

United States Patent

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Limited
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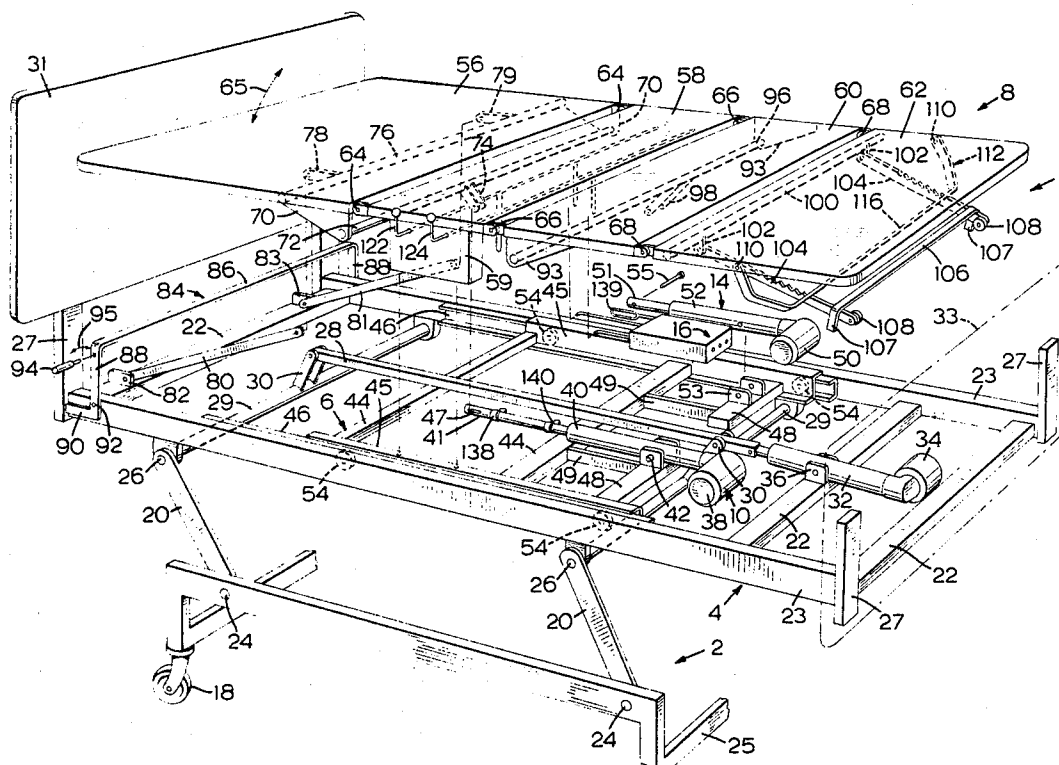
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[54] RETRACTABLE BED 45 Claims, 6 Drawing Figs.

[52] U.S. Cl. 5/66, 5/68
 [51] Int. Cl. A61g 7/10,
 A61g 7/00
 [50] Field of Search 5/63,
 66—69

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ABSTRACT: A retractable bed having a first frame supported off the floor by a high-low mechanism and a second frame slidably mounted on the first frame. A mattress frame, having a head section, seat section, and leg section which includes thigh and foot sections, is supported on the second frame with the seat section rigidly attached to the second frame. An actuating mechanism is provided for pivoting the head section to permit the patient to be moved from a prone position to a sitting position and vice versa, while at the same time moving the second frame and the mattress frame towards or away from the headboard of the bed, to thereby keep the patient's head and shoulders at substantially the same horizontal distance from the end of the bed.



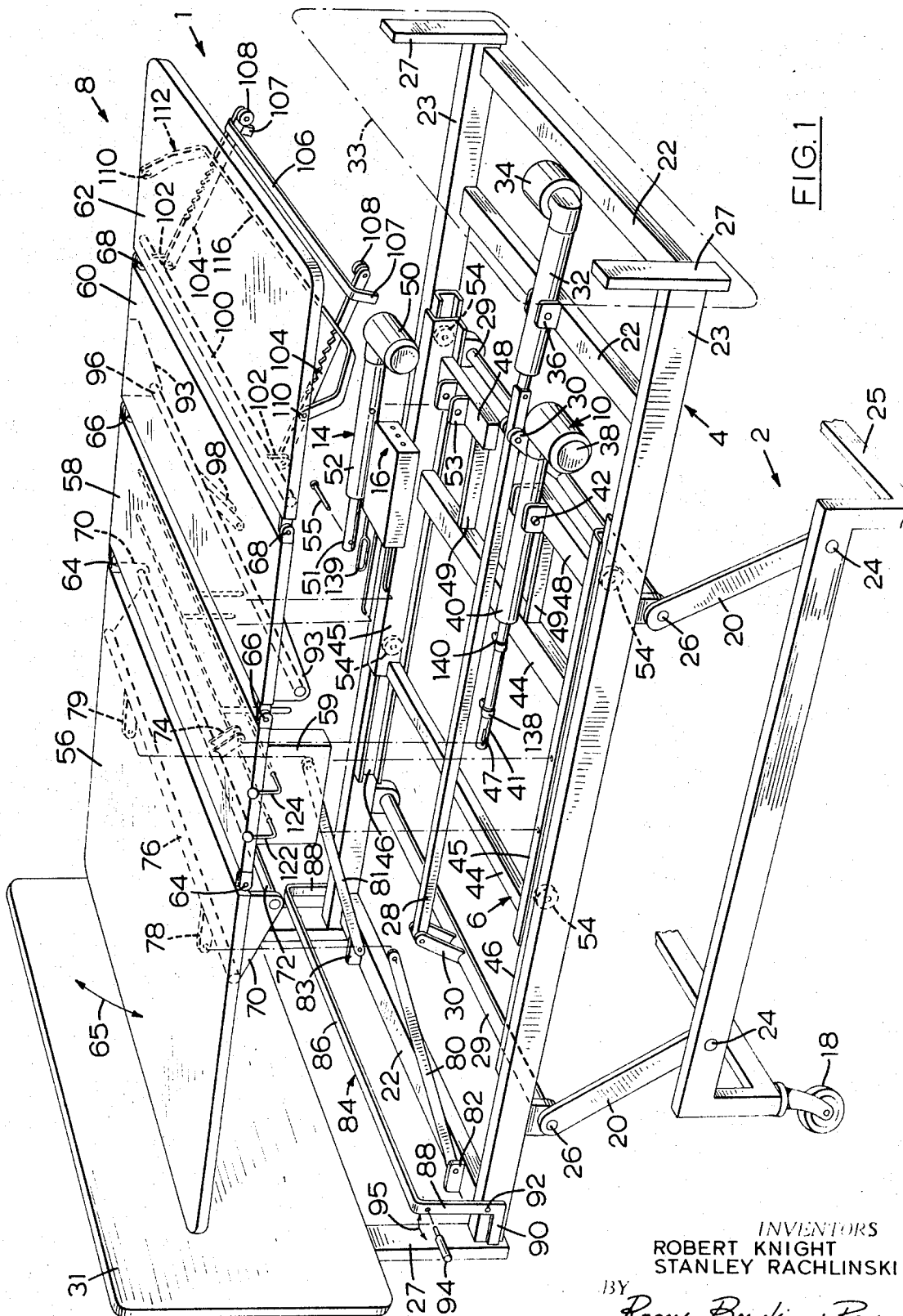


FIG. 1

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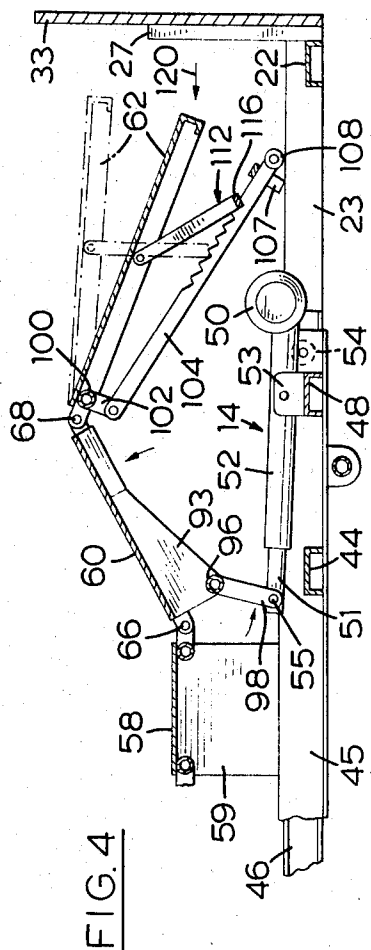


FIG. 4

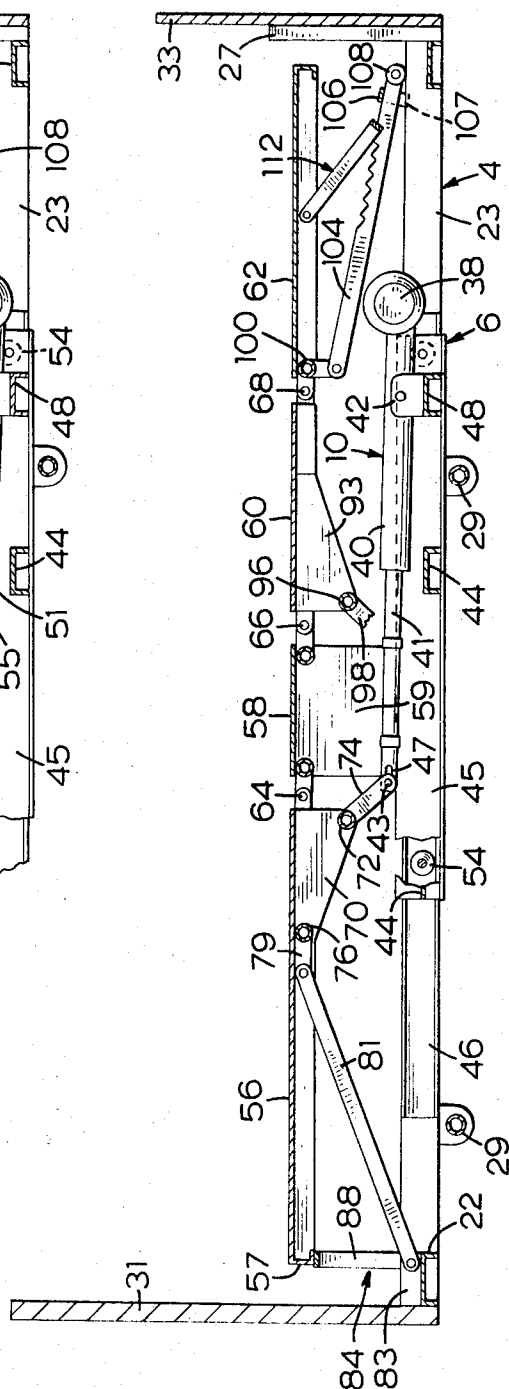


FIG. 2

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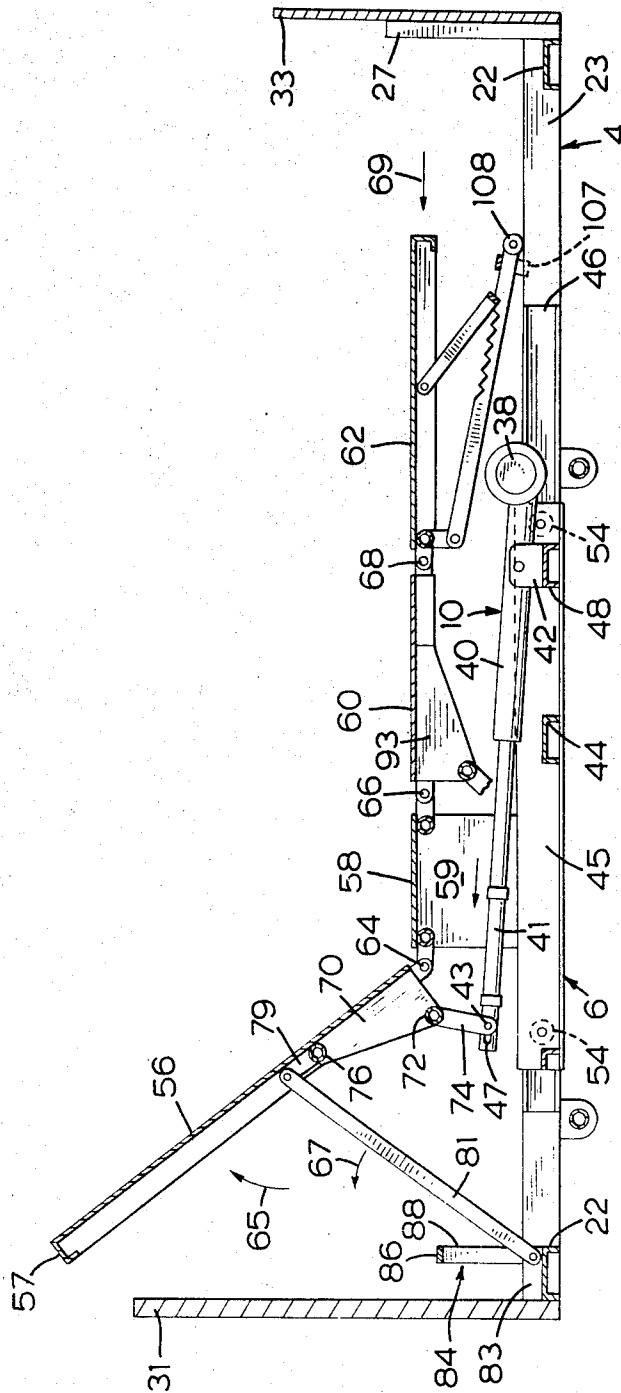
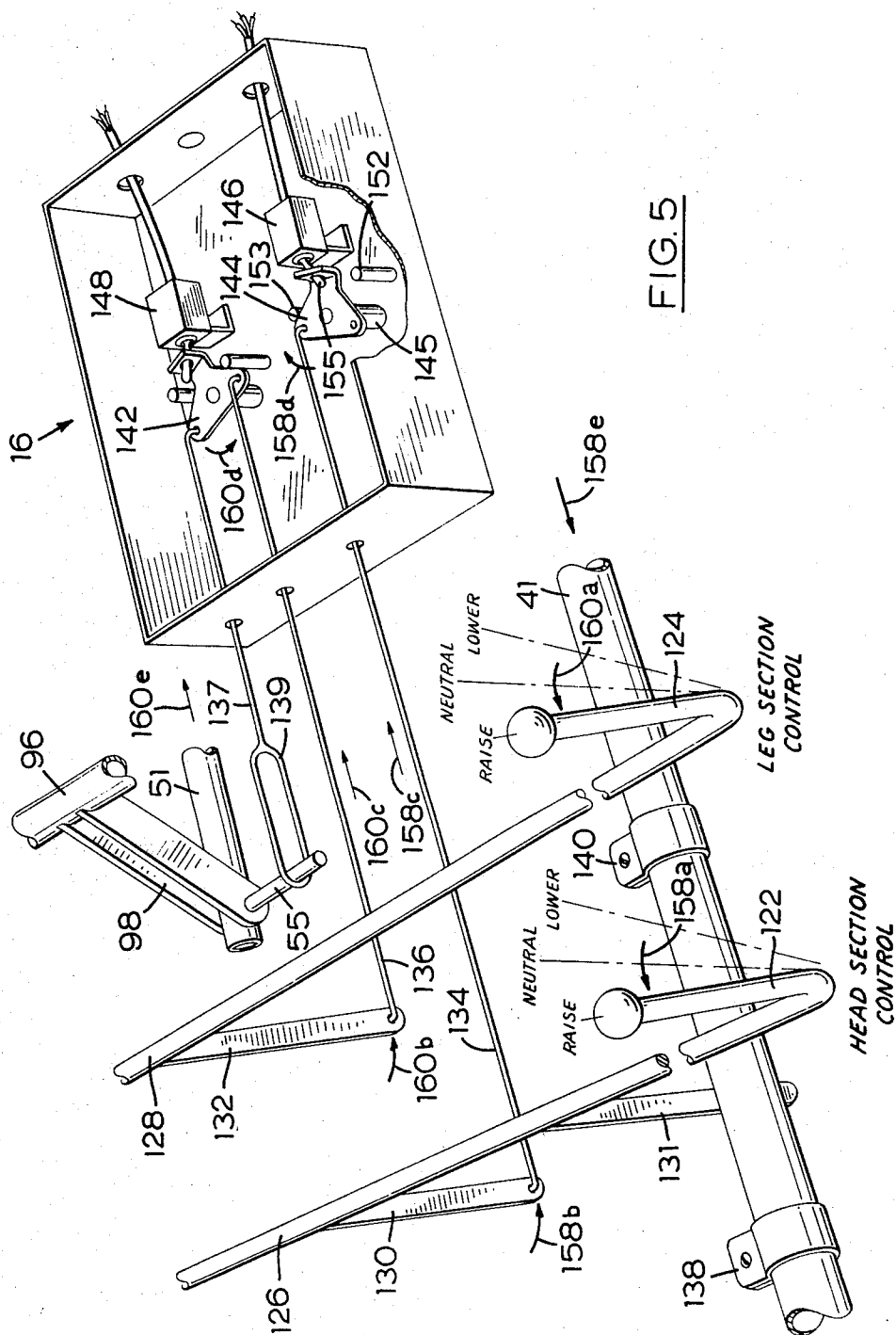


FIG. 3

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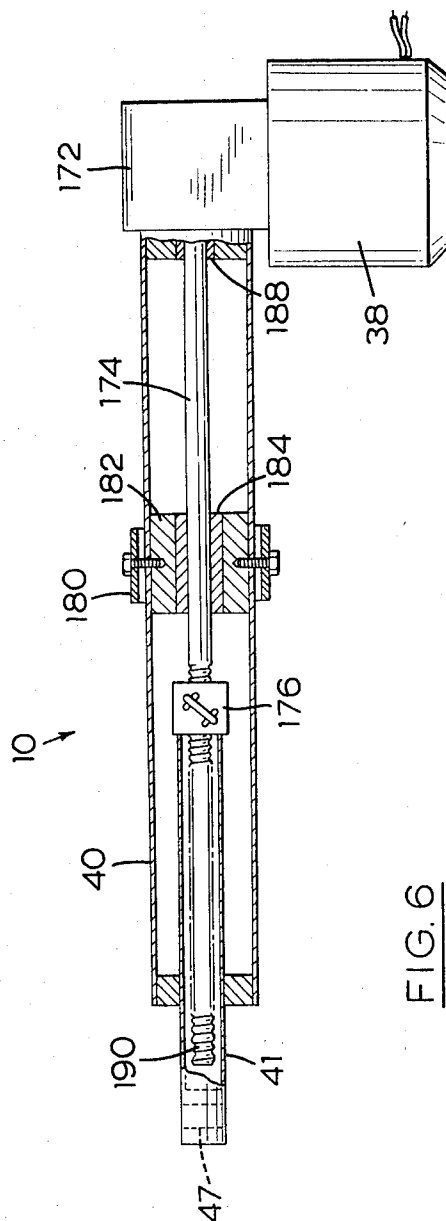


FIG. 6

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RETRACTABLE BED

This invention relates to beds and in particular to a retractable hospital bed.

It is customary to provide hospital beds with numerous adjustable elements to improve patient comfort, to facilitate nursing care, and to assist in the treatment of certain medical conditions. For example, the height of the bed usually is adjustable between high and low positions. When the bed is in its high position, it is easier for the nurse to care for the patient, and when it is in its low position it is easier for the patient to get into and out of bed. A bed incorporating this feature is commonly referred to as a "high-low" bed. Other adjustments are commonly provided to allow a mattress frame to hinge at a number of points along its length so that the patient can be supported in various positions, such as a sitting position, Trendelenberg position, and reverse Trendelenberg position. A typical bed incorporating these adjustments has a seat section attached to a main frame of the bed, a head section, and a leg section, the head and leg sections respectively being pivotally secured to the seat section on opposite sides thereof. The leg section includes a thigh section and a foot section pivotally secured to the thigh section. The foot and thigh sections usually are coplanar when the bed is in the Trendelenberg or reverse Trendelenberg positions, but of course they may be pivoted to an appropriate degree when the patient is in a sitting position with his legs bent somewhat.

When the head section is tilted to support a patient in the sitting position, his head and shoulders are further away from the head end of the bed than they are when he is in a prone position. This relative movement of the patient's head and shoulders often causes the patient some difficulty in reaching switches and personal effects placed in bedside cabinets and the like, which are usually positioned for easy access in one position of the patient and therefore are somewhat out of position when the patient is in the other position.

Objects of the present invention are to provide an improved bed having a mattress frame which automatically retracts towards the head end of the bed as the head section is elevated, which can easily be adjusted into the various positions described above, and which is reliable, sturdy, and relatively economical to manufacture.

A preferred form of the present bed consists of a main or first frame spaced from the floor, preferably supported by a high-low mechanism of the kind described in Canadian Pat. No. 728,839, and a second frame slidably mounted on the first frame. A mattress frame, having a head section seat section, and leg section (including thigh and foot sections) is supported on the second frame with the seat section rigidly attached to the second frame. An actuating mechanism is provided for pivoting the head section to permit the patient to be moved from a prone position to a sitting position and vice versa, while at the same time moving the second frame and the mattress frame towards (or away from) the headboard of the bed, to thereby keep the patient's head and shoulders at substantially the same horizontal distance from the end of the bed.

In drawings illustrating a preferred embodiment of the invention,

FIG. 1 is a perspective partially exploded view of an improved retractable bed;

FIG. 2 is a sectional view of the bed in the horizontal, or normal, position;

FIG. 3 is a sectional view of the bed showing the mattress frame in position for supporting a patient in a sitting position;

FIG. 4 is a diagrammatic sectional view of the bed showing the leg section of the mattress frame in various positions;

FIG. 5 is a somewhat diagrammatic perspective view of a control system for use with the bed; and

FIG. 6 is a sectional view through an actuating mechanism used in performing various adjustments.

Referring to FIG. 1, an improved retractable bed 1 consists of a rectangular main or first frame 4 supported by a high-low

mechanism 2, and a rectangular second frame 6 slidably mounted on the first frame 4 to allow longitudinal motion of the second frame 6 relative to the first frame 4. Supported on the second frame 6 is a generally rectangular mattress support frame 8 consisting of a head section 56, a seat section 58, a thigh section 60, and a foot section 62 hingedly connected in series. The seat section 58 is fixed to the second frame 6, the other sections being free to pivot. A head-section-actuating mechanism 10 is mounted in a trunnion 42 on the second frame 6 and is adapted to tilt the head section 56 about pivot points 64 attached to the seat section 58 and contemporaneously to slide the second frame 6 along the first frame 4 towards a headboard 31. A leg-section-actuating mechanism 14 is also mounted on the second frame 6 and it is adapted to lift the thigh section 60 about pivot points 66.

The first frame 4 consists of a pair of longitudinal members 23 connected by a series of transverse members 22 and is provided with vertical standards 27 to which the headboard 31 and a footboard 33 are secured. The high-low mechanism 2 which is similar to the apparatus described in Canadian Pat. No. 728,839 consists of a lower frame 25 supported on wheels 18 and it has parallel links 20 pivotally mounted on the frame 25 at points 24. A pair of axles 29, each having a link 20 rigidly attached at each end, is pivotally supported on the underside of the main frame at pivot points 26 and a pair of parallel cranks 30 are respectively fixed to the axles 29 and interconnected with a pushrod 28 pivotally secured at its ends to the cranks 30. A cylindrical housing 32 is secured to a trunnion 36 on a transverse member 22, and it houses an actuating mechanism (described in detail below with reference to FIG. 6) which is driven by a reversible electric motor 34 for imparting longitudinal movement to the pushrod 28. The high-low mechanism 2 utilizes the longitudinal motion of the pushrod 28 to raise and lower the first frame 4.

The second frame 6 consists of a pair of longitudinal members 45 spaced apart by a pair of transverse members 44. Two trunnion support bars 48 are respectively fixed to each of the longitudinal members 45 and each is strengthened by a bar 49 which extends between an adjacent transverse bar 44 and the trunnion support bar 48. The longitudinal members 45 each have a pair of wheels or rollers 54 secured to the outside face of the members 45. The wheels 54 are constrained within U-sectioned tracks 46 secured to the longitudinal members 23.

The head-section-actuating mechanism 10 is mounted on trunnion bolts 42 (one of which is shown) and it is contained within a cylindrical housing 40. The mechanism 10 (described in detail below with reference to FIG. 6) is operated by a reversible motor 38 and is adapted to move a rod 41 longitudinally inwards and outwards. As the rod 41 moves it operates a system of interconnected rods and cranks to lift the head section 56 as follows.

A pair of identical brackets 70 are respectively attached to opposite sides of the head section 56 and a first rod 72 and a second rod 76 extend between them. A crank 74 is fixed to the rod 72 and is pivotally connected at its distal end to the distal end of the rod 41. As the crank 74 rotates, the actuating mechanism 10 rocks in trunnion bolts 42. A pair of identical cranks 78 and 79 are fixed to the second rod 76 and are pivotally connected at their distal ends to one end of identical radius arms 80 and 81 which respectively are pivotally supported in brackets 82 and 83 on transverse member 22. The position of the second frame 6 relative to the first frame 4 is determined by the angle of the radius arms 80 and 81 with respect to the longitudinal axis of the bed.

When the head section 56 of the mattress frame 8 is in a horizontal position as shown in FIG. 1, it is supported by a frame 84 formed with a generally horizontal portion 86, and two generally vertical portions 88 which terminate in horizontal portions 90 which constitute stops. The frame 84 is pivotally connected to the longitudinal members 23 at pivot points 92 and is normally balanced in the position shown in FIG. 1 with the stop portions 90 abutting the standards 27. A handle 94 is used to move the frame 84 towards the headboard

31, as indicated by arrow 95, so that the head section 56 may pivot downwardly to provide the Trendelenberg position. A slot 47 in the rod 41 allows the head section 56 to so move without pulling on the rod 41.

FIGS. 2 and 3 illustrate the position of the head-section-actuating mechanism 10 and its associated parts when the head section 56 is in a horizontal position (FIG. 2) and a raised position (FIG. 3). The head section 56 is raised by the actuation of the motor 38 which causes the rod 41 to extend outwardly from the housing 40 and thereby operate the crank 74 through pin 43. The crank 74, rod 72, brackets 70 and head section 56 are all welded together to form an integral unit. Since the unit is hinged at 64 to a pair of similar supports 59 (only one of which is shown) which forms part of the second frame, and the mechanism 10 is also mounted on the second frame, all of the movement of the rod 41 is used to move the head section 56 upwardly about the pivot points 64.

Longitudinal motion of the second frame 6 relative to the first frame 4 is possible only if the radius arms 80 and 81 describe an arc about their lower pivot points. Referring to FIG. 3, when the mechanism 10 causes the head section 56 to rotate about the pivots 64 in the direction of arrow 65, the radius arms 80, 81 rotate in the direction of arrow 67. The projected horizontal length of the arms 80 and 81 in the position shown in FIG. 2 is longer than the projected horizontal length of the same arms in the position shown in FIG. 3 because they are obviously at a steeper angle in FIG. 3. Since the radius arms 80 and 81 control the position of the second frame 6 relative to the first frame 4, the second frame 6 must move towards the headboard 31 in order to compensate for the change in projected length of the arms 80 and 81. Arrow 69 (FIG. 3) indicates the movement of the second frame and its associated parts. Thus, when the head section 56 of the bed is raised its leading edge 57 maintains almost exactly the same horizontal position, i.e. directly above the support frame 84. The patient's head and shoulders thus remain at substantially the same distance away from the headboard 31 during raising and lowering of the head section 56.

In the bed shown in the drawings, the head-section-actuating mechanism 10 is secured to the second frame 6. However, the head-section-actuating mechanism 10 may be secured to the first frame 4 if required. It would then be necessary to lengthen the rod 41 on the actuating mechanism 10 since the second frame 6 moves relative to the first frame 4 and this movement must be taken up by the rod 41. It is therefore preferable to mount the mechanism 10 on the second frame 6 so that the length of the rod 41 can be kept to a minimum. The mechanism 10 could also be secured to the main frame 4 near the headboard 31 or below the transverse member 22. The rod 41 would then act directly on the leading edge 57 of the head section 56 of the mattress frame 8. However, this arrangement has the disadvantage that it may interfere with the high-low motion, and make the bed less attractive.

FIGS. 1, 3 and 4 illustrate the operation of the leg-section-actuating mechanism 14. Referring to FIG. 1 a reversible motor 50 and cylindrical housing 52 similar to that of the head-section-actuating mechanism 10 is supported in a trunnion 53 and operates a rod 51 longitudinally inwards and outwards. The thigh section 60 is hingedly connected at pivot points 66 to the seat section 58, and a pair of identical plates 93 which are connected rigidly by a rod 96 are fixed to the thigh section 60 on opposite sides thereof. A crank 98 is rigidly connected to the rod 96 and is pivotally connected at its distal end by a pin 55 to the distal end of the rod 51. The pin 55 forms part of a control mechanism more fully described below with reference to FIG. 5. The thigh section 60 of the mattress frame 8 is pivoted at pivot points 68 to the foot section 62. A rod 100 carries a pair of rigidly connected cranks 102 and is fixed at its end to the foot section 62. The foot section 62 is supported by a pair of parallel notched bars 104 which are pivotally connected to the cranks 102. The notched bars 104 can be pivoted into various angular positions by engagement of their notches with a U-shaped notch-engaging

member 112. The parallel notched bars 104 each have a roller or wheel 108 rotatably secured at their distal ends and the U-shaped bar 112 is pivotally attached at pivot points 110 to the foot section 62. The U-shaped bar 112 has a generally horizontal portion 116 for engagement with the notches of the notched bars 104. A transverse bar 106 fixed at its ends to the notched bars 104 keeps them parallel to each other. The rollers 108 are sufficiently far apart to allow them to run on the upper surfaces of the longitudinal members 23, and they are guided by legs 107 which slide on the outer faces of the longitudinal members 23. The foot section 62 may be lowered into the reverse Trendelenberg position by lifting the foot section 62 and U-shaped notch-engaging bar 112, and then lowering the foot section 62 with the notch-engaging bar 112 against the transverse member 106 (this position is not shown in the drawings).

FIGS. 2 and 4 illustrate the thigh section 60 and foot section 62 and their associated parts in a horizontal position (partially shown in FIG. 2) and a raised position (FIG. 4). To move the thigh section 60 upwardly as shown in FIG. 4, the electric motor 50 is activated, thereby causing the rod 51 to withdraw into the housing 52. The crank 98, rod 96 and plates 93 are rigidly connected and turn as a unit about the pivot points 66 as the rod 51 moves inwardly. The foot section 62, notched bars 104, and U-shaped notch-engaging bar 112, pivot as a unit about the pivot points 68 while moving in the direction of arrow 120 (FIG. 4). A typical position of the foot section 62 is shown in FIG. 4 in solid outline. If it is required to raise the foot section 62 further, the nurse can lift the foot section 62 manually to the desired extent and the notch-engaging bar 112 then falls into the nearest notch, thereby locking the foot section 62 in position (e.g. the position shown in chain-dotted outline in FIG. 4). It is preferable to lower the foot section 62 back to the position shown in solid outline in FIG. 4 before lowering the thigh section 60 with the aid of the motor 50. This will ensure that the bed returns to the flat horizontal position shown in FIG. 2. Movement of the thigh section 60 does not result in movement of the second frame 6 relative to the first frame 4.

The motor 50, housing 52, and associated internal parts are similar to the motor 38, housing 40 and its associated internal parts. The operations described above require the rod 41 of the head-section-actuating mechanism 10 to move away from the motor 38, and the rod 51 of the leg-section-actuating mechanism 14 to move towards the motor 50, when the head sections 56 and the thigh section 60 are raised from their horizontal positions shown in FIG. 2. However, since both of these operations are reversible, the actuating mechanisms can be identical.

The actuating mechanisms described in detail below are controlled as follows. Referring to FIGS. 1 and 5, a pair of control levers 122 and 124 extend through openings in the supports 59 for the seat section 58 (see FIG. 1) and they control the movement of the head and thigh sections respectively. The head section control lever 122 (FIG. 5) is shown in "raise" position; the other positions are "neutral" and "lower." A control bar 126 is integrally formed with the lever 122, and it has a pair of cranks 130 and 131 rigidly attached to it. A control rod 134 is pivotally attached at one end to the distal end of the crank 130 and is pivotally attached at its opposite end to a switch-actuating plate 144. A support pillar 145 pivotally supports the switch-actuating plate 144. The switch-actuating plate 144 can move from a first position where it abuts against a stop 153, to a second position (not shown) where it abuts against a stop 152. These positions of the switch-actuating plate 144 respectively correspond to the "raise" and "lower" positions shown for the lever 122. When the lever 122 is in the "neutral" position the switch-actuating plate 144 is midway between the stops 153 and 152. A switch 146 for activating the electric motor 38 is connected through a switch lever 155 to the switchplate 144 so that as the switchplate 144 is moved by the lever 122 it sets the switch 146 in one of three positions corresponding to the "raise," "lower," and "neutral" positions.

neutral" and "lower" positions of the lever 122. The switch 146 is a SPDT (single pole double throw) toggle switch with a center "off" position.

When the lever 122 is moved from the "neutral" position to the "raise" position (arrow 158a), it causes the crank 130 to move in the direction of arrow 158b so that the rod 134 moves in the direction of arrow 158c and causes the switchplate 144 to rotate in the direction of arrow 158d until it hits the stop 153. One circuit of the switch 146 thereupon closes, thereby actuating the motor 38 which results in movement of rod 41 in the direction of arrow 158e. The rod 41 has a pair of stops 138 and 140 adjustably secured to it. If the lever 122 is left in the "raise" position, the stop 140 eventually engages the crank 131 and turns the lever 122 back to the "neutral" position. The resulting motion of the rod 134 returns the switch 146 to its center "off" position, thereby stopping the motor 38. The operation is similar when the lever 122 is placed in the "lower" position. In this case the stop 138 will return the lever 122 to the "neutral" position when it engages the crank 131. In the "lower" position, the direction of the arrow 158e is reversed.

The leg section control lever 124 is shown in the "raise" position in FIG. 5. A control bar 128 is rigidly attached to the lever 124 and it has a crank 132 rigidly attached to it. A control rod 136 is pivotally connected at one end to the distal end of the crank 132 and is pivotally connected at its other end to a switch-actuating plate 142, similar to switch-actuating plate 144. A SPDT center "off" switch 148 is linked to the switch-actuating plate 142 in the same way as the switch-actuating plate 144 is linked to the switch 146. A second control rod 137 is pivotally connected at one end to the switch-actuating plate 142 and it has a parallel-sided rigid loop 139 at its other end. The pin 55 on the rod 51 pivotally connects the rod 51 to crank 98, and slides freely within the loop 139.

When the lever 124 is moved from the "neutral" to the "raise" position (arrow 160a), it rotates the crank 132 in the direction of arrow 160b thereby causing the rod 136 to move in the direction of arrow 160c, and causing the switch-actuating plate 142 to rotate in the direction of arrow 160d. One circuit of the switch 148 thereupon closes, thus activating the motor 50 (FIG. 1) and causing the rod 51 to move in the direction of arrow 160e (FIG. 5). If the lever 124 is left in the "raise" position, the rod 51 will carry the pin 55 along the loop 139 until the pin 55 engages the closed end of the loop 139 nearest the switch-actuating plate 142. The rod 51 will continue to move until the pin 55 has pushed the rod 137 sufficiently to move the switch 148 into the "off" position. The motor 50 then stops and the thigh section is then in the maximum raised position. When the lever 124 is moved into the "lower" position, the same operation occurs except that the direction of the arrows 160 is reversed. The pin 55 will then pull the free end of the loop 139 to move the switch 148 to the "off" position.

The purpose of the stops 138, 140 and loop 139 is to automatically limit the travel of the rods 41 and 51 respectively. However, the movement of the rods 41 and 51 (and hence the inclination of the head and thigh sections) can be stopped at any time by moving the levers 122 and 124 into the "neutral" position.

The levers 122 and 124 are duplicated on the other side of the bed (not shown in the drawings). A control box 16 houses the switches 146, 148 and associated parts and is positioned on any convenient portion of the second frame 6.

The head-section-actuating mechanism 10 (which is identical to the thigh-section-actuating mechanism 14 and the high-low actuating mechanism) is shown in FIG. 6. The reversible motor 38 drives a shaft 174 through a right-angle reduction gearbox 172. Bearings 184 and 188 support the shaft 174. The lower end of the rod 41 is provided with a rigidly attached recirculating ball nut 176, and is threadably connected to a portion 190 of the shaft 174. The whole assembly is mounted on a trunnion 180 and trunnion block 182 which also supports the bearing 184. When the motor 38 is energized, the shaft

174 rotates, and the rod 41 moves linearly outwards due to the relative rotation between the nut 176 and the shaft 174. The rod 41 must be restrained to prevent it from turning (e.g. by slidably attaching it to a link or crank which forms part of the associated mechanism). Slot 47 through the rod 41 facilitates connection of the rod 41 to the associated parts. The complete actuating mechanism can be removed from the bed by disconnecting the trunnion 180, electrical connections to the motor 38, and the pin through the slot 47. The trunnion 180 allows the actuating mechanism 10 to compensate for changes in height of the pin 43 (FIG. 3) which follows a circular path about the pivot point 64.

What we claim as our invention is:

1. A hospital bed comprising:
 - a. a first frame having head and foot ends and parallel, spaced-apart longitudinal members;
 - b. means supporting said frame above a floor and parallel thereto;
 - c. a mattress support frame having a head section and a seat section, said head section being pivotally connected to said seat section;
 - d. means slidably supporting said mattress support frame above said first frame, said supporting means being adapted to permit said mattress support frame to slide longitudinally relative to said first frame;
 - e. first linkage means pivotally connected between said first frame and said head section whereby the longitudinal position of said mattress support frame is varied in accordance with the inclination of said head section so that the head end of said head section remains in a substantially constant longitudinal position relative to the first frame at any inclination of said head section;
 - f. second linkage means fastened to said head section below the plane of said head section;
 - g. a first actuator operatively connected to said second linkage means for pivoting the head section relative to said seat section; and
 - h. a first actuator support means pivotally supporting said first actuator whereby said first actuator is permitted to pivot about an axis to accommodate variations in height of said second linkage means as the inclination of the head section is varied.
2. A hospital bed as claimed in claim 1 wherein said first actuator comprises:
 - i. a reversible electric motor;
 - ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
 - iii. a nut threadably engaged on said output shaft;
 - iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being pivotally connected at its opposite end to said second linkage means; and
 - v. control means including a switch for actuating said motor.
3. A hospital bed as claimed in claim 1 wherein said means for slidably supporting said mattress support frame comprises:
 - i. a pair of elongated U-sectioned tracks respectively secured to the inner sides of the said longitudinal members of said first frame;
 - ii. a second frame having longitudinal side members;
 - iii. at least two rollers rotatably mounted on each of said side members, said rollers being confined within said U-sectioned tracks and movably supporting said second frame to move longitudinally relative to said first frame.
4. A hospital bed as claimed in claim 1 wherein said first linkage means comprises a pair of radius arms, each of said radius arms being pivotally attached at one end to the head end of said first frame and at the opposite end to said head section at points intermediate the transversely extending ends of said head section.
5. A hospital bed as claimed in claim 1 wherein the second linkage means comprises: a pair of opposed brackets rigidly attached to the respective opposite sides of said head section

adjacent said seat section; a transversely extending bar fixed to said plates below said head section; a crank fixed at one end to said bar, and extending downwardly from the bar; a pivot pin attached to the other end of said bar; and said rod of said first actuator having a slot accommodating said pin for sliding movement therein longitudinally of said rod.

6. A hospital bed as claimed in claim 1 which further comprises a pivotal support frame for supporting said head section with the head section in a generally horizontal position, said pivotal support frame comprising: a transversely extending elongated first portion upon which said head section rests; a pair of opposed second portions extending from the ends of said first portion and pivotally attached to said first frame near the head end thereof; stop means for holding said pivotal support frame in a position in which said second portions are generally vertical and said first portion is substantially horizontal; and a handle attached to one of said second portions for rotating said pivotal support frame out of engagement with said head section to thereby permit said head section to be lowered.

7. A hospital bed as claimed in claim 1 wherein said axis of said first actuator support means is transverse to the longitudinal axis of the bed.

8. A hospital bed as claimed in claim 4 wherein the second linkage means comprises: a pair of opposed brackets rigidly attached to the respective opposite sides of said head section adjacent said seat section; a transversely extending bar fixed to said plates below said head section; a crank fixed at one end to said bar, and extending downwardly from the bar; a pivot pin attached to the other end of said bar; and said rod of said first actuator having a slot accommodating said pin for sliding movement therein longitudinally of said rod.

9. A hospital bed as claimed in claim 2 wherein said second linkage means comprises: a pair of opposed brackets rigidly attached to the respective opposite sides of said head section adjacent said seat section; a transversely extending bar fixed to said plates below said head section; a crank fixed at one end to said bar, and extending downwardly from the bar; a pivot pin attached at its other end; and said rod of said first actuator having a slot accommodating said pin for sliding movement therein longitudinally of said rod.

10. A hospital bed as claimed in claim 9 wherein said first linkage means comprises: a pair of radius arms, each of said radius arms being pivotally attached at one end to the head end of said first frame and at their opposite ends to said head section at points intermediate the transversely extending ends of said head section.

11. A hospital bed as claimed in claim 10 which further comprises: a pivotal support frame for supporting said head section with the head section in a generally horizontal position, said pivotal support frame comprising: a transversely extending elongated first portion upon which said head of opposed second portions extending from the ends of said first portion and pivotally attached to said first frame near the head end thereof; stop means for holding said pivotal support frame in a position in which said second portions are generally vertical and said first portion is substantially horizontal; and a handle attached to one of said second portions for rotating said pivotal support frame out of engagement with said head section to thereby permit said head section to be lowered.

12. A hospital bed as claimed in claim 11 wherein said axis of said first actuator support means is transverse to the longitudinal axis of the bed.

13. A hospital bed as claimed in claim 1 which further comprises: a generally rectangular thigh section pivotally connected at a first side to the side of said seat section remote from said head section; and a generally rectangular foot section pivotally connected to a second side of said thigh section parallel to said first side.

14. A hospital bed as claimed in claim 13 and which further includes a second actuator for pivoting said thigh section relative to said seat section, said second actuator comprising:

- i. a reversible electric motor;

- ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
- iii. a nut threadably engaged on said output shaft;
- iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being operatively connected at its opposite end to said thigh section; and
- v. control means including a switch for actuating said motor.

15. A hospital bed as claimed in claim 14 which further includes: a pair of opposed plates rigidly attached to the respective opposite sides of said thigh section adjacent said seat section; a transversely extending bar fixed to said plates below said thigh section; a crank fixed at one end to said bar, said crank having a pivot pin coupled to its other end; said rod of said second actuator having an aperture for receiving said pivot pin.

16. A hospital bed as claimed in claim 15 which further includes a second actuator support means for pivotally supporting said second actuator whereby said second actuator is permitted to pivot about an axis to accommodate variations in height of said crank as the inclination of said thigh section is varied.

17. A hospital bed as claimed in claim 16 which further includes a support for said foot section, said support comprising: a pair of spaced-apart parallel bars having a first end pivotally attached to the underside of said foot section adjacent said thigh section, each of said bars having a roller rotatably attached at the other end of said bars for rolling on an upper surface of one of said longitudinal members, said parallel bars extending from said first end downwardly and towards said foot portion, and each of said bars having a series of notches along an upwardly facing edge; a generally U-shaped notch-engaging member having legs with free ends and a straight portion between said legs, said notch-engaging member being pivotally connected at its free ends to the sides of said foot section at substantially the longitudinal center of said sides of said foot section, said straight portion of said notch-engaging member being adapted to releasably fit into said notches to retain said foot section at a predetermined angle to said thigh section.

18. A hospital bed as claimed in claim 2 wherein said rod is provided with a pair of spaced-apart stops which are adjustably attached to said rod, said stops being positioned to operate said switch when said head section reaches predetermined limits of travel.

19. A hospital bed comprising:

- a. a first frame having head and foot ends and parallel, spaced-apart longitudinal members;
- b. means supporting said frame above a floor and parallel thereto;
- c. a mattress support frame having a head section and a seat section, said head section being pivotally connected to said seat section;
- d. means slidably supporting said mattress support frame above said first frame, said supporting means being adapted to permit said mattress support frame to slide longitudinally relative to said first frame;
- e. first linkage means pivotally connected between said first frame and said head section whereby the longitudinal position of said mattress support frame is varied in accordance with the inclination of said head section so that the head end of said head section remains in a substantially constant longitudinal position relative to the first frame at any inclination of said head section;
- f. second linkage means fastened to said head section below the plane of said head section;
- g. a first actuator attached to said means for slidably supporting said mattress support frame whereby said actuator travels longitudinally to follow the longitudinal travel of said mattress support frame, said first actuator being operatively connected to said linkage means for pivoting said head section relative to said seat section.

20. A hospital bed as claimed in claim 19 wherein said first actuator is pivotally supported about an axis to permit it to accommodate variations in height of said second linkage means as the inclination of the head section is varied.

21. A hospital bed as claimed in claim 19 wherein said first actuator comprises:

- i. a reversible electric motor;
- ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
- iii. a nut threadably engaged on said output shaft;
- iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being pivotally connected at its opposite end to said second linkage means; and
- v. control means including a switch for actuating said motor.

22. A hospital bed as claimed in claim 19 wherein said means for slidably supporting said mattress support frame comprises:

- i. a pair of elongated U-sectioned tracks respectively secured to the inner sides of the said longitudinal members of said first frame;
- ii. at least two rollers rotatably mounted on each of said side members, said rollers being confined within said U-section tracks and movably supporting said second frame to move longitudinally relative to said first frame.

23. A hospital bed as claimed in claim 19 wherein said first linkage means comprises a pair of radius arms, each of said radius arms being pivotally attached at one end to the head end of said first frame and at the opposite end to said head section at points intermediate the transversely extending ends of said head section.

24. A hospital bed as claimed in claim 19 wherein the second linkage means comprises: a pair of opposed brackets rigidly attached to the respective opposite sides of said head section adjacent said seat section; a transversely extending bar fixed to said plates below said head section; a crank fixed at one end to said bar, and extending downwardly from the bar; a pivot pin attached to the other end of said bar; and said rod of said first actuator having a slot accommodating said pin for sliding movement therein longitudinally of said rod.

25. A hospital bed as claimed in claim 19 which further comprises a pivotal support frame for supporting said head section with the head section in a generally horizontal position, said pivotal support frame comprising: a transversely extending elongated first portion upon which said head section rests; a pair of opposed second portions extending from the ends of said first portion and pivotally attached to said first frame near the head end thereof; stop means for holding said pivotal support frame in a position in which said second portions are generally vertical and said first portion is substantially horizontal; and a handle attached to one of said second portions for rotating said pivotal support frame out of engagement with said head section to thereby permit said head section to be lowered.

26. A hospital bed as claimed in claim 19 wherein said first actuator is pivotally supported about an axis transverse to the longitudinal axis of the bed to permit said first actuator to accommodate variations in height of said second linkage means as the inclination of the head section is varied.

27. A hospital bed as claimed in claim 23 wherein the second linkage means comprises: a pair of opposed brackets rigidly attached to the respective opposite sides of said head section adjacent said seat section; a transversely extending bar fixed to said plates below said head section; a crank fixed at one end to said bar, and extending downwardly from the bar; a pivot pin attached to the other end of said bar; and said rod of said first actuator having a slot accommodating said pin for sliding movement therein longitudinally of said rod.

28. A hospital bed as claimed in claim 21 wherein said second linkage means comprises: a pair of opposed brackets rigidly attached to the respective opposite sides of said head section adjacent said seat section; a transversely extending bar

fixed to said plates below said head section; a crank fixed at one end to said bar, and extending downwardly from the bar; a pivot pin attached at its other end; and said rod of said first actuator having a slot accommodating said pin for sliding movement therein longitudinally of said rod.

29. A hospital bed as claimed in claim 28 wherein said first linkage means comprises: a pair of radius arms, each of said radius arms being pivotally attached at one end to the head end of said first frame and at their opposite ends to said head section at points intermediate the transversely extending ends of said head section.

30. A hospital bed as claimed in claim 29 which further comprises: a pivotal support frame for supporting said head section with the head section in a generally horizontal position, said pivotal support frame comprising: a transversely extending elongated first portion upon which said head section rests; a pair of opposed second portions extending from the ends of said first portion and pivotally attached to said first frame near the head end thereof; stop means for holding said pivotal support frame in a position in which said second portions are generally vertical and said first portion is substantially horizontal; and a handle attached to one of said second portions for rotating said pivotal support frame out of engagement with said head section to thereby permit said head section to be lowered.

31. A hospital bed as claimed in claim 19 which further comprises a generally rectangular thigh section pivotally connected at a first side to the side of said seat section remote from said head section; and a generally rectangular foot section pivotally connected to a second side of said thigh section parallel to said first side.

32. A hospital bed as claimed in claim 31 and which further includes a second actuator for pivoting said thigh section relative to said seat section, said second actuator comprising:

- i. a reversible electric motor;
- ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
- iii. a nut threadably engaged on said output shaft;
- iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being operatively connected at its opposite end to said thigh section; and
- v. control means including a switch for actuating said motor.

33. A hospital bed as claimed in claim 32 which further includes: a pair of opposed plates rigidly attached to the respective opposite sides of said thigh section adjacent said seat sections; a transversely extending bar fixed to said plates below said thigh section; a crank fixed at one end to said bar, said crank having a pivot pin coupled to its other end; said rod of said second actuator having an aperture for receiving said pivot pin.

34. A hospital bed as claimed in claim 33 which further includes a second actuator support means for pivotally supporting said second actuator whereby said second actuator is permitted to pivot about an axis to accommodate variations in height of said crank as the inclination of said thigh section is varied.

35. A hospital bed as claimed in claim 34 which further includes a support for said foot section, said support comprising a pair of spaced-apart parallel bars having a first end pivotally attached to the underside of said foot section adjacent said thigh section, each of said bars having a roller rotatably attached at the other end of said bars for rolling on an upper surface of one of said longitudinal members, said parallel bars extending from said first and downwardly towards said foot portion, and each of said bars having a series of notches along an upwardly facing edge; a generally U-shaped notch-engaging member having legs with free ends and a straight portion between said legs, said notch-engaging member being pivotally connected at its free ends to the sides of said foot section at substantially the longitudinal center of said sides of said foot section, said straight portion of said notch-engaging

member being adapted to releasably fit into said notches to retain said foot section at a predetermined angle to said thigh section.

36. A hospital bed as claimed in claim 21 wherein said rod is provided with a pair of spaced-apart stops which are adjustably attached to said rod, said stops being positioned to operate said switch when said head section reaches predetermined limits of travel.

37. A hospital bed as claimed in claim 1 wherein said first frame is movable between an uppermost position and a lowermost position, and said means for supporting said frame above a floor and parallel thereto comprises:

- a. a lower frame;
- b. first and second link means pivotally connected to said lower frame and said first frame on mutually parallel sets of axes, said axes including a first pair of parallel axes containing pivot points at which said first and second links are connected to said first frame, said first and second link means being adapted to maintain said first frame substantially parallel to said lower frame in any position of said first frame between said uppermost and lowermost positions;
- c. a crank fixed to one of said first and second link means, said crank having an end which is positioned such that when said first crank frame is in said uppermost position, said end is above a plane containing said first pair of axes;
- d. a second actuator means operatively connected to said end of said crank for pivoting said first and second link means, to thereby adjust the height of said first frame relative to said lower frame.

38. A hospital bed as claimed in claim 37 which further includes a second support means for pivotally supporting said second actuator on said first frame, whereby said second actuator is permitted to pivot about an axis to accommodate variations in height of said crank.

39. A hospital bed as claimed in claim 38 wherein said second actuator comprises:

- i. a reversible electric motor;
- ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
- iii. a nut threadably engaged on said output shaft;
- iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being pivotally connected at its opposite end to said crank; and
- v. control means including a switch for actuating said motor.

40. A hospital bed as claimed in claim 19 wherein said first frame is movable between an uppermost position and a lowermost position, and said means for supporting said frame above a floor and parallel thereto comprises:

- a. a lower frame;
- b. first and second link means pivotally connected to said lower frame and said first frame on mutually parallel sets of axes, said axes including a first pair of parallel axes containing pivot points at which said first and second link means are connected to said first frame, said first and second link means being adapted to maintain said first frame substantially parallel to said lower frame in any position of said first frame between said uppermost and lowermost positions;
- c. a crank fixed to one of said first and second link means, said crank having an end which is positioned such that when said first frame is in said uppermost position, said end is above a plane containing said first pair of axes; and
- d. a second actuator means operatively connected to said end of said crank for pivoting said first and second link means, to thereby adjust the height of said first frame relative to said lower frame.

41. A hospital bed as claimed in claim 40 which further includes a second actuator support means for pivotally supporting said second actuator on said first frame whereby said second actuator is permitted to pivot about an axis to accom-

modate variations in height of said second linkage means as the inclination of the head section is varied.

42. A hospital bed as claimed in claim 41 wherein said second actuator comprises:

- i. a reversible electric motor;
- ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
- iii. a nut threadably engaged on said output shaft;
- iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being pivotally connected at its opposite end to said crank; and
- v. control means including a switch for actuating said motor.

43. A hospital bed of adjustable height comprising:

- a. a lower frame;
- b. a first frame, said first frame being movable between an uppermost position and a lowermost position;
- c. first and second link means pivotally connected to said lower frame and said first frame on mutually parallel sets of axes, said axes including a first pair of parallel axes containing pivot points at which said first and second link means are connected to said first frame, said first and second link means being adapted to maintain said first frame substantially parallel to said lower frame in any position of said first frame between said uppermost and lowermost positions;
- d. a crank fixed to one of said first and second link means, said crank having an end which is positioned such that when said first frame is in said uppermost position, said end is above a plane containing said first pair of axes;
- e. actuator means operatively connected to said end of said cranks for pivoting said first and second link means to thereby adjust the height of said first frame relative to said lower frame; and
- f. actuator support means pivotally supporting said actuator on said first frame, said actuator being coupled only to said actuator support means and to said end of said cranks so that said actuator is permitted to pivot about an axis to accommodate variations in height of said crank as the first and second link means are pivoted.

44. A hospital bed of adjustable height is claimed in claim 43 wherein said actuator means comprises:

- i. a reversible electric motor;
- ii. a reduction gearbox coupled to said electric motor and having a threaded output shaft;
- iii. a not threadable engaged on said output shaft;
- iv. a rod fixed at one end to said nut, said rod being driven linearly by said nut upon actuation of said motor, said rod being pivotally connected at its opposite end to said crank; and
- v. control means including a switch for actuating said motor.

45. A hospital bed as claimed in claim 19 which further includes a high-low mechanism for adjusting the height of said first frame between an uppermost position and a lowermost position, said high-low mechanism comprising:

- a. a lower frame;
- b. first and second link means pivotally connected to said lower frame and said first frame on mutually parallel sets of axes, said axes including a first pair of parallel axes containing pivot points at which said first and second link means are connected to first frame, said first and second link means being adapted to maintain said first frame substantially parallel to said lower frame in any position of said first frame between said uppermost and lowermost positions;
- c. a crank fixed to one of said first and second link means, said crank having an end which is positioned such that when said first frame is in said uppermost position, said end is above a plane containing said first pair of axes;
- d. a second actuator means operatively connected to said end of said cranks for pivoting said first and second link

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means to thereby adjust the height of said first frame relative to said lower frame; and
e. a second actuator support means for pivotally supporting said second actuator on said first frame, whereby said

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second actuator is permitted to pivot about an axis to accommodate variations in height of said crank as the first and second link means are pivoted.

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