of the line is prevented from moving, such as when an obstacle is encountered by the second end of the line. For example, the actuator may comprise a torque limiter configured to enable rotation or movement of the actuator without corresponding movement of the carriage when the torque experienced by the actuator reaches or exceeds a predetermined threshold.

[0052] The line may be any suitable type of line. The line may be any suitable length or strip of material capable of supporting the required load. The line may be configured to support any suitable load. Typically, the line is required to support at least the weight of a patient. The line may be configured to support at least about 50 Kg, at least about 100 Kg or preferably at least about 200 Kg.

[0053] The line may comprise at least one of: a belt, a cable, a chain, a rope, a strap, a cord or a wire. The line may be comprised of any suitable material. For example, the line may comprise metals, alloys, ceramics, plastics materials and polymers, such as nylon.

[0054] In some embodiments, the line may comprise a single type of line. In other embodiments, the line may comprise more than one type of line. In some embodiments, the line may comprise a first type of line at the first end and a second type of line at the second end.

[0055] In some embodiments, the line comprises a first section and a second section. The first section of the line extends between the first end and at least the line guide and the second section of the line extends between the first section and the second end. In some embodiments, the first and second sections of the line are integrally formed. However, preferably the first and second sections of the line are secured or attached together. The first and second sections of the line may be removably attached or coupled together. The first and second sections of the line may be formed of the same material. Preferably the first and second sections of the line are formed of different materials.

[0056] In some preferred embodiments, the first section of the line may have a transverse cross-section that is smaller than the transverse cross section of the second section. Providing the first section of the line with a smaller transverse cross-section than the second section of the line may enable the second section of the line to be sized such that it is easy and comfortable to handle for a patient or a caregiver and may enable the first section of the line to be sized such that it may be received by a relatively small and/or compact frame and carriage.

[0057] In some preferred embodiments, the first section of the line may be a first type of line and the second section of the line may be a second type of line. This may enable the first and second sections of the line to comprise different types of line. The first section of the line may comprise a type of line that is resistant to tangling or kinking on movement over the line guides. For example, the first section of the line may comprise a cable, a chain or a rope. The second section of the line may comprise a type of line that is easy and comfortable to handle for a patient or a caregiver. For example, the second section of the line may comprise a strap or a belt.

[0058] The line extends from a first end to a second end. Generally, the line terminates at the first end and terminates at the second end. The line has a length. As used herein, the length of the line means the extent of the line between the first end and the second end. The length of the line may be any suitable length.

[0059] The second end of the line is generally not fixed or secured to the frame. The line is arranged to extend away from the frame to the second end. Movement of the carriage along the longitudinal axis of the frame moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage. Accordingly, the second end of the line is arranged away from the frame and the distance between the second end of the line and the frame is adjustable by moving the carriage along the longitudinal axis of the frame in either direction.

[0060] As mentioned above, the second end of the line may comprise a patient lifting device, such as a sling bar. However, preferably, the second end of the line comprises attachment means for attaching an external lifting device to the second end of the line. For example, the second end of the line may comprise a loop for receiving a hook of an external lifting device, such as a sling bar.

[0061] In some embodiments, the second end of the line may comprise one or more patient service elements of a patient service unit for providing assistance and/or services to a patient in or on a patient support apparatus. The second end of the line may comprise attachment means for attaching one or more patient service elements of a patient services unit to the second end of the line. Suitable types of patient service units are described in more detail later on.

[0062] The lift assembly may be configured to conform to certain design requirements.

[0063] In a first example, the lift assembly may be configured to lift and lower a patient. Such a lift assembly may be required to have a minimum stroke of at least about 500 mm. In other words, the second end of the line

is required to be able to move at least about 500 mm towards and away from the frame. The lift assembly may be configured to have a safe working load of at least about 200 kg. In other words, the maximum lifting capacity of the lift assembly may be greater than about 200 kg. In addition, the lift assembly may be required to permit freewheeling of the actuator in both lifting and lowering directions, under certain conditions.

[0064] In a second example, the lift assembly may be configured to lift and lower one or more patient service elements of a patient service unit. Such a lift assembly may be required to have a minimum stroke of at least about 350 mm. The lift assembly may be required to have a safe working load of at least about 100 kg. In addition, the lift assembly may be required to permit freewheeling of the actuator in at least the lifting direction.

[0065] The lift assembly of the present invention may form part of a patient lift system. In some embodiments, the lift assembly may form part of a mobile patient lift system. A mobile patient lift system may comprise a lift assembly supported by a frame mounted on rollers. This type of patient lift system is typically configured to be moved with a patient supported by the system. In preferred embodiments, the lift assembly forms part of a fixed patient lift system, such as an overhead patient lift system.

[0066] According to a second aspect of the present invention, there is provided a patient lift system comprising a lift assembly according to the first aspect of the present invention. Preferably, the patient lift system is an overhead patient lift system.

[0067] Preferably, the patient lift system comprises a support frame. The support frame may be mountable or fixable to a wall. The support frame may be mountable or fixable to a post or a column. The support frame may comprise a post, column or mast that is securable to a floor surface. Preferably, the support frame is fixable or mountable to a ceiling. In particularly preferred embodiments, the lift assembly is configured to be an overhead lift system. The overhead lift system may be arranged above or in the vicinity of a patient support apparatus such as a hospital bed. The support frame may be securable to a portion of a ceiling substantially above a patient support apparatus.

[0068] In some embodiments, the frame of the lift assembly may be an integral part of the support frame of the lift system. However, preferably the frame of the lift assembly is mounted or secured to the support frame of the patient lift system. Preferably, the frame of the lift assembly is movably mounted or secured to the support frame. Movably mounting the frame of the lift assembly to the support frame of the lift system may enable a load supported by the lift assembly to be moved whilst supported by the lift system.

[0069] In preferred embodiments, the proximal end of the frame of the lift assembly may be movably secured to the support frame of the patient lift system.

[0070] In particularly preferred embodiments, the lift assembly may be movably secured to the support frame such that the longitudinal axis of the frame of the lift assembly is substantially horizontal and the frame of the lift assembly is movable substantially in a horizontal plane. Arranging the frame of the lift assembly such that the longitudinal axis is oriented horizontally may advantageously increase the distance between the lift assembly and the floor or patient support apparatus below the lift assembly. This may enable the second end of the line of the lift assembly to be raised above the floor or patient support apparatus below the lift assembly to a greater height than if the lift assembly were to be oriented with its longitudinal axis at a different orientation, such as vertically.

[0071] In some preferred embodiments, the patient lift system further comprises a rail. In these embodiments, the proximal end of the frame may be movably secured to the support frame and the distal end of the frame of the lift assembly may be slidably coupled to the rail. Typically, the rail extends substantially in a horizontal plane, such that the orientation of the frame of the lift assembly may be maintained at a substantially horizontal orientation.

[0072] In some preferred embodiments, the proximal end of the frame of the lift assembly is pivotally secured to the support frame of the patient lift system. In these embodiments, the rail of the patient lift system may be substantially arcuate.

[0073] In some embodiments, the frame of the lift assembly is movably secured to the support frame of the patient lift system by a linkage. In these embodiments, the rail of the lift assembly may follow any suitable path that the linkage allows the distal end of the frame of the lift assembly to follow.

[0074] The patient lift system may further comprise a cover or a housing. The cover or housing may substantially surround or enclose the fame of the lift assembly and the support frame. The cover or housing may provide protection for the moving parts of the lift system. The cover or housing may also substantially shield or protect caregivers and patients supported by the patient lift system from moving parts of the lift system.

[0075] The lift system may comprise an external lifting device at the second end of the line of the lift assembly. In particular, the lift system may comprise an external patient lifting device at the second end of the line. In some embodiments, the lift system may comprise a sling bar at the second end of the line. In some embodiments, the lift system may comprise a sheet gripper at the second end of the line. Where the lift system comprises a sheet gripper at the second end of the line, the lift system may be configured to turn a patient supported on a patient support apparatus.

[0076] The lift system may comprise one or more patient service elements of a patient services unit at the second end of the lift assembly.

[0077] A patient service unit is a unit configured to provide assistance and/or services to a patient in or on a

patient support apparatus. The expression "providing assistance and/or services" encompasses providing a functionality or service of use to a patient or caregiver. This includes, for example, providing storage space (e.g. using a drawer unit), providing support (e.g. on egress bar), providing an eating or working surface (e.g. an overbed table) as well as providing access to medical or patient care equipment and services (e.g. an IV pole or patient transfer system).

[0078] In some preferred embodiments, the patient lift system comprises one or more patient service elements of a patient service unit at the second end of the lift assembly and the patient lift system is mounted to a ceiling or at a high position on a wall or a post or column. In particular, the patient lift system may be arranged substantially above a patient support surface. In these preferred embodiments, the patient services unit may comprise:

> a first substantially vertical tubular shaft having a first end and a second end and a vertical axis extending from the first end to the second end, the first shaft being fixed or fixable at the first end on the support frame;
> a second substantially vertical tubular shaft arranged at or around the second end of the first shaft, coupled to the first shaft and moveable in a vertical direction relative to the first shaft; and
> at least one patient service element for supplying assistance and/or services to a patient, the at least one patient service element being mounted to the second shaft,

wherein the second end of the line of the lift assembly is coupled to the second shaft for moving the second shaft relative to the first shaft in a vertical direction.

[0079] This arrangement may enable the lift assembly to lift or lower the one or more patient service elements of the patient service unit, such that a the one or more patient service elements may be accessible to a patient or may be moved out of the way of a patient, as needed.

[0080] The second end of the line may be coupled or secured to the second shaft by any suitable means.

[0081] In preferred embodiments, the first and second shafts are substantially hollow tubes. In these embodiments, the line may extend through the first and second tubular shafts. In some of these embodiments, a central column or post may extend through the first and second tubular shafts. In embodiments where the support frame of the lift system is mounted to a ceiling, the central column may extend substantially between the support frame at the ceiling and the floor.

[0082] In some embodiments, the first and second shafts each have a substantially circular transverse or horizontal cross-section. In some embodiments, the first shaft may be configured to substantially circumscribe the second shaft. In these embodiments, the first shaft is arranged outside of the second shaft and is slidable thereover. In some embodiments, the second shaft may be configured to substantially circumscribe the first shaft. In these embodiments, the second shaft is arranged outside of the first shaft and is slidable thereover.

[0083] In some embodiments, the one or more patient service elements may be pivotally mounted to the second shaft, such that the or each patient service element is rotatable about the vertical axis of the second shaft.

[0084] In some embodiments, the second tubular shaft may include at least one mounting comprising a first curved bearing surface, the first bearing surface supporting a second bearing surface moveable relative to the first bearing surface to pivot about the vertical axis of the first shaft. The second bearing surface may be coupled to the or each patient service element, such that the patient service element is pivotable about the first and second shafts, and moveable in a vertical direction relative to the first shaft.

[0085] The bearing surfaces may be substantially circular and the second bearing surface may extend around the first bearing surface. This may result in an effective, easy to make bearing. In some embodiments, the first bearing surface is a layer or coating on the surface of the second shaft and the second bearing surface is at least part of the internal circumferential surface of a curved member surrounding or extending partially around the second shaft. At least part of the or each bearing surface may be made from a low friction plastics material such as polyoxymethylene (POM or Acetal).

[0086] In some particularly preferred embodiments of the present invention, the lift system comprises two lift assemblies according to the present invention, a first lift assembly and a second lift assembly.

[0087] The frame of the first lift assembly may be movably secured to the support frame of the patient lift system as described above. In particular, the proximal end of the frame of the first lift assembly may be movably secured to the support frame. In some embodiments, the frame of the second lift assembly may be movably secured to the support frame of the lift system. However, in preferred embodiments, the frame of the second lift assembly is fixedly coupled to the support frame of the lift system.

[0088] Preferably, the frame of the first lift assembly is movably secured to the support frame such that the longitudinal axis of the frame is substantially horizontal. The frame may be movable relative to the support frame substantially in a horizontal plane. Preferably the frame of the second lift assembly is secured to the support frame such that the longitudinal axis of the frame is substantially horizontal.

[0089] In preferred embodiments, the frame of the first lift assembly and the frame of the second lift assembly are mounted on the support frame such that the longitudinal axes of the frames are arranged substantially on the same plane.

[0090] The first and second lift assemblies may be arranged on the support frame such that the proximal end of the frame of the second lift assembly is arranged at or

around the proximal end of the first lift assembly. Where one or more of the lift assemblies is pivotally secured to the frame at the proximal end, this arrangement may enable the or each lift assembly to pivot about substantially the same point on the lift assembly.

[0091] In preferred embodiments, the patient lift system comprises a patient lifting device at the second end of the line of the first lift assembly or comprises attachment means for attaching a patient lifting device to the second end of the line of the first lift assembly.

[0092] In preferred embodiments, the second lift assembly comprises one or more elements of a patient services unit at the second end of the line.

[0093] In particularly preferred embodiments of the patient lift system, the support frame is configured to be mounted to a portion of a ceiling substantially above a bed, such as a long term care bed. The patient lift system comprises a patient lifting device, such as a sling bar, at the second end of the line of the first lift assembly, and a patient service unit comprising one or more elements at the second end of the line of the second lift assembly. The first lift assembly is arranged on the support frame such that the distal end of the frame of the first lift assembly is movable along a path for moving the second end of the line between a head region of the bed, a seat region of the bed and a side of the bed. This may enable a patient lifting device at the second end of the line to move a patient between the bed and a chair or other support apparatus arranged at the side of the bed. The second lift assembly is arranged on the support frame such that the second end of the line may be lifted and lowered along a substantially vertical path substantially adjacent or next to the bed. This may enable one or more elements of a patient support unit attached to the second end of the line to be positioned adjacent or next to the bed and raised and lowered as needed.

[0094] According to a third aspect of the present invention, there is provided a lift assembly for a patient lift system, the lift assembly comprising: a frame having a proximal end and a distal end and a longitudinal axis extending from the proximal end to the distal end; a carriage movable relative to the frame substantially in the direction of the longitudinal axis; an actuator secured to the frame at or around the proximal end of the frame, the actuator being coupled to the carriage for moving the carriage relative to the frame substantially in the direction of the longitudinal axis; and a line having a first end and a second end, the first end of the line being secured to the carriage. The frame comprises a first frame line guide and the carriage comprises a first carriage line guide. The line is arranged to extend from the first end over and around the first frame line guide, over and around the first carriage line guide and away from the frame to the second end. The line is coupled to the carriage at least at the first end and at the first carriage line guide such that movement of the carriage substantially along the longitudinal axis of the frame draws the line with the carriage and moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage.

[0095] According to a fourth aspect of the present invention, there is provided a patient services unit comprising a lift assembly according to the first or third aspects of the present invention.

[0096] The patient services unit may comprise:

a lift assembly according to the first or third aspect of the present invention;
a first substantially vertical tubular shaft having a first end and a second end and a vertical axis extending from the first end to the second end, the first shaft being fixed or fixable at the first end on the support frame;
a second substantially vertical tubular shaft arranged at or around the second end of the first shaft, coupled to the first shaft and moveable in a vertical direction relative to the first shaft; and
at least one patient service element for supplying assistance and/or services to a patient, the at least one patient service element being mounted to the second shaft,

wherein the second end of the line of the lift assembly is coupled to the second shaft for moving the second shaft relative to the first shaft in a vertical direction.

[0097] As used herein, the terms "preferably", "may", and "optionally", refer to features of the present invention which are not essential, but which may be combined with the claimed subject matter to form various embodiments of the invention.

[0098] Furthermore, any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa. Furthermore, any, some and/or all features in one aspect can be applied to any, some and/or all features in any other aspect, in any appropriate combination.

[0099] It should also be appreciated that particular combinations of the various features described and defined in any aspects of the invention can be implemented and/or supplied and/or used independently.

[0100] The invention will be further described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a patient lift system according to an embodiment of the present invention;
Figure 2 shows the patient lift system of Figure 1 in situ in the vicinity of a hospital bed;
Figure 3 shows the patient lift system of Figure 1 in situ in the vicinity of a patient support apparatus being used to transfer a patient between a hospital bed and a chair;
Figure 4 shows a cross-section of the patient lift system of Figure 1;

Figure 5 shows a cross-section of a first lift assembly of the patient lift system of Figure 1;
Figure 6 shows the carriage and line of the first lift assembly of the patient lift system of Figure 1;
Figure 7 shows a cross-section of a second lift assembly of the patient lift system of Figure 1; and
Figure 8 shows the carriage and line of the second lift assembly of the patient lift system of Figure 1.

[0101] Figure 1 shows a patient lift system 1 according to an embodiment of the present invention. The patient lift system 1 is configured as an overhead patient lift system, particularly for arrangement over a patient support apparatus, such as a hospital bed, a long term care (LTC) bed or a wheelchair.

[0102] The patient lift system 1 is mounted to a ceiling substantially above a hospital bed, as shown in Figures 2 and 3. However, it will be appreciated that in other embodiments the patient lift system may be mounted to a wall, a column or post or to a moveable frame.

[0103] The patient lift system 1 comprises two lift assemblies, a first lift assembly 100 and a second lift assembly 200, which are described in more detail later on.

[0104] The first lift assembly 100 is configured to support the weight of a patient and to raise and/or lower a patient supported thereon. The first lift assembly 100 is particularly configured to help raise and lower a patient on a hospital bed. The first lift assembly 100 is also configured to help move a patient supported thereon along a predetermined path around the vicinity of the bed.

[0105] A sling bar 2 is coupled to a line of the first lift assembly 100. The sling bar 2 may be any suitable type of sling bar. A suitable sling bar currently commercially available is the Universal SlingBar 450 available from Liko A.B.. Other suitable types of sling bar are well known in the art and will not be described further here. A patient may directly grip the sling bar 2 and use the sling bar and first lift assembly 100 as an aid when sitting and standing. Alternatively, a sling may be suspended on the sling bar 2 for lifting a patient.

[0106] As shown in Figure 3, the first lift assembly 100 may be used to transfer a patient between a bed and a chair. The bed and chair may be standard and well-known apparatus, which will not be described further here. An example bed might be the HR900 bed available from Hill-Rom, and an example chair might be the Anatome chair also available from Hill-Rom. Anatome is a trade mark of Hill-Rom. All medical beds and chairs, including beds and chairs with controllable height, are suitable for use with the described embodiment.

[0107] To manoeuvre the patient into a lift sling suspended from the sling bar 2, the lift sling may be arranged around the patient as he or she is in the bed or chair with the respective bed or chair being in a raised position such that the sling lift can then be mounted on the sling bar 2 without the sling lift being in tension and significant effort being necessary to lift the patient into position. Once the patient is in the sling lift and the sling lift is mounted on the sling bar 2, the lift assembly 100 may be operated to raise the patient off of the bed or chair on which the patient is supported so that the weight of the patient is gradually taken up by the sling bar 2 and the first lift assembly 100. Once the patient in the sling lift is sufficiently clear of the bed or chair from which the patient is being transferred, a caregiver can easily manoeuver the sling lift away from the respective bed or chair until the patient is arranged in position over the destination bed or chair he or she is being transferred to. Once the destination bed or chair is arranged in a position under the sling lift, the lift assembly 100 may be operated to lower the patient into position unit the destination bed or chair takes the patient weight and the sling lift may be removed from the patient.

[0108] Alternatively, once the patient is in the sling lift and the sling lift is mounted on the sling bar 2, the bed or chair on which the patient is supported may be lowered so that the weight of the patient is gradually taken up by the sling bar 2 and the first lift assembly 100. Once the bed or chair from which the patient is being transferred is sufficiently clear of the patient in the sling lift, a caregiver can easily manoeuver the sling lift away from the respective bed or chair until the patient is over the lowered destination bed or chair he or she is being transferred to. Once the destination chair is arranged in position under the sling lift, that bed or chair may be raised into position until it takes the patient weight and the sling lift may then be removed from the patient. This arrangement makes use of the height change functionality of the bed and chair and does not require the height change functionality on the first lift assembly 100.

[0109] The sling bar 2 is releasably attached to a line of the first lift assembly 100, such that the sling bar 2 may be attached or detached from the line as required. The sling bar 2 may be detached from the second end of the line and other lifting devices may be releasably attached to the second end.

[0110] One example of an alternative lifting device that may be releasably attached to the line of the first lift assembly 100 is a sheet gripper (not shown). Suitable sheet grippers are well known in the art and will not be described further here. A sheet gripper secured to the line of the first lift assembly 100 may be used to help a caregiver turn a patient supported on the bed. To help turn a patient supported on the bed, the sheet gripper may be secured to a portion of a sheet on the bed at one side of the patient. The lift assembly 100 may then be operated to lift the portion of the sheet gripped by the sheet gripper. As the side of the sheet is lifted by the sheet gripper, the patient supported on the bed may roll on the sheet away from the lifted side. Once the patient has been turned to a desired position, the lift assembly 100 may be operated in the opposite direction to lower the raised side of the sheet back onto the bed surface and the sheet may be released from the sheet gripper.

[0111] It will be appreciated that other types of lifting devices may also be releasably attached to the line of the first lift assembly 100. It will also be appreciated that

in other embodiments a sling bar or another lifting device may be fixedly attached to the line of the first lift assembly 100.

[0112] The second lift assembly 200 is configured to raise and lower one or more patient service elements of a patient service unit 4. In this embodiments, the patient service unit 4 is a bedside or chair-side unit configured to provide assistance and/or services to a patient in or on a patient support apparatus at different heights and/or positions. The unit 4 comprises a plurality of service elements which may be necessary to aid or supply services to a patient. The patient service elements may include a drawer cabinet, including a pair of drawers, an over bed table, an electrical socket or power point (to, for example, charge electronic devices and/or phones), a screen support or mount for a screen for use by a patient and/or caregiver and a bedside light.

[0113] The lift system 1 comprises a control unit (not shown) for controlling the first and second lift assemblies 100, 200. The control unit comprises a graphical user interface configured to provide signals to the first and second lift assemblies 100, 200 for operating the first and second lift assemblies 100, 200 to raise and lower their respective loads. In this embodiment, the control unit and graphical user interface comprise one of the patient service elements of the patient service unit 4, which are raisable and lowerable by the second lift assembly 200, and the control unit and graphical user interface are connected to each of the first and second lift assemblies 100, 200 via a wired connection. It will be appreciated that in other embodiments, the control unit may be wirelessly connected to the first and second lift assemblies 100, 200 for remotely controlling the lift assemblies. The control unit may also be any suitable type of control unit. Suitable control units are well known in the art and will not be described in more detail here.

[0114] The lift system 1 is shown in more detail in Figure 4. The lift system 1 generally comprises the first lift assembly 100, the second lift assembly 200, a support frame 5 on which the first and second lift assemblies 100, 200 are mounted, and a rail 14.

[0115] The first lift assembly 100 generally comprises a frame 102, having a proximal end 104 and a distal end 106, a linear actuator 108 arranged at the proximal end of the frame 102, a carriage 120 coupled to the linear actuator 108 and a line 140 coupled to the frame and the carriage 120.

[0116] The second lift assembly 200 is generally similar to the first lift assembly 100 and will be described in more detail later on.

[0117] The support frame 5 generally comprises three support frame lengths or members 6, 7, 8. The three support frame members 6, 7, 8 each comprise one or more steel sections. The three support frame members 6, 7, 8 generally extend on a common plane and are welded together at one end at a common point 9. The first support frame member 6 extends from the common point 9 to a free end 10, at which the distal ends of the frames of the first and second lift assemblies 100, 200 are attached to the support frame 5. The second and third support frame members 7, 8 generally extend from the common point 9 on either side of the first frame member 6 to free ends 11, 12 respectively. The second and third support frame members 7, 8 generally form two sides of a convex curved triangle. A rail 14 is arranged above the second support frame member 7 and follows the path of the second support frame member 7 from the common point 9 to the free end 11.

[0118] The support frame 5 is configured to be mounted on a ceiling. In this embodiments, the support frame 5 is configured to be suspended or hung from brackets (not shown) that are fixed to a ceiling. However, it will be appreciated that in other embodiments, the frame may be directly fixed or secured to the ceiling. In particular, the support frame 5 is configured to be mounted to the ceiling such that the common plane of the support frame members 6, 7, 8 is substantially horizontal.

[0119] The first lift assembly 100 is movably secured to the support frame 5 at the free end 10 of the first support frame member 6. The proximal end 104 of the frame 102 of the first lift assembly 100 is movably secured to the free end 10 of the first support frame member 6 via a linkage 16. The linkage 16 comprises a linkage member pivotally secured to the free end 10 of the first frame member 6. The proximal end 104 of the frame 102 of the first lift assembly 100 is slidably coupled to the linkage member. As such, the first lift assembly 100 is rotatable about the free end 10 of the first support frame member 6 and slidable on the linkage member towards and away from the free end 10 of the first support frame member 6.

[0120] The distal end 106 of the frame 102 of the first lift assembly 100 is slidably coupled to the rail 14. The distal end 106 of the frame is configured to slide along the rail 14 between the free end 11 of the second support frame member 7 and the common point 9, substantially following the path of the second support frame member 7. The linkage 16 enables the proximal end 104 of the frame 102 of the first lift assembly 100 to move such that the distal end 106 of the frame 102 may move freely along the rail 14. The frame 102 of the first lift assembly 100 extends generally in the same plane as the three support frame members 6, 7, 8 and is movable relative to the support frame 5 generally in the plane of the three support frame members 6, 7, 8.

[0121] The line 140 of the first lift assembly 100 extends from the frame 102 at the distal ends 106, and extends substantially vertically downwards to a second end 144, at which the sling bar 2 is releasably attached. The second end 144 of the line 140 comprises a loop (not shown) to which a quick release hook (not shown) of the sling bar 2 is releasably attached.

[0122] Movement of the distal end 106 of the frame 102 of the first lift assembly 100 along the rail 14 provides corresponding movement of the second end 144 of the line 140. As such, the sling bar 2 may be moved substantially along the path of the rail 14, in a horizontal plane

below the rail.

[0123] A shroud 20 comprising a substantially cylindrical plastic tube is also slidably and rotatably coupled to the rail 14 by a roller 21 arranged at the distal end 106 of the frame 102 of the lift assembly 100. The shroud 20 depends from the rail 14 and substantially surrounds an upper section of the portion of the line 140 that extends out of the frame 102 to the second end 144. The shroud 20 provides a comfortable hand hold for a caregiver, such that a caregiver may hold the shroud 20, rather than the line 140, to move the frame 102 and the line 140 along the rail 14. The shroud 20 may also enable a caregiver to hold the frame 102 of the first lift assembly 100 in position on the rail 14 whilst the second end 144 of the line 140 is being lifted and lowered. The shroud 20 is also rotatably coupled to the rail 14, such that the shroud 20 may be inclined at an angle to the vertical, with the line 140, if needed. The shroud 20 may be any suitable length, and may be removable if the second end 144 of the line 140 is required to be lifted closer to the frame 102 than the shroud 20 permits.

[0124] The second lift assembly 200 is fixedly coupled or secured to the support frame 5. The second lift assembly 200 is arranged such that a proximal end of the frame of the second lift assembly 200 is secured to the free end 10 of the first support frame member 6 and the distal end of the frame of the second lift assembly 200 is secured to the free end 12 of the third support frame member 8. The frame of the second lift assembly 200 also extends generally in the same plane as the three support frame members 6, 7, 8.

[0125] Arranging the support frame members 6, 7, 8 and the first and second lift assemblies 100, 200 substantially on a common plane enables the lift system 1 to be thin. In other words, the size or extend of the lift system 1 in the common plane is substantially greater than the height of the lift system 1, in a direction transverse to the common plane. The height or depth of the support frame 5 and the first and second lift assemblies 100, 200 is generally about 120 mm. Since the support frame 5 and lift assemblies 100, 200 are thin, the support frame and lift assemblies depend only a short distance from the ceiling, which enables the stroke length of the first and second lift assemblies 100, 200 to be substantially the height of the room (i.e. the distance between the ceiling to the floor).

[0126] A cover 18 is arranged to extend substantially over the lower, exposed side of the support frame 5 and the first and second lift assemblies 100, 200. The cover is generally formed from a durable plastic material and provides some protection to the support frame 5 and the lift assemblies 100, 200, hides the support frame 5 and lift assemblies 100, 200 from view to improve the aesthetics of the lift system 1 and substantially prevents or inhibits caregivers and patients from encountering the frame 102 of the first lift assembly 100 as the first lift assembly 100 is moved along the rail 14.

[0127] The first lift assembly 100 is shown in more detail in Figures 5 and 6.

[0128] The frame 102 of the first lift assembly 100 comprises an elongate steel channel. The frame 102 has a proximal end 104, a distal end 106 and a longitudinal axis extending from the proximal end 104 to the distal end 106.

[0129] The linear actuator 108 of the first lift assembly 100 is a screw-driven linear actuator with a maximum capacity of about 800 daN and a stroke length of about 145 mm. Suitable screw-driven linear actuators are well known in the art and will not be described in detail here. The linear actuator 108 comprises a reversible electric motor 110, a tubular outer shaft 112 and an inner shaft 114 slidably received in the outer shaft 114 and coupled to the motor at a proximal end such that the inner shaft 114 may be moved along the axis of the outer shaft 112 in both directions.

[0130] The linear actuator 108 is fixedly secured to the frame 102 at the proximal end 104, and is oriented such that the outer and inner shafts 112, 114 are substantially aligned with the longitudinal axis of the frame 102 and extend from the motor 110 towards the distal end 106 of the frame 102. In this arrangement, the inner shaft 114 is movable by the motor 110 towards and away from the proximal end 106 of the frame 102 substantially along the longitudinal axis of the frame 102.

[0131] The carriage 120 generally comprises a body of aluminium having a body portion 122 at one end and four finger portions 124, 126 extending away from the body portion 122. The body portion 122 of the carriage 120 is coupled to the distal end of the inner shaft 114 of the linear actuator 108. The finger portions 124, 126 extend away from the body portion 122 substantially in the direction of the longitudinal axis of the frame, towards the distal end 106 of the frame 102. The finger portions 124, 126 are spaced substantially evenly apart and comprise two outer finger portions 124 arranged either side of two inner finger portions 126. The finger portions 124, 126 define three elongate cavities 128 that extend substantially in the direction of the longitudinal axis of the frame 102. In this embodiments, the finger portions 124, 126 are joined at the distal ends, such that the three cavities 128 are closed at both ends. The carriage 120 is movable by the inner shaft 114 of the linear actuator 108 substantially along the longitudinal axis of the frame 102. The carriage 120 is moveable by a distance of about 145 mm.

[0132] The carriage 120 further comprises two carriage line guides 130 for coupling the line 140 to the carriage 120. In this embodiment, each carriage line guide 130 comprises a roller pivotally secured to the carriage 120. The axes of the rollers of the carriage line guides 130 are substantially parallel to each other and are oriented substantially perpendicular to the longitudinal axis of the frame 102. The roller of the first carriage line guide 130a is pivotally coupled to the carriage 120 at a distal end of a first one of the inner finger portions 126 and the roller of a second carriage line guide 130b is pivotally coupled to the carriage 120 at a distal end of a second

one of the inner finger portion 126 of the carriage 120. The rollers of the first and second carriage line guides 130a, 130b are arranged distally of the cavities 128 on the inner finger portions 126 and substantially on a transverse axis extending substantially perpendicularly to the longitudinal axis of the frame 102.

[0133] The frame 102 comprises a mounting pin 138 for attaching the first end 142 of the line 140 to the frame 102. The mounting pin 138 is arranged substantially at the proximal end of the frame 102, at an upper side of the frame 102. The first end 142 of the line 140 is looped around the mounting pin 138 at the distal end of the frame 102 is and secured to itself with an adhesive. As such, the first end 142 of the line is fixedly secured to the frame 102.

[0134] The frame 102 further comprises a plurality of frame line guides 132, 134 for coupling the line 140 to the frame 102. In this embodiment, each frame line guide 132, 134 comprises a roller pivotally secured to the frame 102. The axes of the rollers of the frame line guides 132, 134 are substantially parallel and are oriented substantially perpendicular to the longitudinal axis of the frame 102.

[0135] A distal line guide 132 is provided at the distal end 106 of the frame 102, at a lower side of the frame 102 (i.e. the opposite side of the frame 102 to the mounting pin 138). The distal line guide 132 is arranged below the mounting pin 138, substantially on a transverse axis extending in a vertical direction.

[0136] Three frame line guides 134 are also provided on the frame 102. The three frame line guides 134 are arranged on a transverse axis extending substantially perpendicularly to the longitudinal axis, about half way along the longitudinal axis, between the distal end of the outer shaft 112 of the linear actuator 108 and the transverse axis on which the mounting pin 138 and distal line guide 132 are arranged. The three frame line guides 134 are arranged to fit within the cavities 128 of the carriage 120. A first frame line guide 134a is arranged to fit in the cavity 128 between the first outer finger portion 124 and the first inner finger portion 126, a second frame line guide 134b is arranged to fit in the cavity 128 between the first inner finger portion 126 and the second inner finger portion 126, and a third frame line guide 134c is arranged to fit in the cavity 128 between the second inner finger portion 126 and the second outer finger portion 124.

[0137] Each cavity 128 is closed at the proximal and distal end, but is open at least at one side for receiving a roller of the frame line guides 134. Each cavity 128 of the carriage 120 is substantially elongate, having a length that is slightly greater than the stroke length of the actuator 108, and each cavity 128 has a width that is greater than the diameter of the rollers of the frame line guides 134. Accordingly, a roller of the frame line guides 134 may be received in each of the cavities 128 when the carriage 120 and linear actuator 108 are arranged on the frame 102, and the carriage may be moved along the longitudinal axis of the frame 102 for a full stroke of the actuator 108 without the frame line guides 134 obstructing movement of the carriage 120.

[0138] The line 140 of the first lift assembly 100 is a polyester strap. The line 140 has a first end 142 that is fixed to the frame and a second end 144 that is arranged away from the frame and is movable towards and away from the frame. The line 140 generally extends along the following path:

- from the first end 142 at the mounting pin 138 to the first frame line guide 134a, in a direction substantially parallel to the longitudinal axis of the frame 102;
- over and around the first frame line guide 134a and to the first carriage line guide 130a;
- over and around the second frame line guide 134c and to the second carriage line guide 130b;
- over and around the second carriage line guide 130b and to the third frame line guide 134c;
- over and around the third frame line guide 134c and to the distal frame line guide 132, in a direction substantially parallel to the longitudinal axis of the frame; and
- over the distal frame line guide 132 and out of the frame 102 in a substantially vertical direction, perpendicular to the longitudinal axis of the frame, to the second end 144.

[0139] The actuator 108 may be operated to move the carriage 120 in either direction along the longitudinal axis of the frame 102. As the carriage 120 is moved along the longitudinal axis of the frame 120, the carriage line guides 130 act on the line 140, drawing the line 140 such that sections of the line between a frame line guide 134 and a carriage line guide 130 are lengthened or shortened depending on the direction of movement of the carriage 120. As the carriage line guides 130 are moved in a distal direction, away from the frame line guides 134, the sections of the line 140 extending to and away from the carriage line guides 130 are lengthened. Conversely, as the carriage 120 is moved in a proximal direction, towards the frame line guides 134 and the proximal end 104 of the frame 102, the sections of the line 144 extending to and away from the carriage line guides 130 are shortened. The number of sections of the line 144 that are lengthened and shortened with movement of the carriage 120 determine the amplification of the stroke of the actuator 110 at the second end 144 of the line 140.

[0140] In this embodiment, four sections of the line are lengthened and shortened on movement of the carriage 120. These sections comprise: the section between the first frame line guide 134a and the first carriage line guide 130a, the section between the first carriage line guide 130a and the second frame line guide 134b, the section between the second frame line guide 134b and the second carriage line guide 130b and the section between the second carriage line guide 130b and the third frame line guide 134c. Accordingly, movement of the carriage

120 along the longitudinal axis of the frame 102 of a first distance causes movement of the second end 144 of the line 140 of a second distance that is four times greater than the first distance. In other words, the stroke of the actuator 108 is amplified by a factor of four (i.e. the number of sections of line that are lengthened and shortened). In this embodiment, the stroke of the actuator 108 is about 145 mm, and the stroke of the first lift assembly 100 is about 580 mm. In other words, the distance that the second end 144 of the line 140 is movable by the actuator is about 580 mm.

[0141] The amplification of the stroke of the actuator 108 results in a corresponding increase in the force required by the actuator 108 to move the carriage 120 and lift a load supported at the second end 144 of the line 140. In this embodiment, the force required to lift a load at the second end 144 of the line 140 at least about four times the load at the second end 144 of the line 140. For example, the actuator 110 is required to produce at least about 800 daN of force to lift a load of about 200 daN supported at the second end of the line 140.

[0142] Apart from the first end 142 of the line 140 which is fixed at the mounting pin 138, the line 140 only contacts the frame 102 and carriage 120 at the line guides, which comprise rollers that are rotatable with movement of the line 140. Accordingly, the arrangement of the line 140 on the frame 102 and carriage 120 provides a low friction lift arrangement that amplifies the stroke of the actuator 108 at the second end 144 of the line 140 to provide a compact lift assembly with a large stroke.

[0143] The second lift assembly 200 is shown in more detail in Figures 7 and 8.

[0144] The second lift assembly 200 has a similar construction to the first lift assembly 100, and generally comprises a frame 202, having a proximal end 204 and a distal end 206, a linear actuator 208 arranged at the proximal end of the frame 202, a carriage 220 coupled to the linear actuator 208 and slidably coupled to the frame 202, and a line 240 coupled to the frame and the carriage 220.

[0145] The frame 202 of the first lift assembly 200 comprises an elongate steel channel. The frame 202 has a proximal end 204, a distal end 206 and a longitudinal axis extending from the proximal end 104 to the distal end 106. The frame 202 of the second lift assembly 200 is smaller than the first lift assembly 100, having a length of about 480 mm from the proximal end 204 to the distal end 206 of the frame 202.

[0146] The linear actuator 208 of the second lift assembly 200 is also a screw-driven linear actuator with a maximum capacity of about 600 daN and a stroke length of about 60 mm. The linear actuator 208 has a motor 210, a tubular outer shaft 212 and an inner shaft 242 slidably received in the outer shaft 214 and coupled to the motor at a proximal end such that the inner shaft 214 may be moved along the axis of the outer shaft 212 in both directions.

[0147] The linear actuator 208 is fixedly secured to the frame 202 at the proximal end 204, and is oriented such that the outer and inner shafts 212, 214 are substantially aligned with the longitudinal axis of the frame 202 and extend from the motor 210 towards the distal end 206 of the frame 202. In this arrangement, the inner shaft 214 is movable by the motor 210 towards and away from the proximal end 206 of the frame 202 substantially along the longitudinal axis of the frame 202. The carriage 220 comprises a body of aluminium having a body portion 222 at one end and three finger portions 224, 226 extending away from the body portion 222. The body portion 222 of the carriage 220 is coupled to the distal end of the inner shaft 214 of the linear actuator 208. The carriage 220 comprises two outer finger portions 224 arranged either side of a central finger portion 226, and spaced apart to define two elongate cavities 228. The finger portions 224, 226 are joined together at their distal ends, such that the cavities 228 are not open at the distal end. The cavities 228 have at least one open side for receiving frame line guides 234. The carriage 220 is movable by the inner shaft 214 of the linear actuator 208 substantially along the longitudinal axis of the frame 102. The carriage 220 is movable by a distance of about 60 mm.

[0148] The carriage 220 further comprises three carriage line guides 230 for coupling the line 240 to the carriage 220. In this embodiment, first and third carriage line guides 230a, 230d comprises a roller pivotally secured to the carriage 220, and a second carriage line guide comprises a first roller 230b and a second roller 230c pivotally secured to the carriage 220. The axes of the rollers of the carriage line guides 230 are substantially parallel to each other and are oriented substantially perpendicular to the longitudinal axis of the frame 202. The roller of the first carriage line guide 230a is pivotally coupled to the carriage 220 at a distal end of a first one of the outer finger portions 224, the first and second rollers 230b, 230c of the second carriage line guide are pivotally coupled to the carriage 220 at a distal end of the inner finger portion 226, and the roller of a third carriage line guide 230d is pivotally coupled to the carriage 220 at a distal end of a second one of the outer finger portions 224 of the carriage 220. The rollers of the first, second and third carriage line guides 230a, 230b, 230c, 230d are arranged distally of the cavities 228 on the finger portions 224, 226 and substantially on a transverse axis extending substantially perpendicularly to the longitudinal axis of the frame 202.

[0149] The frame 202 comprises a mounting pin 238 for attaching the first end 242 of the line 240 to the frame 202. The mounting pin 238 is arranged substantially at the distal end 206 of the frame 202, at a lower side of the frame 202. The first end 242 of the line 240 is looped around the mounting pin 238 at the distal end of the frame 202 is and secured to itself with an adhesive. As such, the first end 242 of the line is fixedly secured to the frame 202.

[0150] The frame 202 further comprises a plurality of frame line guides 232, 234 for coupling the line 240 to the frame 202. In this embodiment, each frame line guide

232, 234 comprises a roller pivotally secured to the frame 202. The axes of the rollers of the frame line guides 232, 234 are substantially parallel and are oriented substantially perpendicular to the longitudinal axis of the frame 202.

[0151] A proximal frame line guide 232 is provided at the proximal end 204 of the frame 202, at an upper side of the frame 202 (i.e. the opposite side of the frame 202 to the mounting pin 238). The proximal line guide 232 is arranged proximal to and above the linear actuator 208 on the frame 202.

[0152] Two frame line guides 234 are also provided on the frame 202. The two frame line guides 234 are arranged towards the distal end 206 of the frame 202 on a transverse axis extending substantially perpendicular to the longitudinal axis of the frame 202. The two frame line guides 234 are arranged to fit within the cavities 228 of the carriage 220. A first frame line guide 234a is arranged to fit in the cavity 228 between the first outer finger portion 224 and the inner finger portion 226, and a second frame line guide 234b is arranged to fit in the cavity 228 between the inner finger portion 226 and the second outer finger portion 224. Each cavity 228 of the carriage 220 is substantially elongate, having a length that is slightly greater than the stroke length of the actuator 208, and each cavity 228 has a width that is greater than the diameter of the rollers of the frame line guides 234.

[0153] The line 240 of the second lift assembly 200 is a polyester strap. The line 240 has a first 242 that is fixed to the frame 202 and a second end 244 that is arranged away from the frame 202 and is movable towards and away from the frame 202. The line 240 generally extends along the following path:

- from the first end 242 at the mounting pin 238 to the first frame line guide 234a;
- over and around the first carriage line guide 230a and to the first frame line guide 234a;
- over and around the first frame line guide 234a and to a first roller 234b of the second carriage line guide;
- over the first roller 234b of the second carriage line guide and to a second roller 234c of the second carriage line guide;
- around the second roller 234c of the second carriage line guide and to the second frame line guide 234b;
- over and around the second frame line guide 234b and to the third carriage line guide 230d;
- over and around the third carriage line guide 230d to the proximal frame line guide 232; and
- over the proximal frame line guide 232 and away from the frame 202 in a substantially vertical direction, perpendicular to the longitudinal axis of the frame 202, to the second end 244.

[0154] The actuator 208 may be operated to move the carriage 220 in either direction substantially along the longitudinal axis of the frame 202. As the carriage is moved along the longitudinal axis of the frame 220, the carriage lines guides 230 act on the line 240, drawing the line such that sections of the line between the frame line guides 234 and the carriage line guides 230 are lengthened or shortened depending on the direction of movement of the carriage 240.

[0155] In this embodiment, six sections of the line 240 are lengthened and shortened on movement of the carriage 220. These sections comprise: the section between the first end 242 and the first carriage line guide 230a, the section between the first carriage line guide 230a and the first frame line guide 234a, the section between the first frame line guide 234a and the first roller 230b of the second carriage line guide, the second between the second roller 230c of the second carriage line guide and the second frame line guide 234b, the section between the second frame line guide 234b and the third carriage line guide 230d and the section between the third carriage line guide 230d and the proximal frame line guide 232. Accordingly, the stroke of the actuator 208 is amplified by six times at the second end 244 of the line 240. In this embodiment, the stroke of the actuator 208 is about 60 mm and the stroke of the second lift assembly 200 is about 360 mm. In other words, the distance that the second end 244 of the line 240 is movable by the actuator 208 is about 360 mm.

[0156] The amplification of the stroke of the actuator 210 results in a corresponding increase in the force required by the actuator 210 to lift a load supported at the second end 244 of the line 240. In this embodiment, the force required to lift a load at the second end 244 of the line 240 is about six times the load at the second end 244 of the line 240. For example, the actuator 210 is required to produce at least about 600 daN of force to lift a load of about 100 daN supported at the second end of the line 140.

[0157] In this embodiments, the patient services unit 4 forms part of the lift system 1. The patient services unit 4 comprises a first substantially vertical tubular shaft (not shown) having a first end and a second end and a vertical axis extending from the first end to the second end. The first end of the first shaft is fixed to the support frame 5 at the proximal end 204 of the frame 202 of the second lift assembly 200, such that the first shaft depends substantially vertically from the support frame 5. The line 240 of the second lift assembly 200 extends out of the frame 202 at the proximal end 206 through the first vertical tubular shaft. The patient services unit 4 further comprises a second substantially vertical shaft (not shown) slidably coupled to the first shaft and moveable in a vertical direction relative to the first shaft. The second end 244 of the line 240 of the second lift assembly 200 is fixed to the second vertical shaft for raising and lowering the second shaft relative to the first shaft. The one or more patient service elements of the patient service unit 4 are pivotally coupled to the second shaft, such that the one or more patient service elements are rotatable about the second shaft 4 and are raisable and lowerable with the second shaft on operation of the second lift assembly 200 to raise

and lower the second end 244 of the line 240.

[0158] It will be appreciated that in other embodiments, the first shaft, second shaft and one or more patient service elements may be coupled alternative arrangements. For example, the second shaft may be pivotally and slidably coupled to the first shaft and the one or more patient service elements may be fixedly coupled to the second shaft.

[0159] The specific embodiments and examples described above illustrate but do not limit the invention. It is to be understood that other embodiments of the invention may be made and the specific embodiments and examples described herein are not exhaustive.

[0160] Various preferred aspects of the invention are set out in the following numbered clauses:

1. A lift assembly for a patient lift system, the lift assembly comprising:

a frame having a proximal end and a distal end and a longitudinal axis extending from the proximal end to the distal end;
a carriage movable relative to the frame substantially in the direction of the longitudinal axis;
an actuator secured to the frame at or around the proximal end of the frame, the actuator being coupled to the carriage for moving the carriage relative to the frame substantially in the direction of the longitudinal axis; and
a line having a first end and a second end, the first end of the line being secured to the frame,

wherein:

the carriage comprises a first carriage line guide;
the line is arranged to extend from the first end over and around the first carriage line guide and away from the frame to the second end; and
the line is coupled to the carriage at least at the first carriage line guide such that movement of the carriage substantially along the longitudinal axis of the frame draws the line with the carriage and moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage.

2. A lift assembly according to clause 1, wherein:

the frame further comprises a first frame line guide;
the carriage further comprises a second carriage line guide; and
the line is arranged to extend from the first end over and around the first carriage line guide, over and around the first frame line guide, over and around the second carriage line guide and away from the frame to the second end.

3. A lift assembly according to clause 1, wherein:

the frame further comprises first, second and third frame line guides;
the carriage further comprises a second carriage line guide; and
the line is arranged to extend from the first end over and around the first frame line guide, over and around the first carriage line guide, over and around the second frame line guide, over and around the second carriage line guide, over and around the third frame line guide and away from the frame to the second end.

4. A lift assembly according to any one of clauses 2 or 3, wherein:

the lift assembly further comprises at least one additional pair of line guides, each additional pair of line guides comprising a frame line guide arranged on the frame and a carriage line guide arranged on the carriage; and
the line is further arranged to extend alternatingly over and around the additional carriage line guide and over and around the frame line guide of each additional pair of line guides.

5. A lift assembly according to any one of clauses 2, 3 or 4, wherein:

the frame line guides are arranged on the frame in a line substantially perpendicular to the longitudinal axis of the frame; and
the carriage line guides are arranged on the carriage in a line substantially perpendicular to the longitudinal axis of the frame when the carriage is coupled to the frame.

6. A lift assembly according to any one of clauses 2 to 5, wherein:

the carriage further comprises:

a body portion coupled to the actuator; and
two or more finger portions extending from the body portion substantially in the direction of the distal end of the frame, neighbouring ones of the finger portions being spaced apart to define a cavity for receiving a frame line guide of the frame; and

the carriage is arranged on the frame such that each cavity defined by neighbouring ones of the finger portions receives a frame line guide at least when the carriage is positioned at or around the distal end of the frame.

7. A lift assembly according to clause 6, wherein each

carriage line guide is arranged at a finger portion of the carriage.

8. A lift assembly according to clause 7, wherein each carriage line guide is arranged at or around a distal end of a finger portion of the carriage.

9. A lift assembly according to any one of clauses 2 to 8, wherein the or each frame line guide comprises at least one roller pivotally secured to the frame.

10. A lift assembly according to any preceding clause, wherein the or each carriage line guide comprises at least one roller pivotally secured to the carriage.

11. A lift assembly according to any preceding clause, wherein the line is arranged to extend away from the frame at or around the distal end of the frame.

12. A lift assembly according to any preceding clause, wherein:

the frame further comprises a distal line guide arranged at or around the distal end of the frame; and
the line is arranged to extend over the distal line guide before extending away from the frame to the second end.

13. A lift assembly according to any one of clauses 1 to 10, wherein the line is arranged to extend away from the frame at or around the proximal end of the frame.

14. A lift assembly according to clause 13, wherein:

the frame further comprises a proximal line guide arranged at or around the proximal end of the frame; and
the line is arranged to extend over the proximal line guide before extending away from the frame to the second end.

15. A lift assembly according to any preceding clause, wherein the first end of the line is secured to the frame at or around the distal end of the frame.

16. A lift assembly according to any preceding clause, wherein the actuator is a linear actuator.

17. A lift assembly according to any preceding clause, wherein the frame is arranged such that the longitudinal axis of the frame is substantially horizontal.

18. A lift assembly according to clause 17, wherein the line is arranged to extend away from the frame in a substantially vertical direction to the second end.

19. A lift assembly according to any preceding clause, wherein the line is one of: a belt, a chain, a rope, a strap or a chord.

20. A lift assembly according to any preceding clause, wherein the second end of the line comprises attachment means for attaching a patient lifting device to the second end of the line.

21. A patient lift system comprising a lift assembly according to any preceding clause.

22. A patient lift system according to clause 21, wherein the patient lift system comprises a support frame and the proximal end of the frame of the lift assembly is movably secured to the support frame of the patient lift system.

23. A patient lift system according to clause 22, wherein the lift assembly is movably secured to the support frame such that the longitudinal axis of the frame of the lift assembly is substantially horizontal and the frame of the lift assembly is movable substantially in a horizontal plane.

24. A patient lift system according to any one of clauses 22 or 23, wherein the patient lift system further comprises a rail and the distal end of the frame of the lift assembly is slidably coupled to the rail.

25. A patient lift system according to clause 24, wherein the proximal end of the frame of the lift assembly is pivotally secured to the support frame of the patient lift system and the rail of the patient lift system is substantially arcuate.

26. A patient lift system according to any one of clauses 22, 23 or 24, wherein the frame of the lift assembly is movably secured to the support frame of the patient lift system by a linkage.

27. A patient lift system according to any one of clauses 22 to 26, wherein the support frame is configured to be mounted to at least one of: a ceiling, a wall and a column.

28. A patient lift system according to any one of clauses 22 to 27, wherein the patient lift system further comprises a housing and the lift assembly and support frame are housed in the housing.

29. A patient lift system according to any one of clauses 21 to 28, wherein the patient lift system further comprises a sling bar coupled to the second end of the line of the lift assembly.

30. A patient lift system according to any one of clauses 21 to 28, wherein the patient lift system further comprises a sheet gripper coupled to the second end of the line of the lift assembly.

31. A patient lift system according to any one of clauses 21 to 30, wherein the patient lift system comprises two lift assemblies according to any one of clauses 1 to 20, a first lift assembly and a second lift assembly.

32. A patient lift system according to clause 31, wherein the proximal end of the frame of the first lift assembly is movably secured to the support frame.

33. A patient lift system according to any one of clauses 31 or 32, wherein the frame of the second patient lift system is fixedly secured to the support frame.

34. A patient lift system according to any one of clauses 31, 32 or 33, wherein the longitudinal axis of the first lift assembly and the longitudinal axis of the second lift assembly are substantially horizontal.

35. A patient lift system according to any one of clauses 31 to 34, wherein the longitudinal axis of the first lift assembly and the longitudinal axis of the second lift assembly are arranged substantially on the same plane.

36. A patient lift system according to any one of clauses 31 to 35, wherein the proximal end of the frame of the second lift assembly is arranged on the support frame at or around the proximal end of the frame of the first lift assembly.

37. A patient lift system according to any one of clauses 31 to 36, wherein:

a patient lifting device is coupled to the second end of the line of the first lift assembly; and
one or more patient service elements of a patient service unit are coupled to the second end of the line of the second lift assembly.

38. A lift assembly for a patient lift system, the lift assembly comprising:

a frame having a proximal end and a distal end and a longitudinal axis extending from the proximal end to the distal end;
a carriage movable relative to the frame substantially in the direction of the longitudinal axis;
an actuator secured to the frame at or around the proximal end of the frame, the actuator being coupled to the carriage for moving the carriage relative to the frame substantially in the direction of the longitudinal axis; and
a line having a first end and a second end, the first end of the line being secured to the carriage,

wherein:

the frame comprises a first frame line guide;
the carriage comprises a first carriage line guide;
the line is arranged to extend from the first end over and around the first frame line guide, over and around the first carriage line guide and away from the frame to the second end; and
the line is coupled to the carriage at least at the first end and at the first carriage line guide such that movement of the carriage substantially along the longitudinal axis of the frame draws the line with the carriage and moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage.

39. A patient services unit comprising:

a lift assembly according to any one of clauses 1 to 21 or clause 38;
a first substantially vertical tubular shaft having a first end and a second end and a vertical axis extending from the first end to the second end, the first shaft being fixed or fixable at the first end on the support frame;
a second substantially vertical tubular shaft arranged at or around the second end of the first shaft, coupled to the first shaft and moveable in a vertical direction relative to the first shaft; and
at least one patient service element for supplying assistance and/or services to a patient, the at least one patient service element being mounted to the second shaft,

wherein the second end of the line of the lift assembly is coupled to the second shaft for moving the second shaft relative to the first shaft in a vertical direction.

Claims

1. A lift assembly for a patient lift system, the lift assembly comprising:

a frame having a proximal end and a distal end and a longitudinal axis extending from the proximal end to the distal end;
a carriage movable relative to the frame substantially in the direction of the longitudinal axis;
an actuator secured to the frame, the actuator being coupled to the carriage for moving the carriage relative to the frame substantially in the direction of the longitudinal axis; and

a line having a first end and a second end, the first end of the line being secured to the frame,

wherein:

the carriage comprises a first carriage line guide; the line is arranged to extend from the first end over and around the first carriage line guide and away from the frame to the second end; and
the line is coupled to the carriage at least at the first carriage line guide such that movement of the carriage substantially along the longitudinal axis of the frame draws the line with the carriage and moves the second end of the line towards or away from the frame depending on the direction of movement of the carriage.

2. A lift assembly according to claim 1, wherein:

the frame further comprises a first frame line guide;
the carriage further comprises a second carriage line guide; and
the line is arranged to extend from the first end over and around the first carriage line guide, over and around the first frame line guide, over and around the second carriage line guide and away from the frame to the second end.

3. A lift assembly according to claim 1, wherein:

the frame further comprises first, second and third frame line guides;
the carriage further comprises a second carriage line guide; and
the line is arranged to extend from the first end over and around the first frame line guide, over and around the first carriage line guide, over and around the second frame line guide, over and around the second carriage line guide, over and around the third frame line guide and away from the frame to the second end.

4. A lift assembly according to any one of claims 2 or 3, wherein:

the lift assembly further comprises at least one additional pair of line guides, each additional pair of line guides comprising a frame line guide arranged on the frame and a carriage line guide arranged on the carriage; and
the line is further arranged to extend alternatingly over and around the additional carriage line guide and over and around the frame line guide of each additional pair of line guides.

5. A lift assembly according to any one of clauses 2, 3 or 4, wherein:

the carriage further comprises:

a body portion coupled to the actuator; and two or more finger portions extending from the body portion substantially in the direction of the distal end of the frame, neighbouring ones of the finger portions being spaced apart to define a cavity for receiving a frame line guide of the frame; and

the carriage is arranged on the frame such that each cavity defined by neighbouring ones of the finger portions receives a frame line guide at least when the carriage is at or around the distal end of the frame.

6. A lift assembly according to any one of claims 2 to 5, wherein:

the or each frame line guide comprises at least one roller pivotally secured to the frame; and
the or each carriage line guide comprises at least one roller pivotally secured to the carriage.

7. A lift assembly according to any preceding claim, wherein the frame is arranged such that the longitudinal axis of the frame is substantially horizontal.

8. A lift assembly according to any preceding claim, wherein the second end of the line comprises attachment means for attaching an patient lifting device to the second end of the line.

9. A patient lift system comprising a lift assembly according to any preceding claim.

10. A patient lift system according to claim 9, wherein the patient lift system comprises a support frame and the proximal end of the frame of the lift assembly is movably secured to the support frame of the patient lift system.

11. A patient lift system according to any one of claims 9 or 10, wherein the patient lift system further comprises a rail and the distal end of the frame of the lift assembly is slidably coupled to the rail.

12. A patient lift system according to any one of claims 10 or 11, wherein the support frame is configured to be mounted to at least one of: a ceiling, a wall and a column.

13. A patient lift system according to any one of claims 9 to 12, wherein the patient lift system further comprises at least one of a sling bar and a sheet gripper coupled to the second end of the line of the lift assembly.

14. A patient lift system according to any one of claims 9 to 13, wherein the patient lift system comprises two lift assemblies according to any one of claims 1 to 8, a first lift assembly and a second lift assembly.

15. A patient lift system according to claim 14, wherein:

a patient lifting device is coupled to the second end of the line of the first lift assembly; and
one or more patient service elements of a patient service unit are coupled to the second end of the line of the second lift assembly.

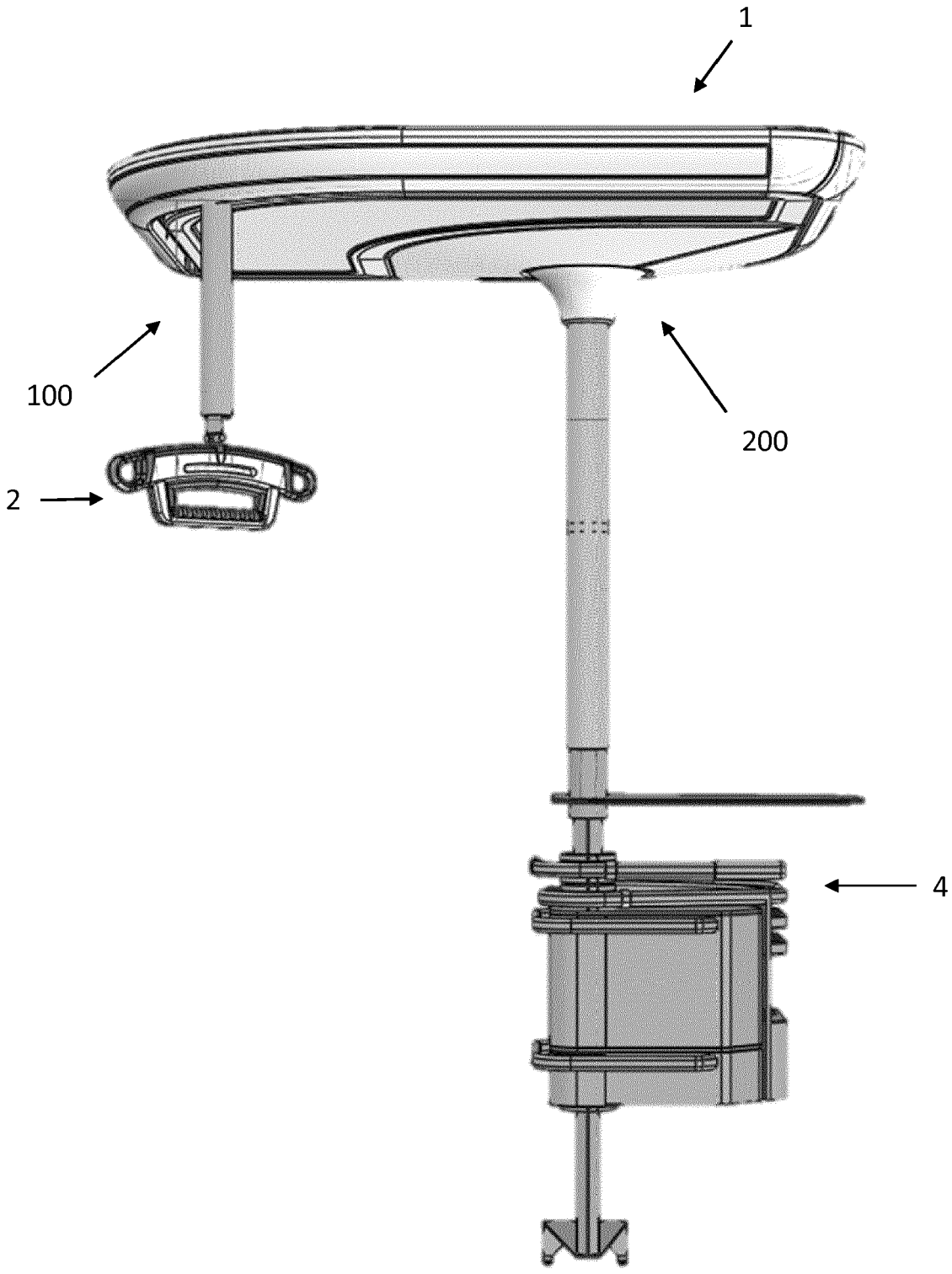

Figure 1

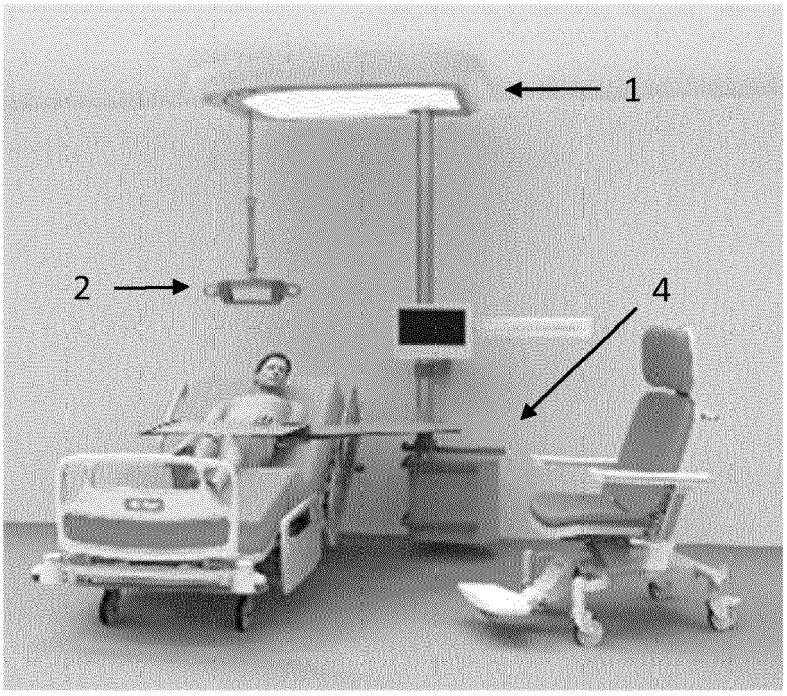

Figure 2

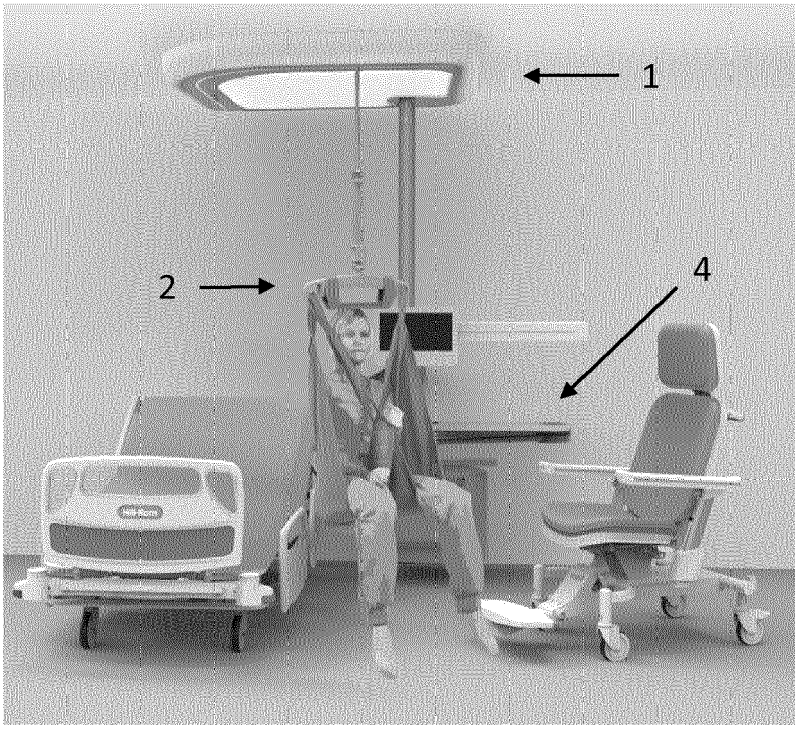

Figure 3

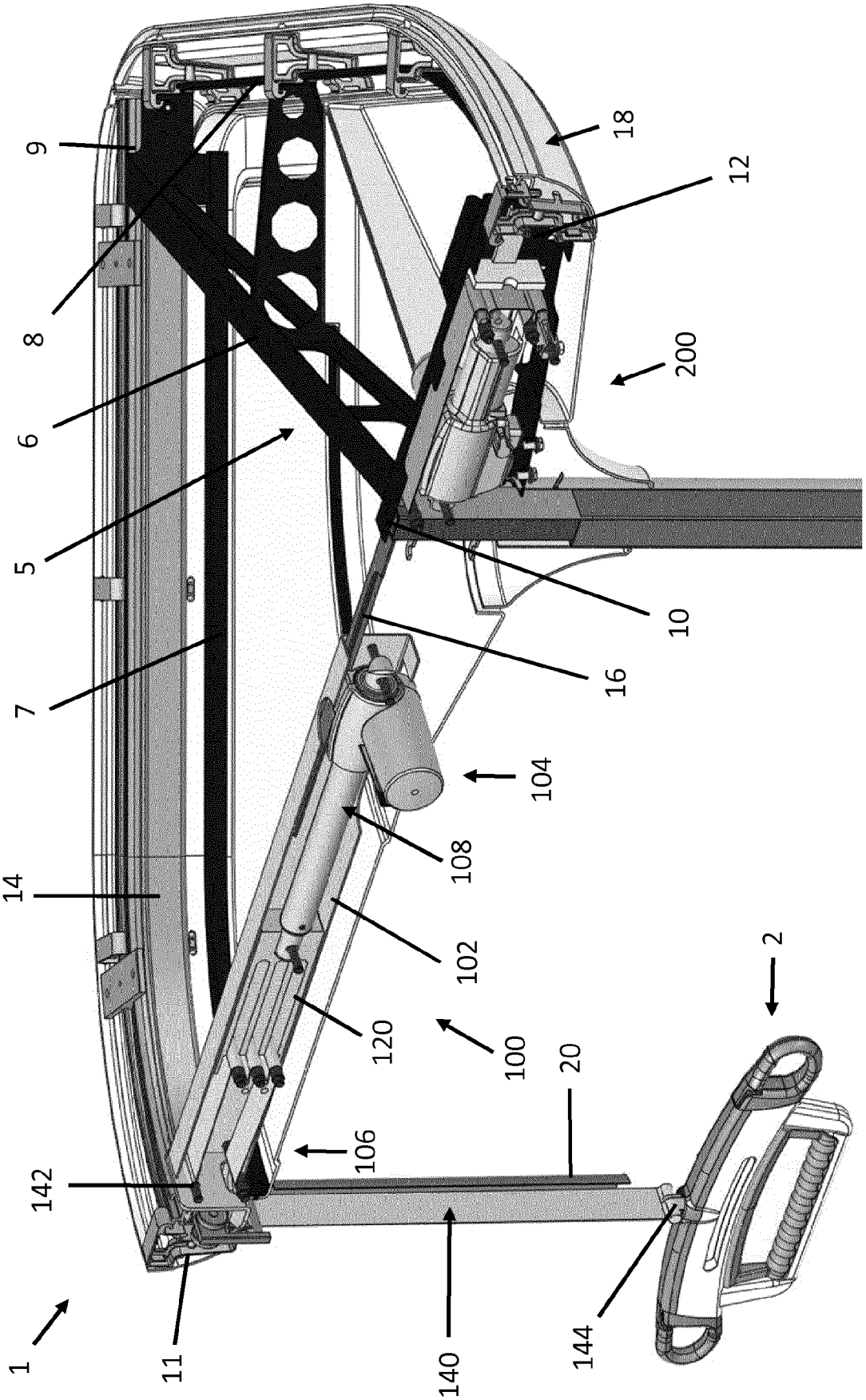
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Figure 4

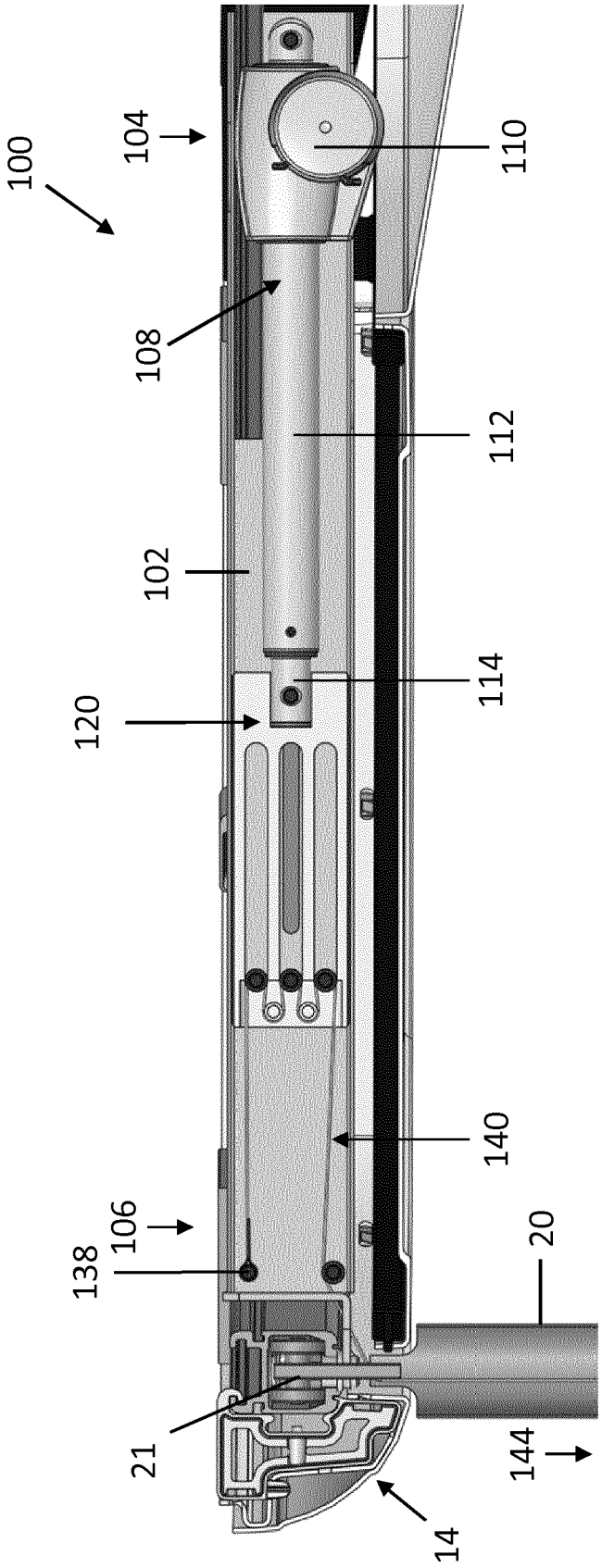

Figure 5

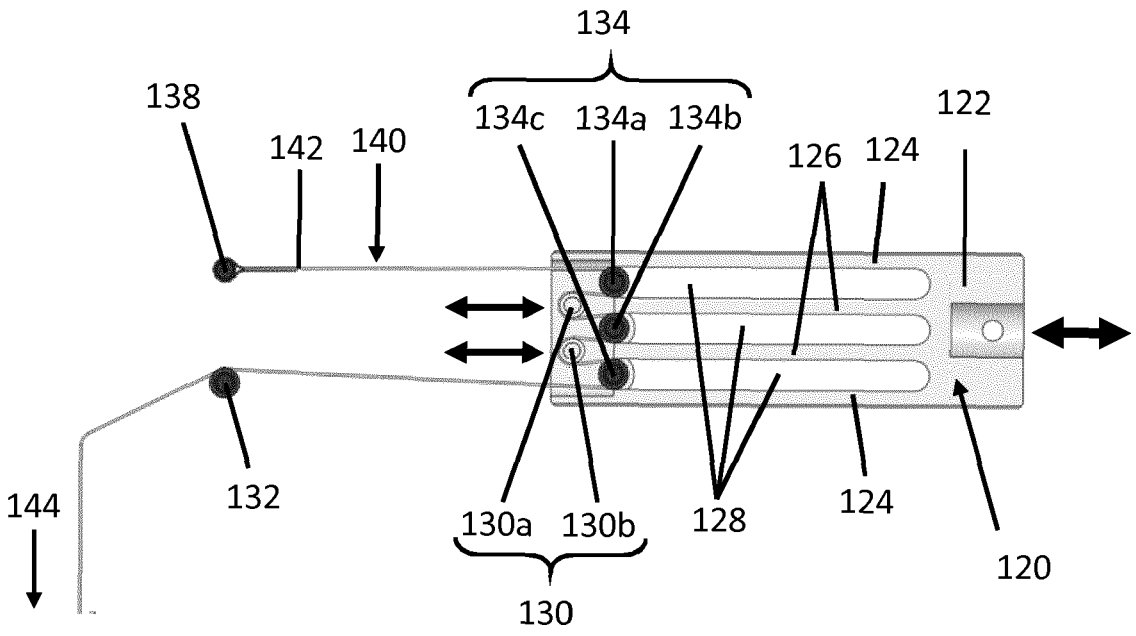
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Figure 6

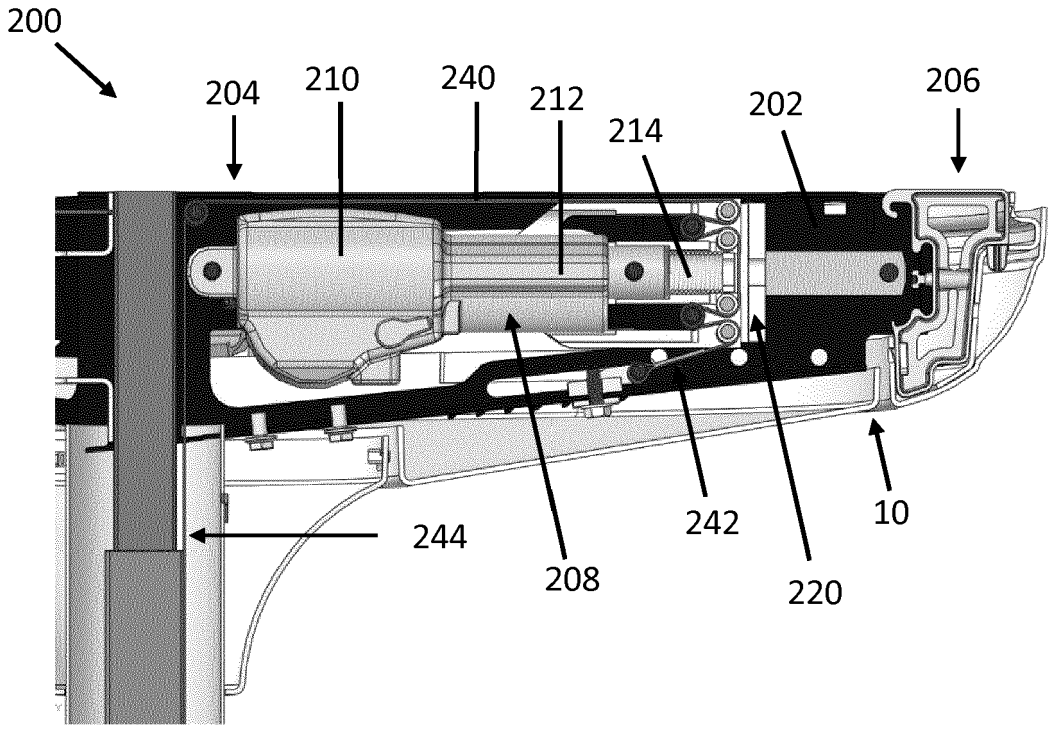

Figure 7

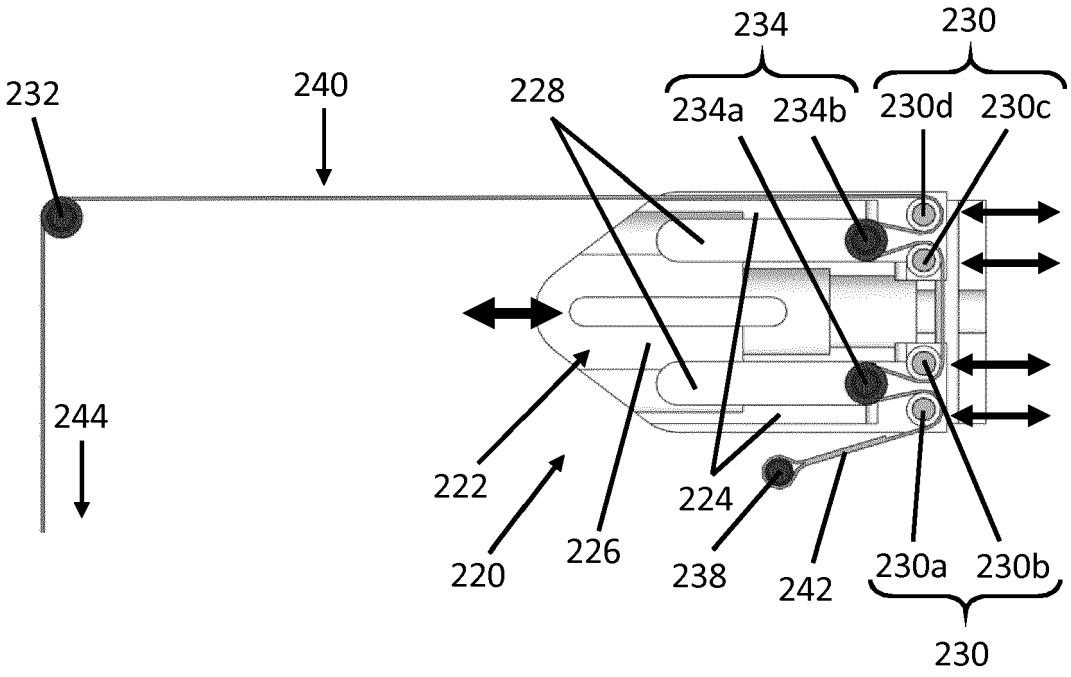

Figure 8

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EUROPEAN SEARCH REPORT

Application Number
EP 17 30 5640

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H05 161676 A (GUNNAA RIRUJIEDAARU) 29 June 1993 (1993-06-29) * paragraphs [0010] - [0020]; figures 1-2 *	1-4,6-15	INV. A61G7/10
X	US 2005/044629 A1 (ROUSE SAMUEL K [US] ET AL) 3 March 2005 (2005-03-03) * paragraphs [0026] - [0052]; figures 1-18 *	1-4, 6-10, 12-15	
A	JP 2004 016717 A (GLORY KOGYO KK) 22 January 2004 (2004-01-22) * paragraphs [0023] - [0034]; figures 1-3 *	11	

TECHNICAL FIELDS SEARCHED (IPC)

A61G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 November 2017	Petzold, Jan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 30 5640

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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17-11-2017

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