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(54) **HOSPITAL BED AND MATTRESS HAVING A RETRACTABLE FOOT SECTION**

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filed on Jul. 28, 1997, now Pat. No. 6,151,739, which is a continuation of application No. 08/367,829, filed on Jan. 3, 1995, now Pat. No. 5,666,681, said application No. 09/120,125 is a division of application No. 08/511,711.

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See application file for complete search history.

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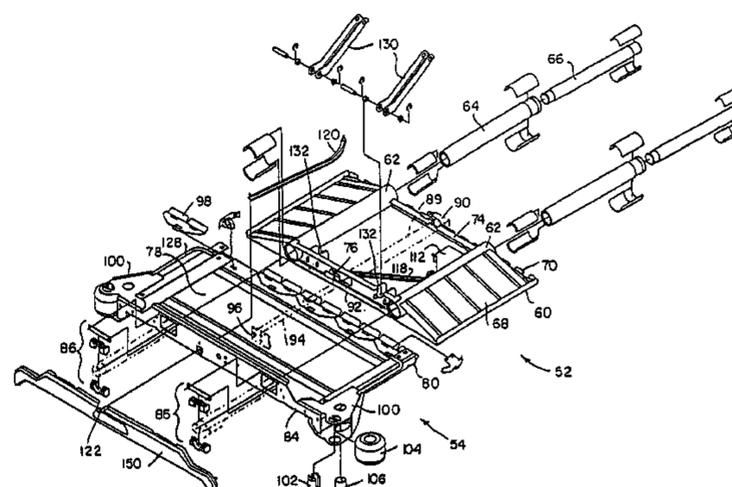
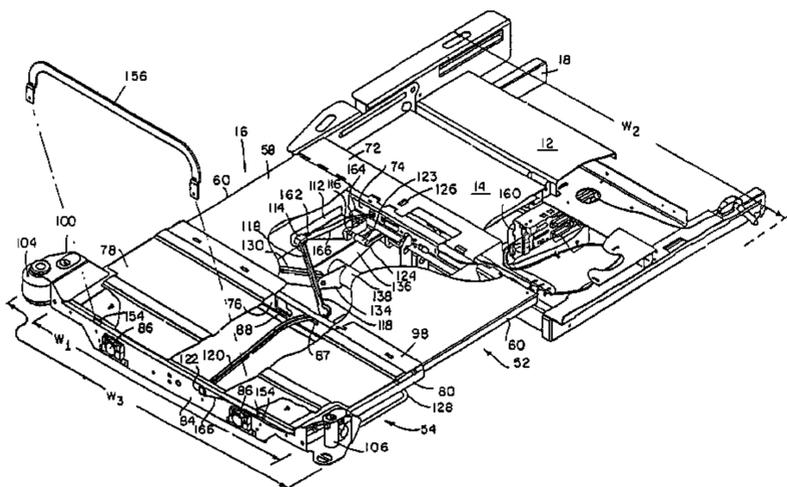
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(57) **ABSTRACT**

A patient support is disclosed having an adjustable length deck and a mattress positionable on the deck.

**28 Claims, 14 Drawing Sheets**



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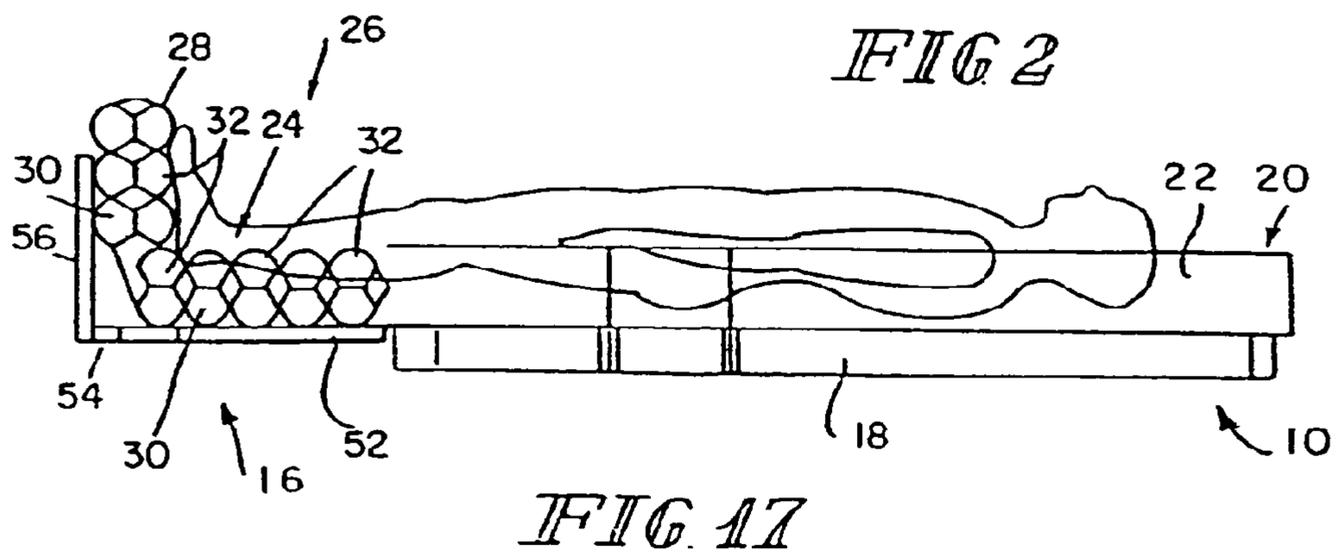
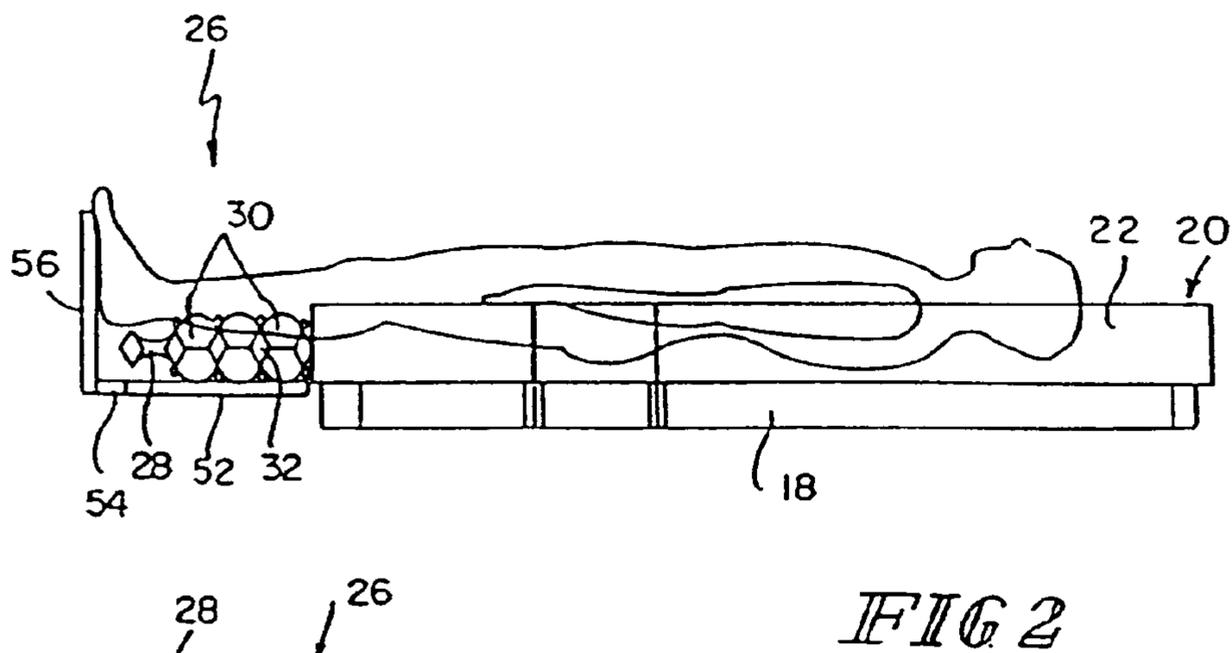
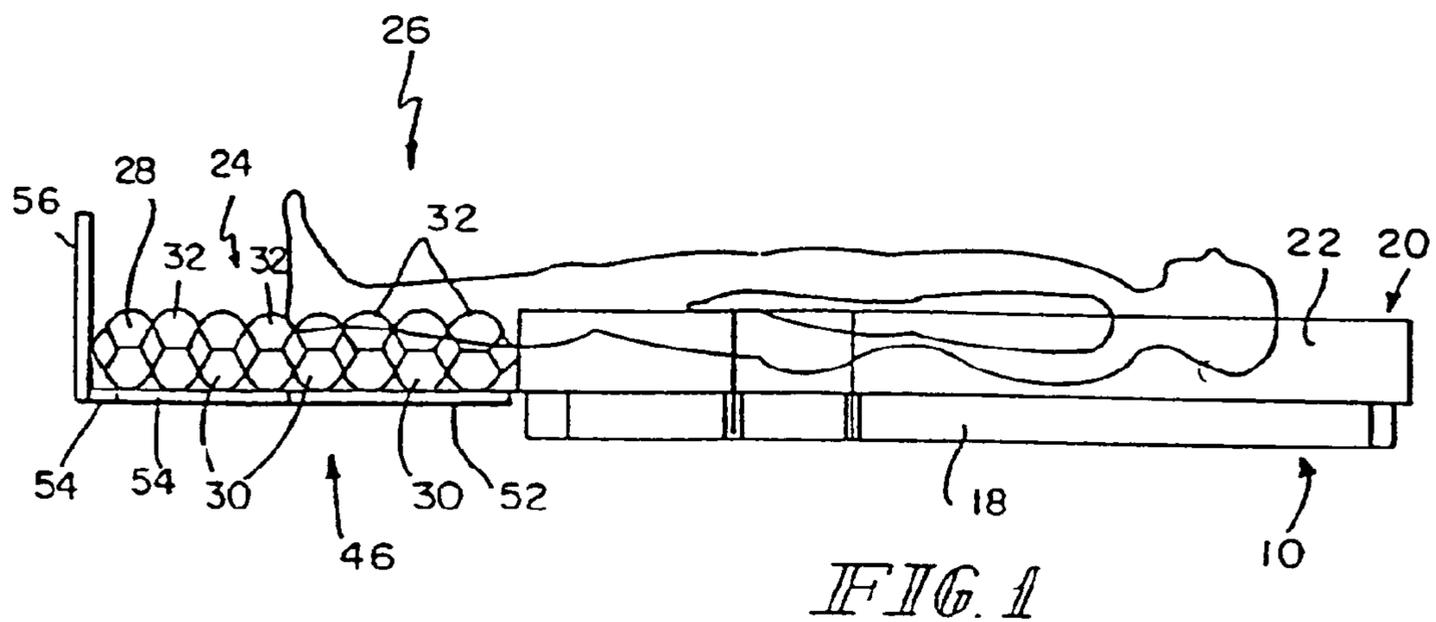
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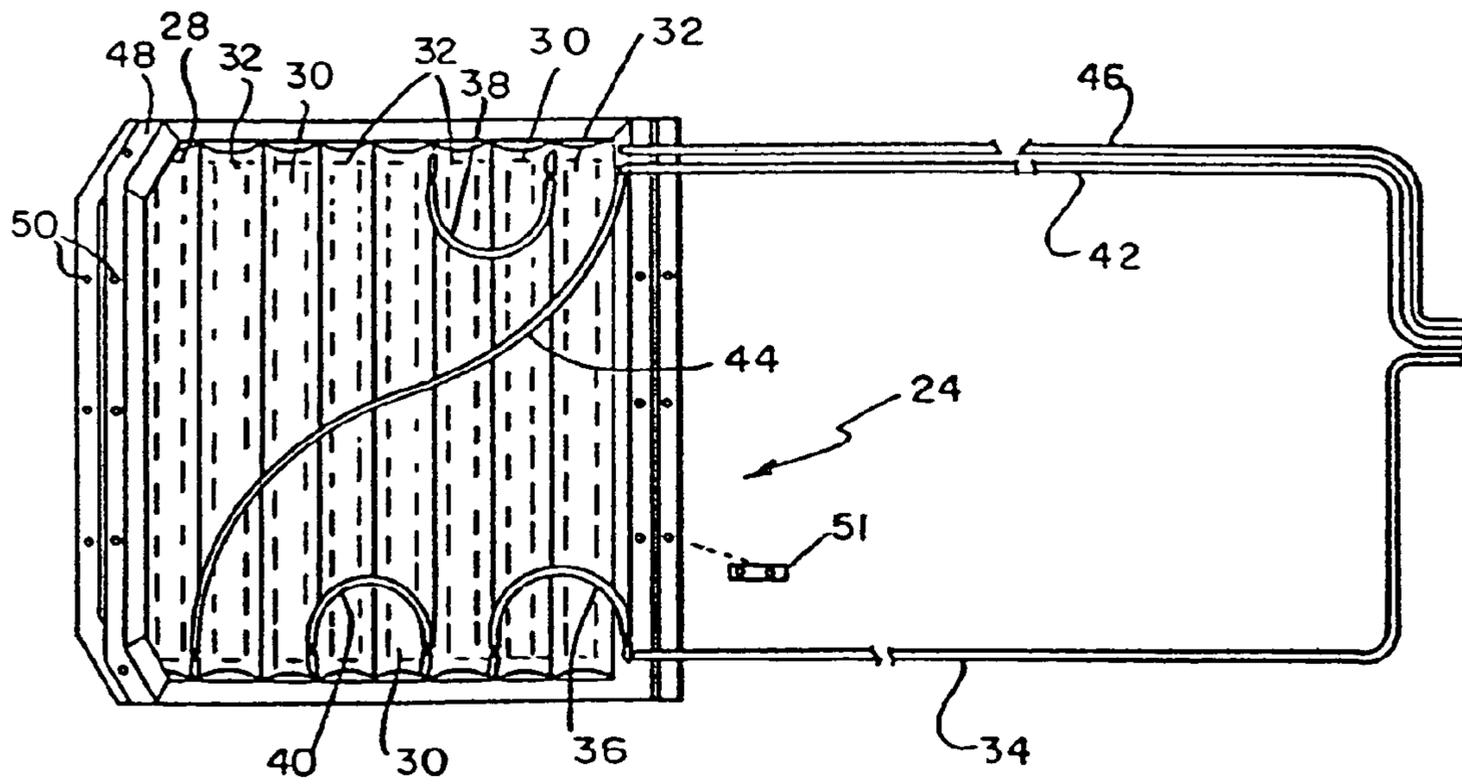


FIG. 3

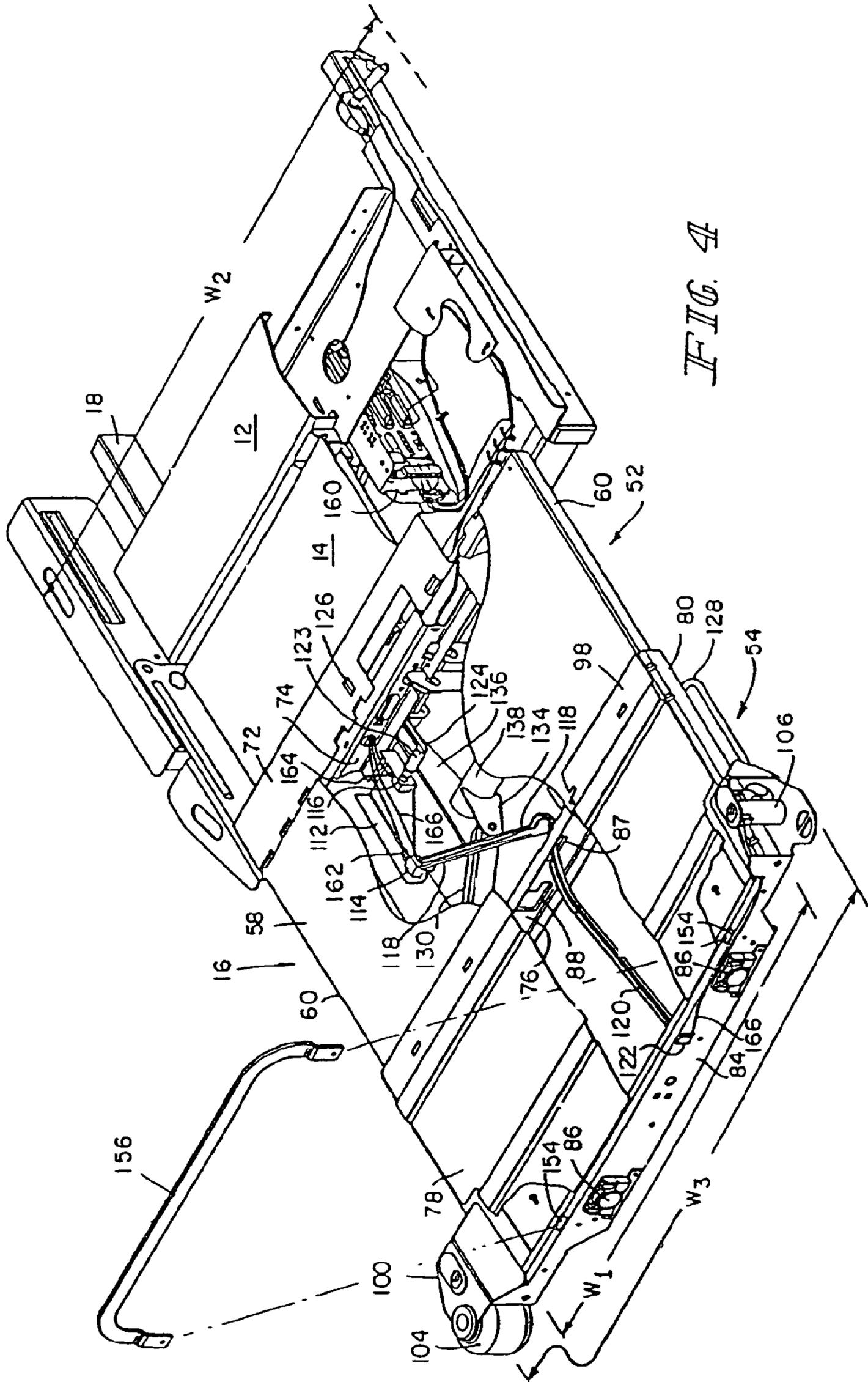


FIG. 4

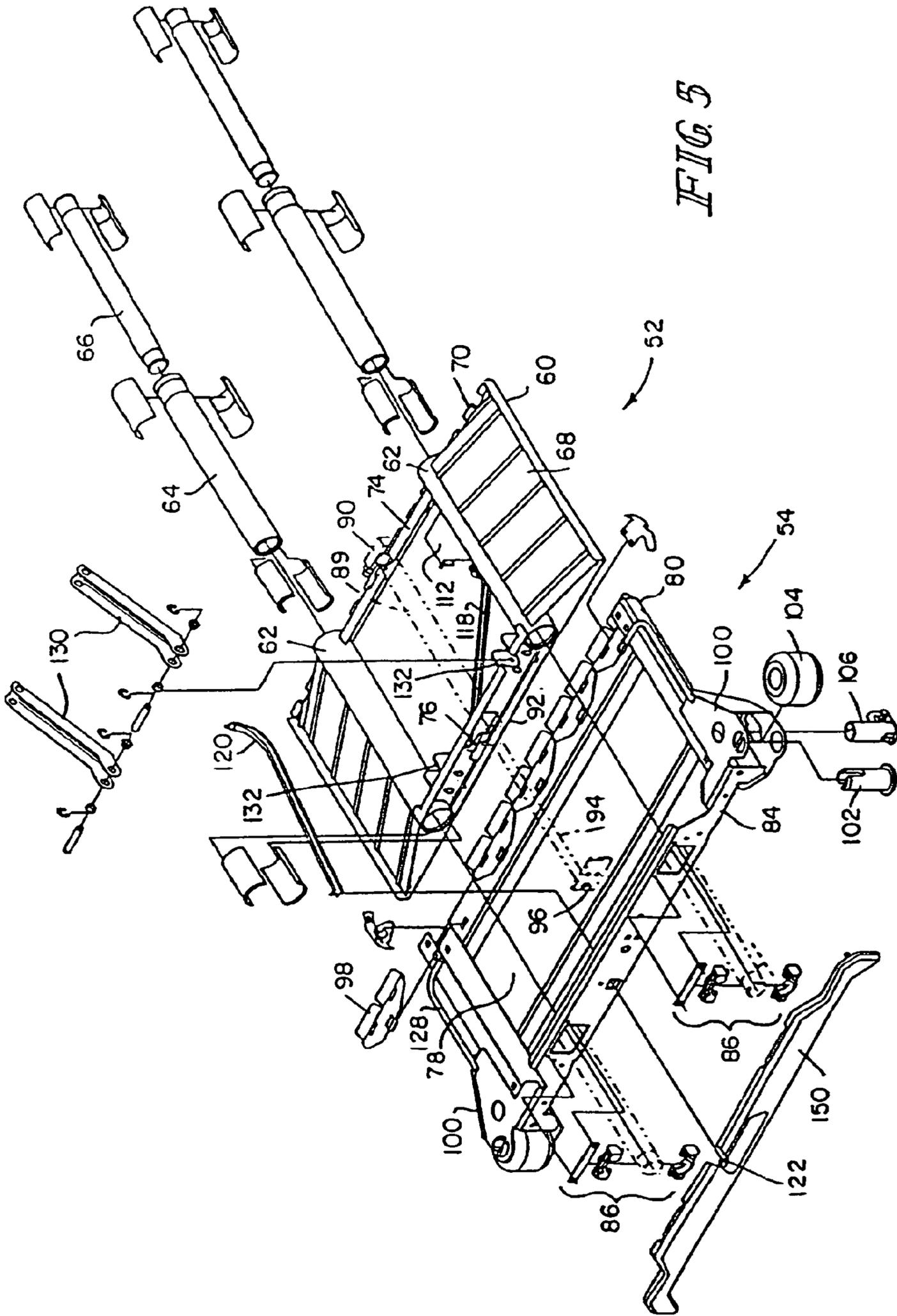


FIG. 5

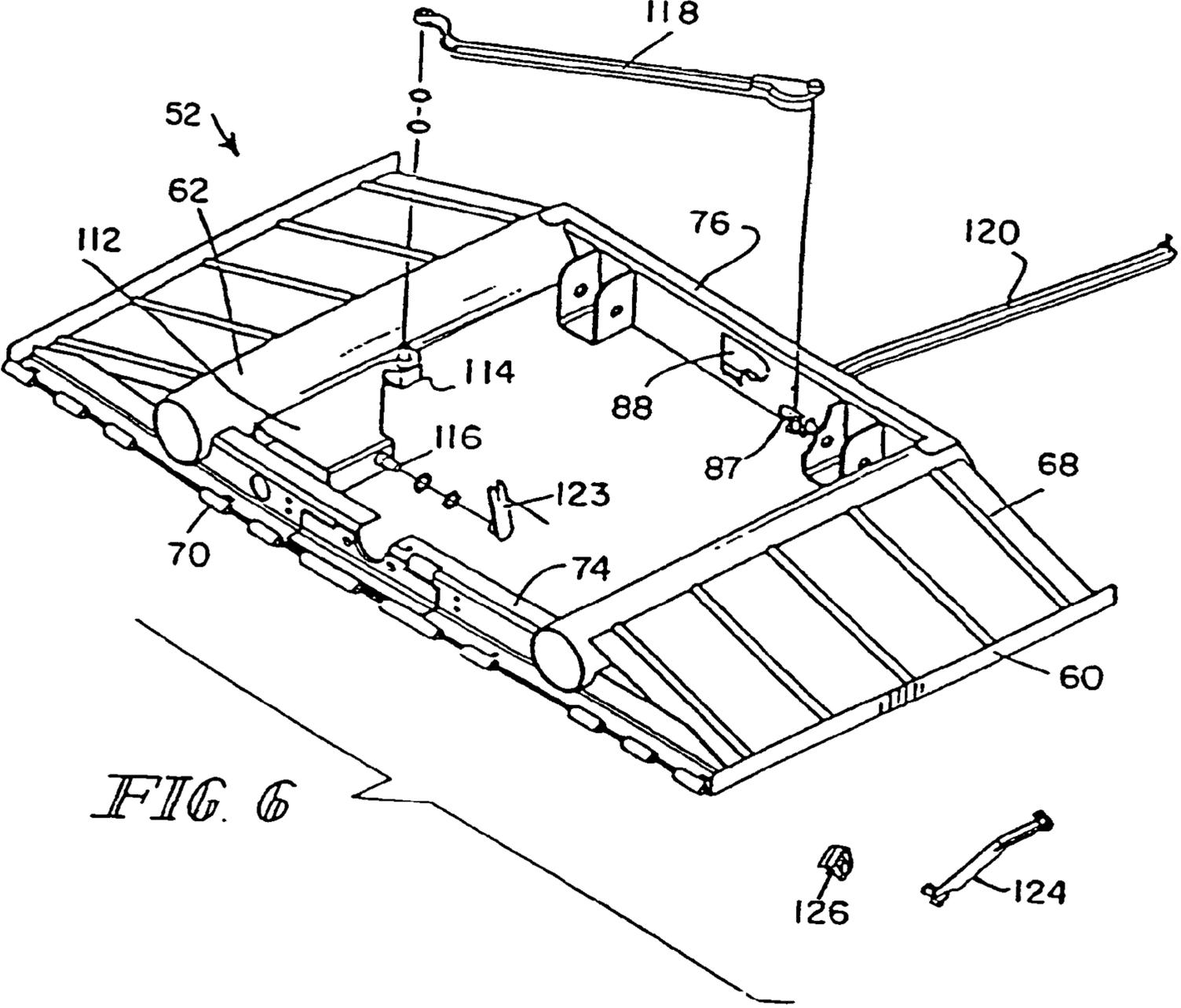


FIG. 6

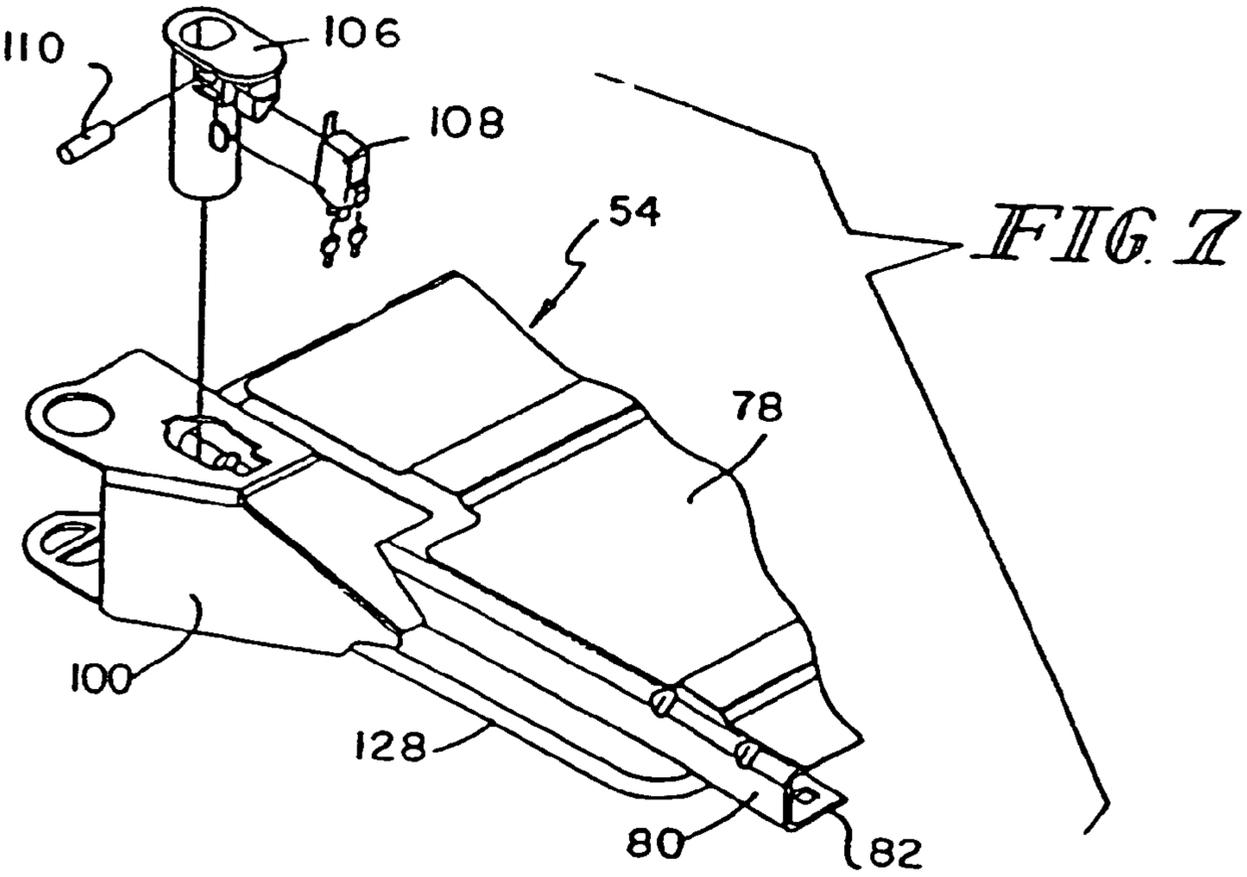
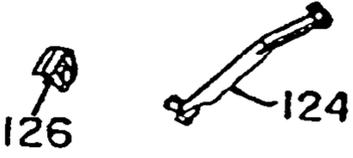
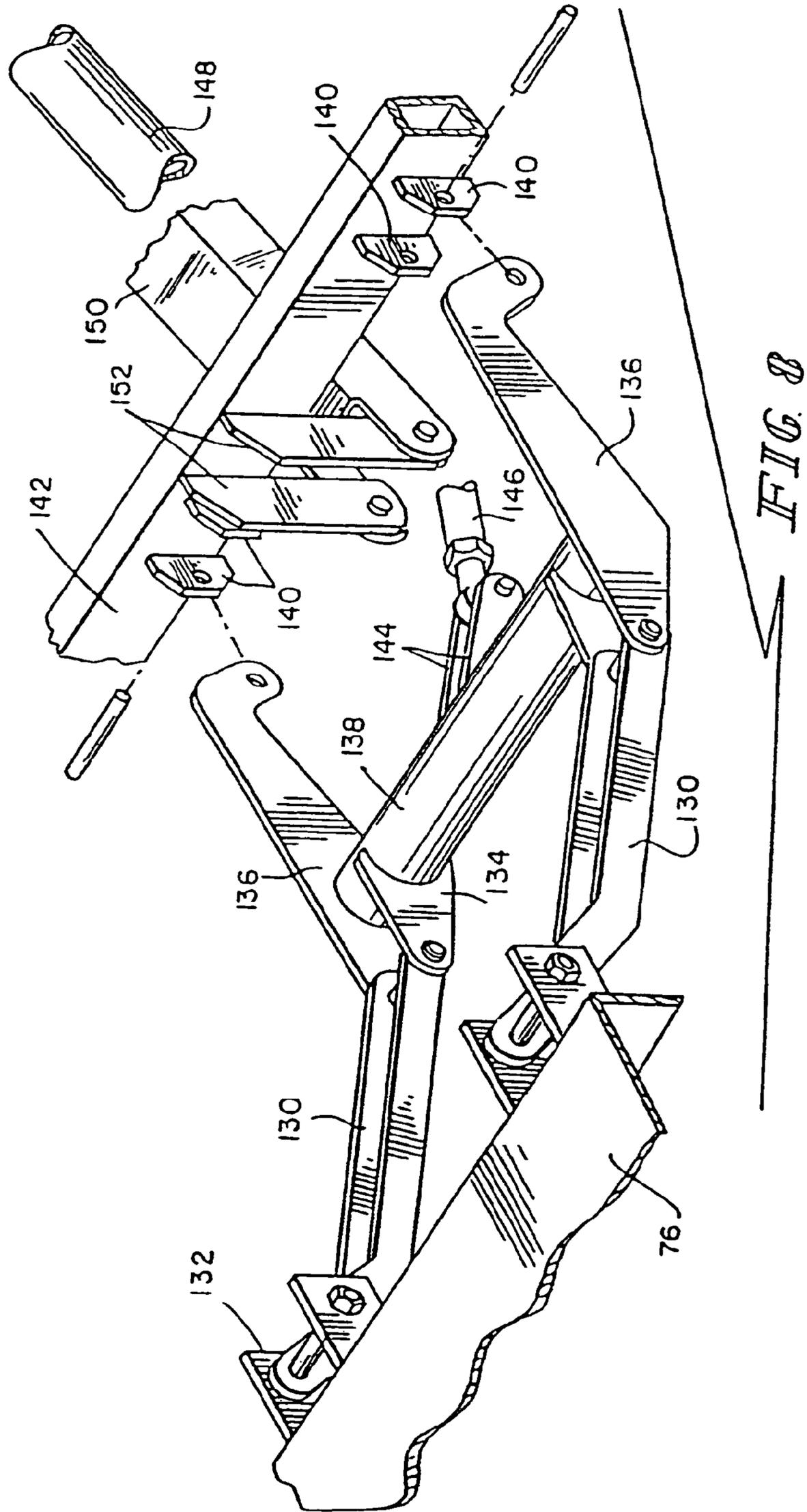
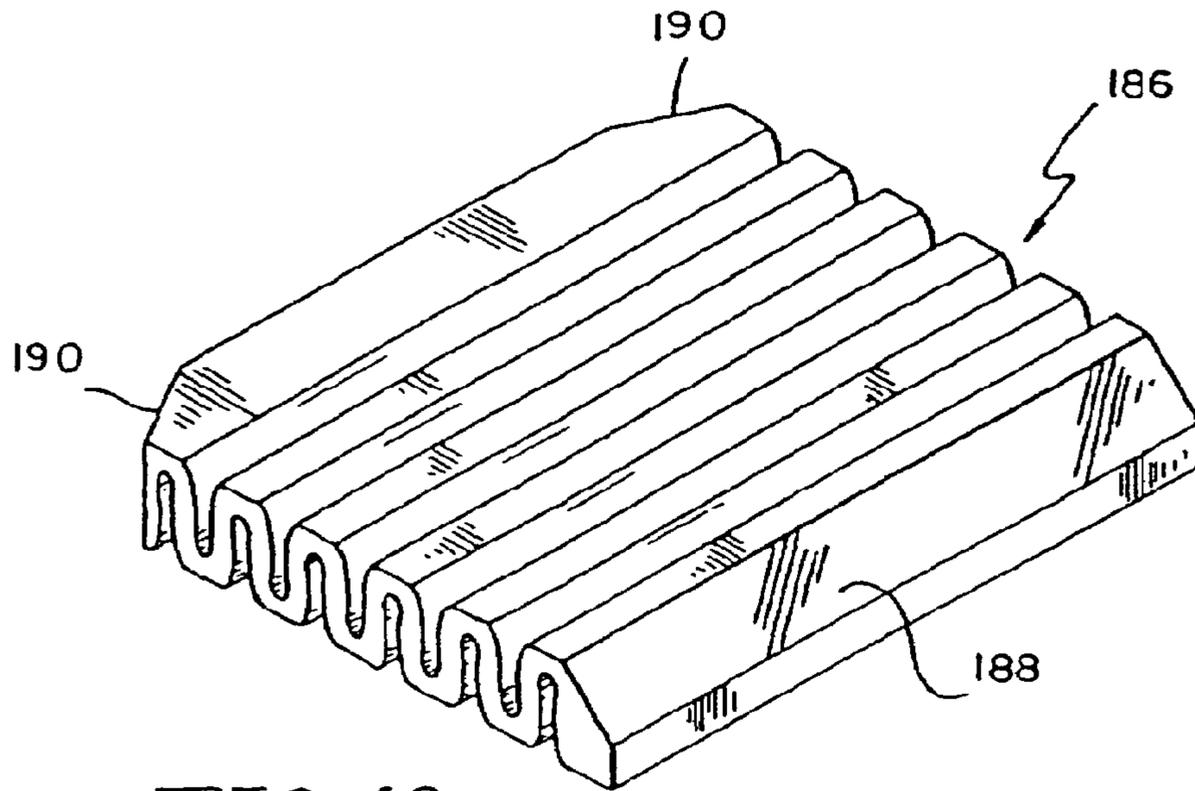


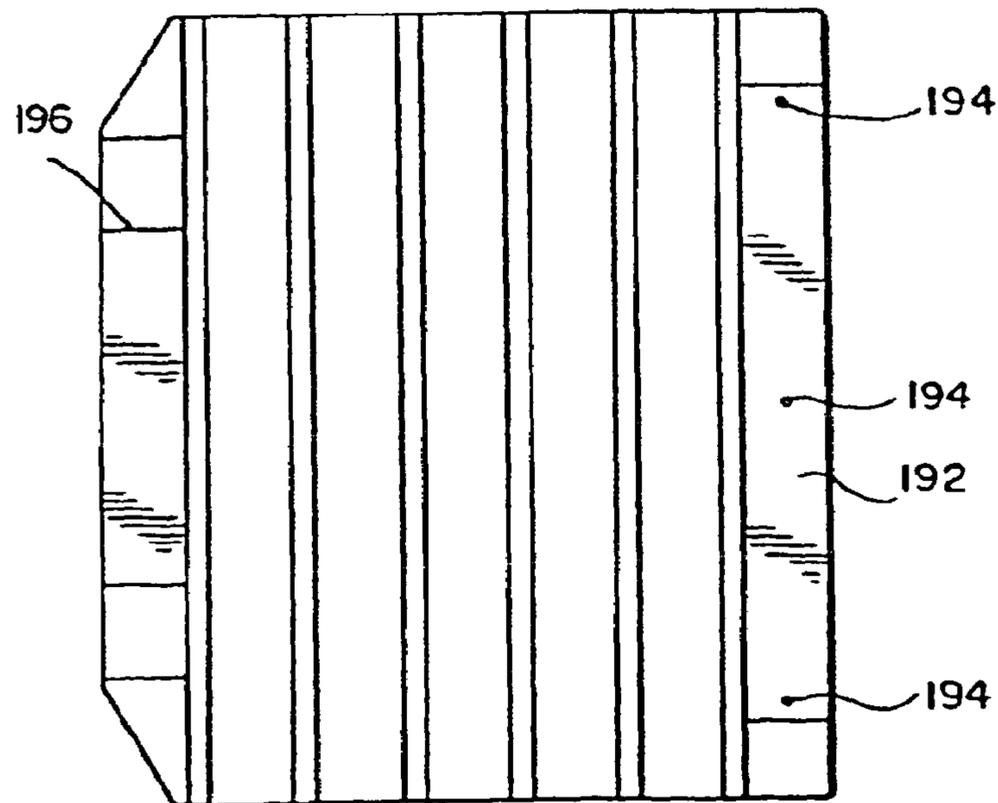
FIG. 7







*FIG. 10*



*FIG. 11*

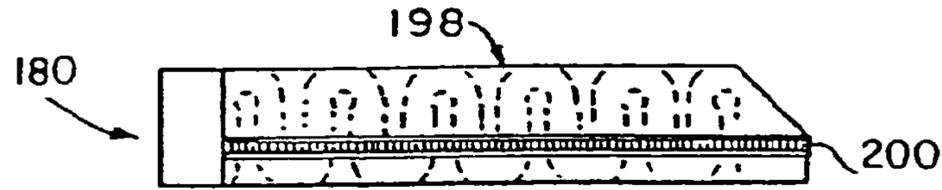


FIG. 12

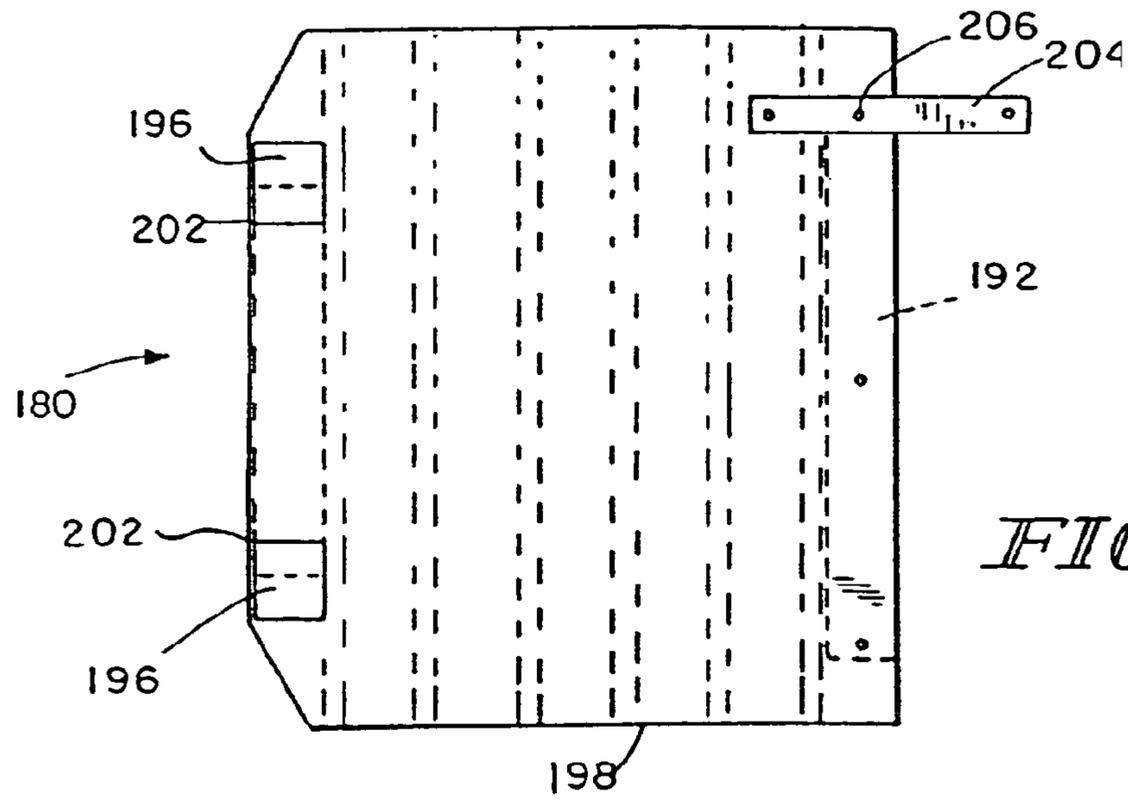


FIG. 13

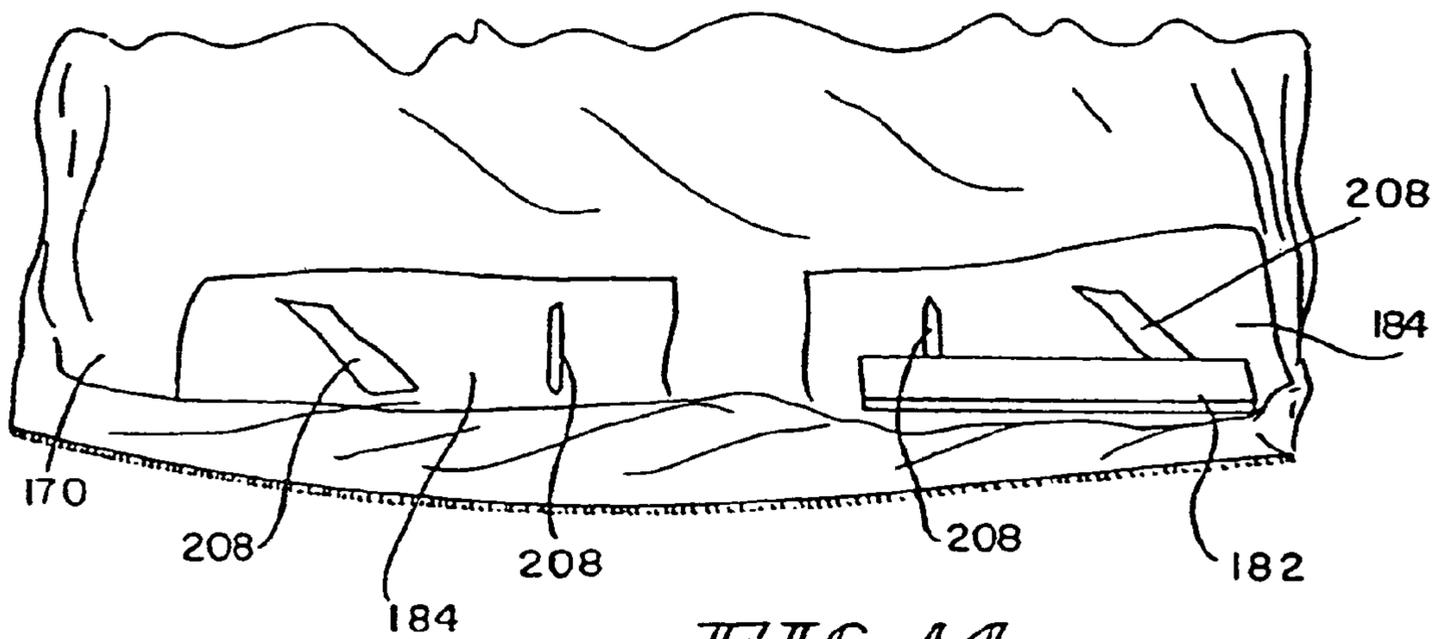
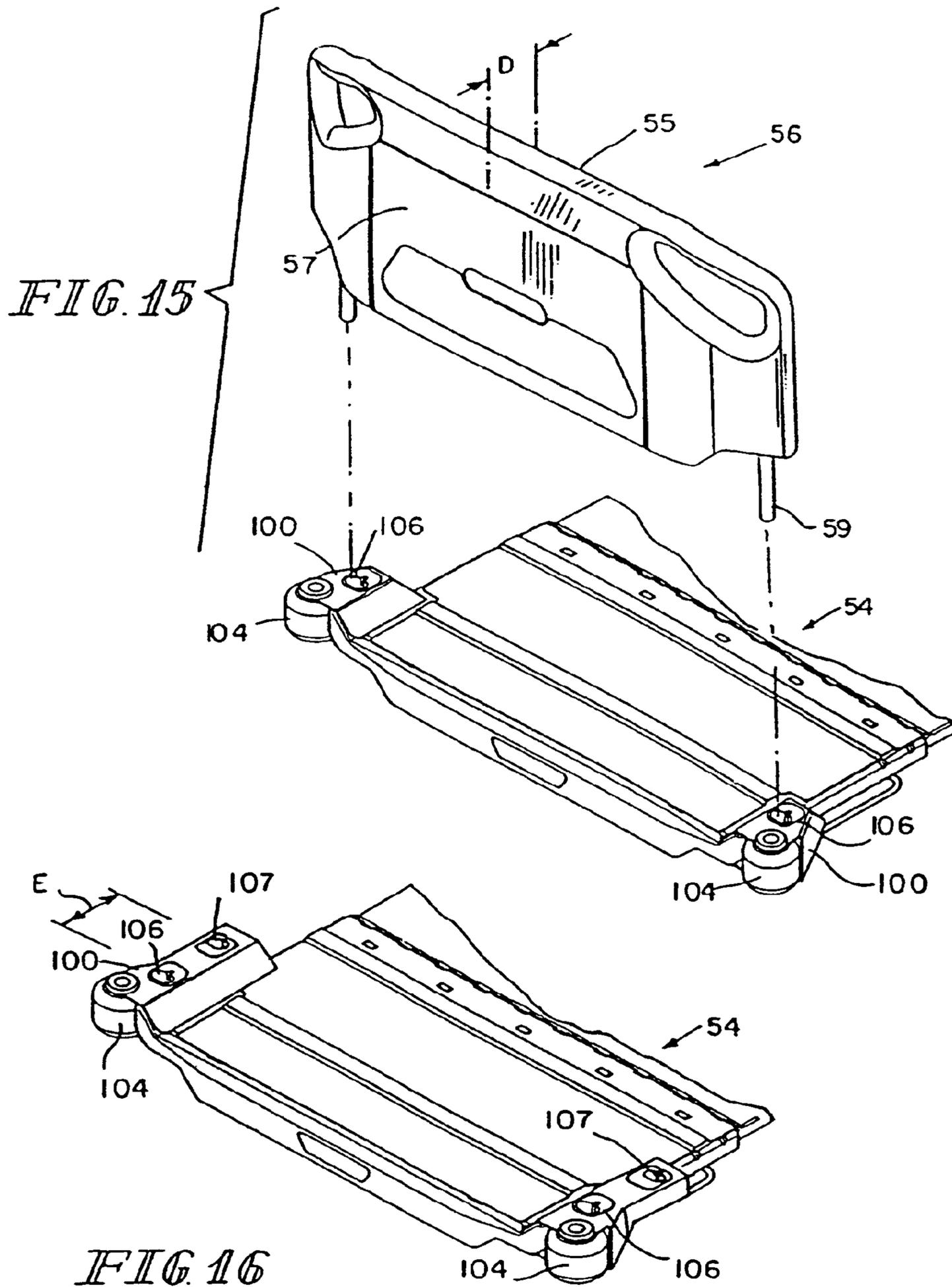


FIG. 14



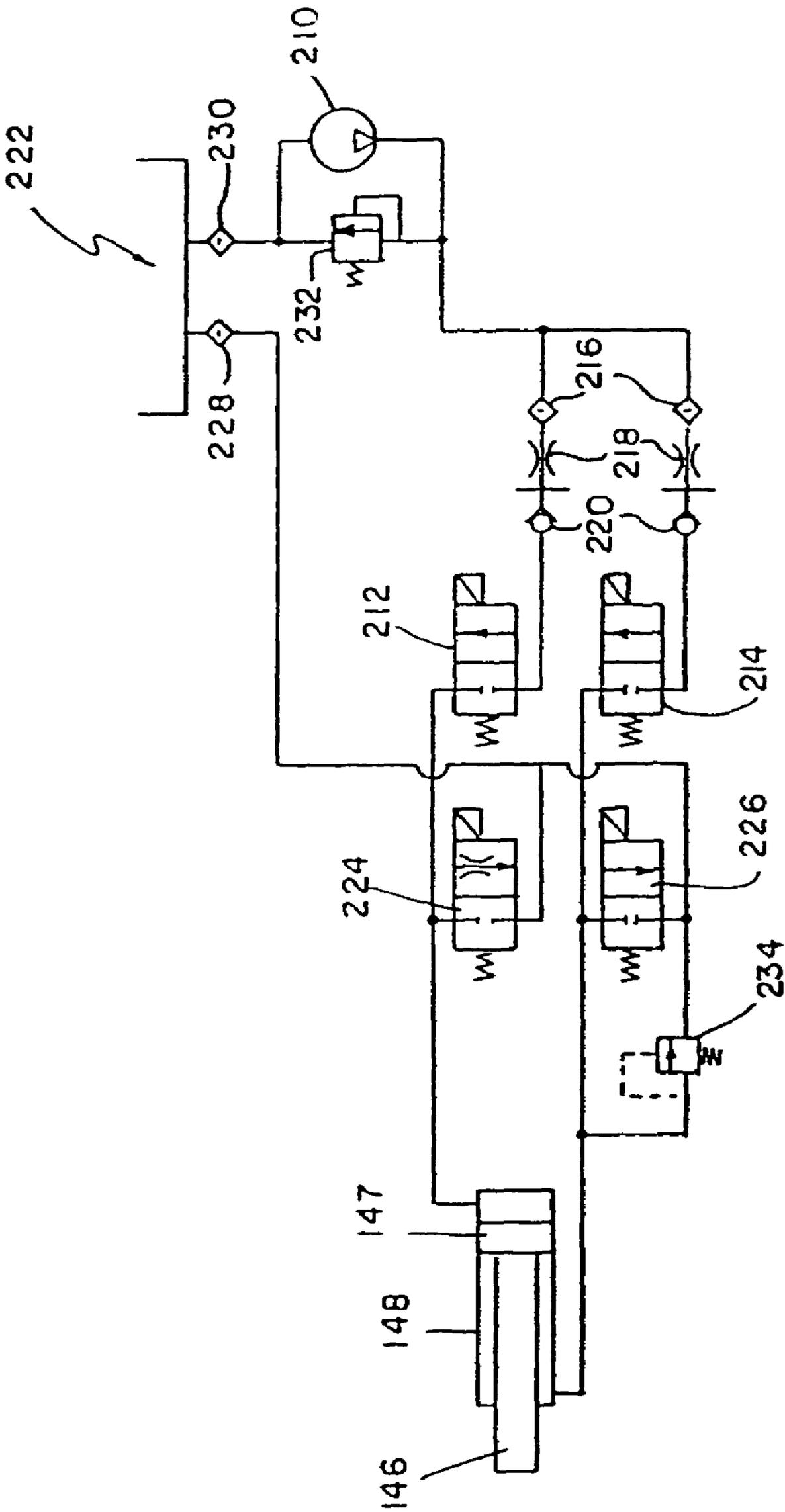


FIG. 1B

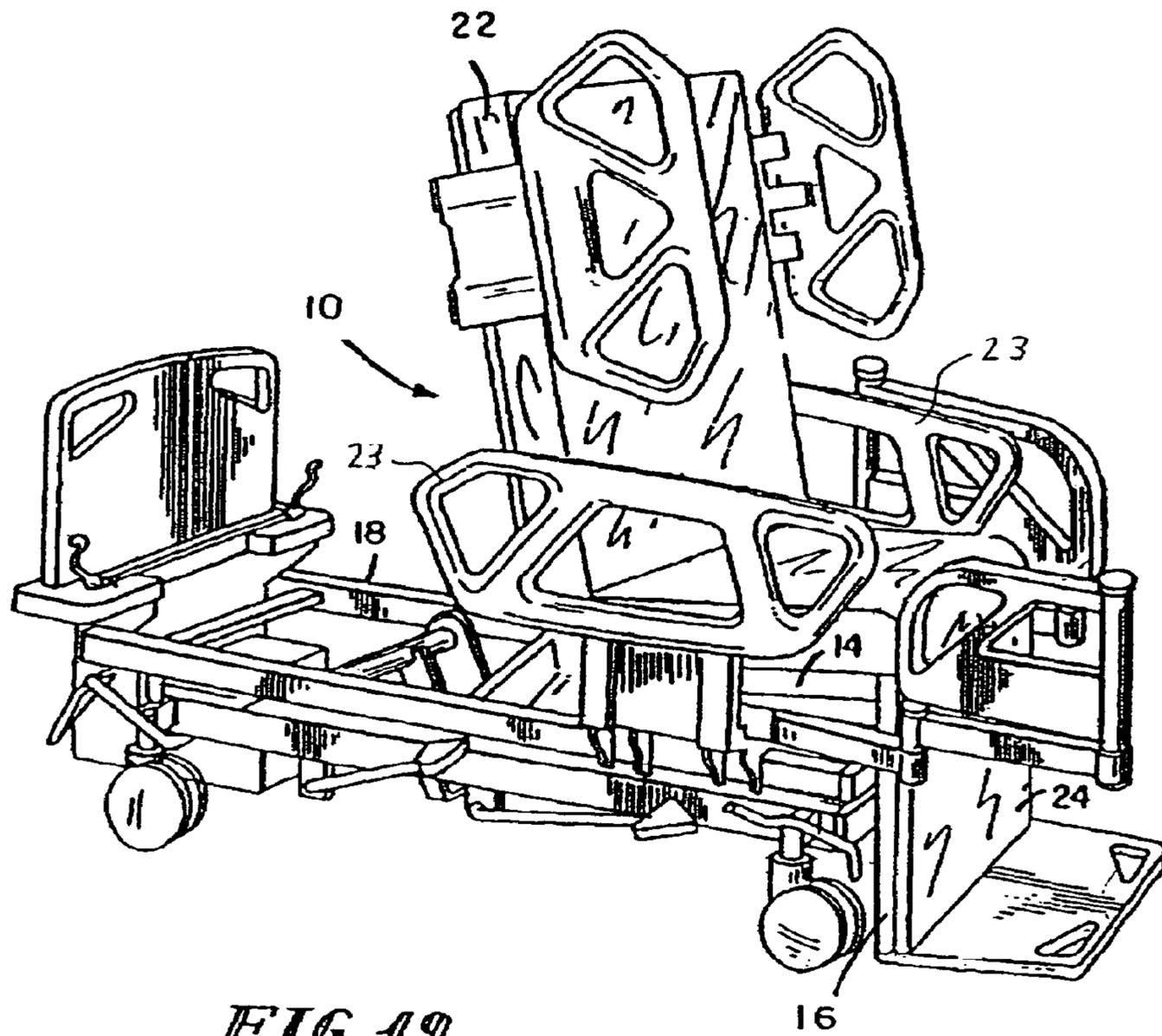


FIG. 19

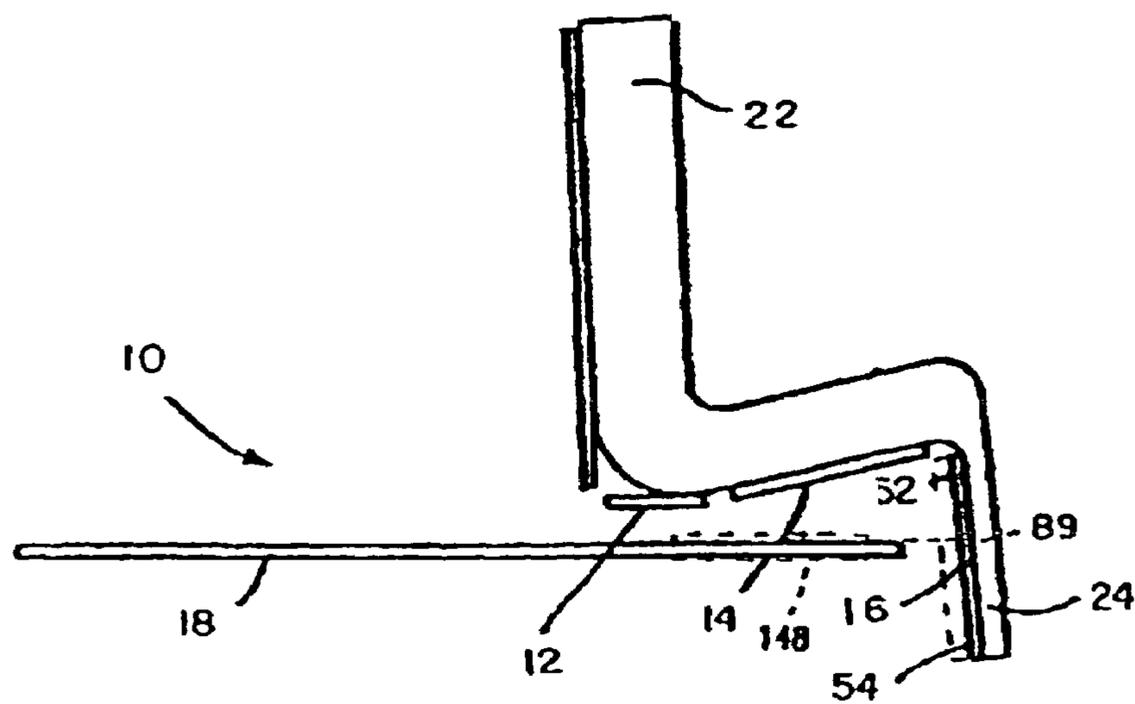


FIG. 20

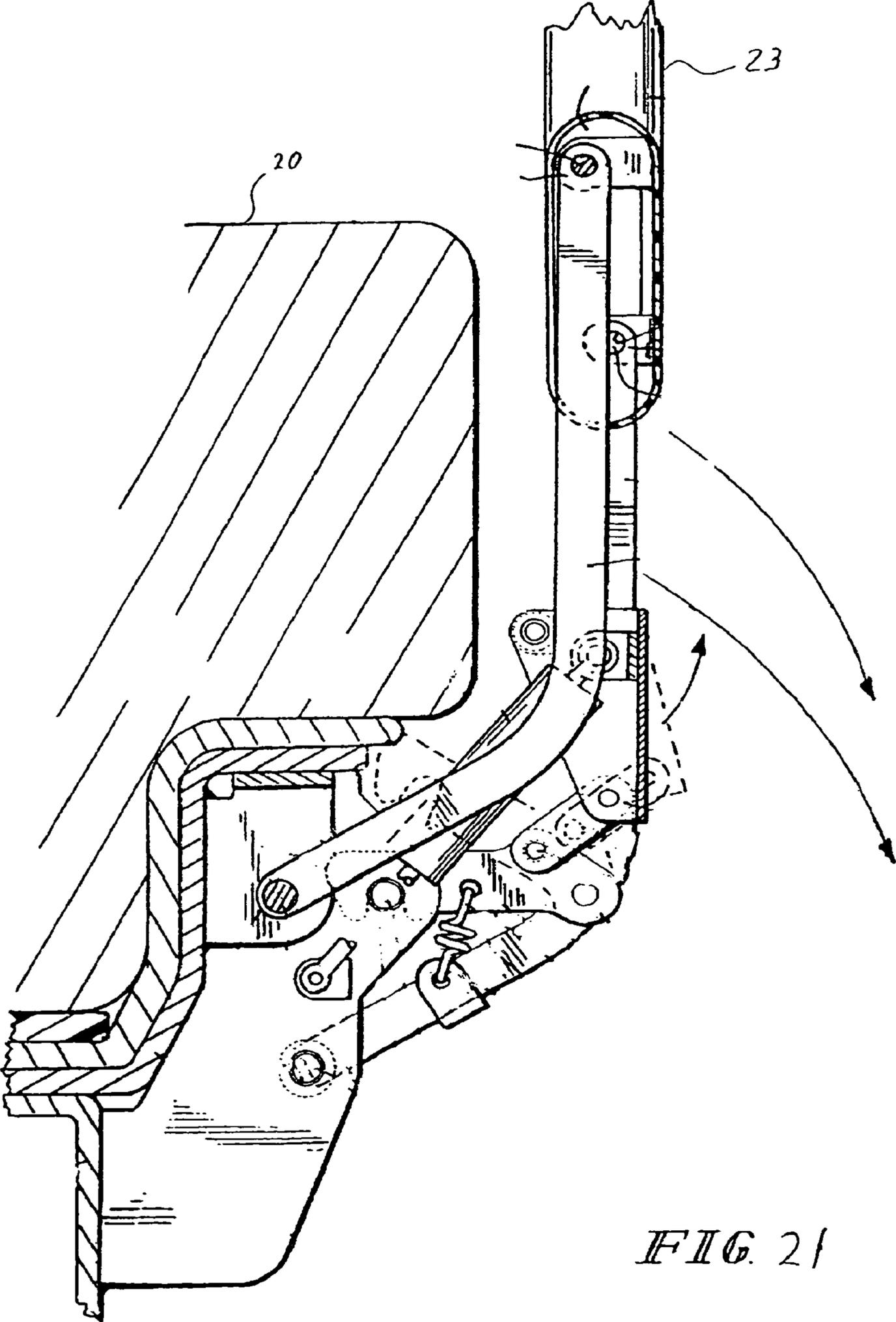


FIG. 21

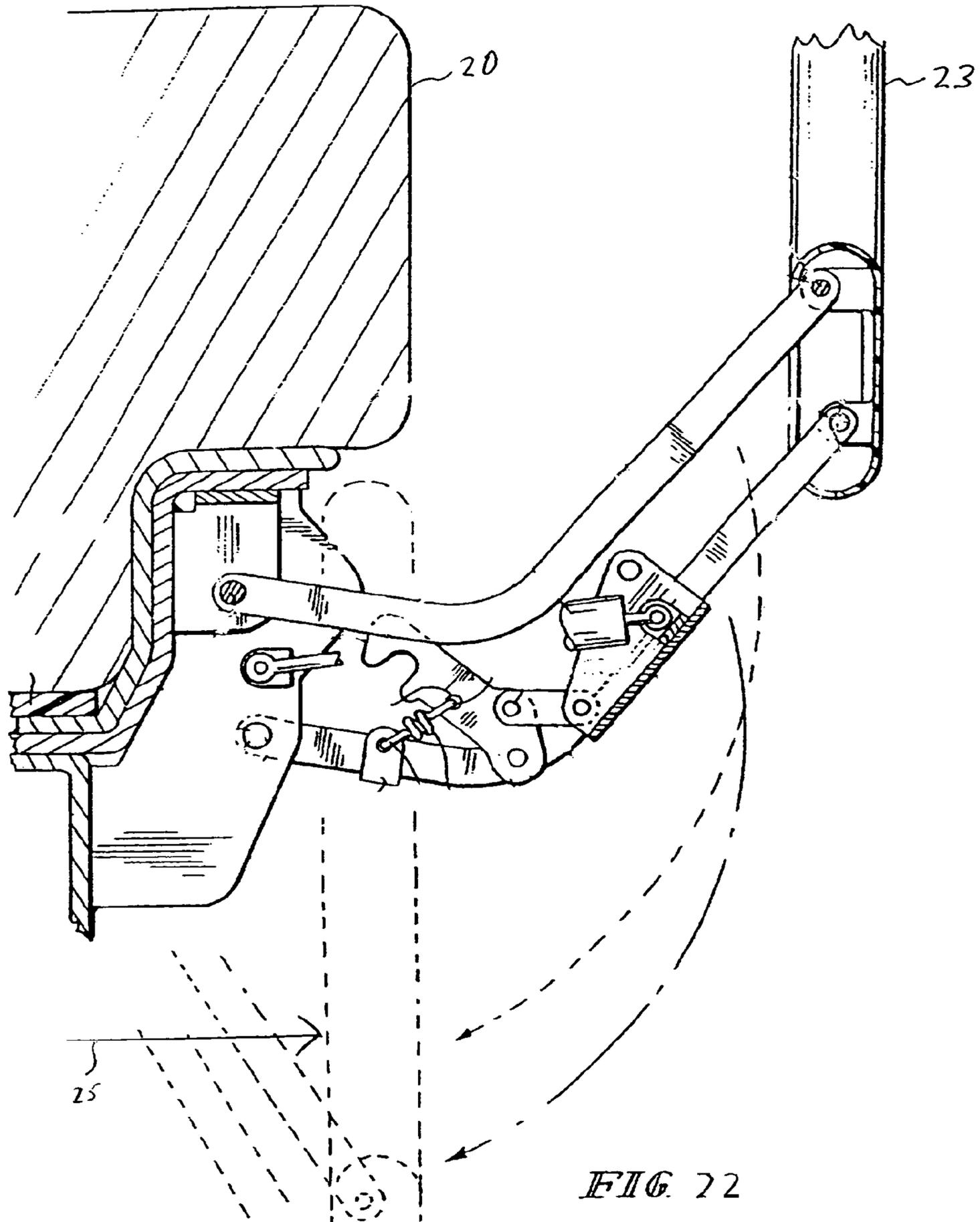


FIG. 72

**HOSPITAL BED AND MATTRESS HAVING A  
RETRACTABLE FOOT SECTION**

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

This is a reissue application of U.S. patent application Ser. No. 11/315,665, now U.S. Pat. No. 7,216,384, which is a continuation of U.S. patent application Ser. No. 10/770,721, filed Feb. 3, 2004 now U.S. Pat. No. 7,000,272, which is a continuation of U.S. patent application Ser. No. 10/327,422, filed on Dec. 20, 2002, now U.S. Pat. No. 6,684,427, which is a continuation of U.S. patent application Ser. No. 09/755,583, filed Jan. 5, 2001, now U.S. Pat. No. 6,496,993, which is a divisional of U.S. patent application Ser. No. 09/120,125, filed Jul. 22, 1998, now U.S. Pat. No. 6,212,714, which is a continuation-in-part of U.S. patent application Ser. No. 09/018,542, filed on Feb. 4, 1998, now U.S. Pat. No. 6,163,903, which is a continuation of U.S. patent application Ser. No. 08/511,711, filed on Aug. 4, 1995, now U.S. Pat. No. 5,715,548, and said application Ser. No. 09/120,125, is a continuation-in-part of U.S. patent application Ser. No. 08/901,840, filed Jul. 28, 1997, now U.S. Pat. No. 6,151,739, which is a continuation of U.S. patent application Ser. No. 08/367,829, filed Jan. 3, 1995, now U.S. Pat. No. 5,666,681; [a continuation-in-part of U.S. patent application Ser. No. 09/018,542, filed Feb. 4, 1998, now U.S. Pat. No. 6,163,903;] and said application Ser. No. 09/120,125 is a divisional of U.S. patent application Ser. No. 08/511,711 filed Aug. 4, 1995, now U.S. Pat. No. 5,715,548 and claims benefit of U.S. Provisional Patent Application No. 60/059,772, filed Sep. 23, 1997 with respect to common subject matter. The disclosures of the above patent applications are expressly incorporated by reference herein.

**BACKGROUND AND SUMMARY OF THE  
INVENTION**

The present invention relates generally to adjustable beds and more specifically to a bed having an improved adjustable foot section.

There are many known bed designs that have adjustable foot sections. On beds that convert from a planar bed configuration to an upright chair configuration, the foot section is generally shortened as the foot section rotates from a horizontal to a vertical position. There are also beds having adjustable lengths wherein an attendant physically repositions the head or foot section of the bed to the desired length. These designs include a sliding telescopic foot section as well as a folding foot section equivalent to a "lazy boy" design. It is also known to deflate the foot section of the mattress when converting from a bed to a chair. For short occupants, there exists a need for adjustment of the foot prop or board in the chair position shorter than that attended by adjusting the length of the foot section.

The ability to adjust the length of the foot section independent of converting from a bed to a chair is also important. This would assist in maneuvering the bed in a confined locations during patient transport. It also allows the bed length to be customized to a patient's size. If a foot prop is provided at the end of the foot section, the adjustment of the foot section and the prop would prevent patient migration across the support surface of the bed. It would also provide support for the feet

to thereby improve the patient's feeling of security. It could also be used in the prevention of peripheral neuropathy ("foot drop"). Positioning the end of the mattress relative to the patient substantially increases the ability to provide heel management. Heel management is wherein the heel is supported by the thigh and the calf and the heel has reduced pressure contact with the mattress.

Certain individuals who are confined to bed for an extended period of time are vulnerable to skin breakdown on the back of the heel. Protection of the skin in this area is important if initial indications of tissue failure are observed. If the breakdown process has progressed to a point of ulceration, protection of the heel area of the patient is essential to healing.

Reducing or eliminating the time an individual spends in a supine position will protect the heel area, although it may increase the risk of skin failure on other areas of the foot and body. The current practice for protecting the heel area of a patient while in the supine position utilizes foot support to reduce or eliminate pressure and shear on the back of the heel. Such support is often provided by placing an ordinary pillow or folded towel under a calf area of the patient's legs. Several different foam boot designs are known that strap to the leg or foot to reduce the effects of heel pressure. In addition, a conventional mattress is known in which removable sections are provided in a foot area.

All of these conventional support methods require a caretaker to add or remove components from the bed in order to control pressure on the heels of the patient. Components which are removed from the bed have the potential to get lost or mislaid. Components that are added to the bed provide an extra cost associated with the purchasing, cleaning, and disposal of the added components. There is also a cost in time for the caregiver who must go through multiple steps to initiate and maintain the support of the device.

According to the present invention, a patient support having an adjustable length deck is provided. The patient support includes a deck support frame, a deck, a head board positioned adjacent a head end of the deck, and a foot board positioned adjacent a foot end of the deck. The deck includes a first section connected to a remainder of the deck, a second section movable in a common plane with the first section, and a first actuator directly connecting the first and second sections.

According to one aspect of the present invention, a patient support having an adjustable length deck is provided. The patient support includes a deck support frame, a deck, a patient rest surface configured to support a patient thereon, and a plurality of siderails configured to block egress of a patient from the patient rest surface. The deck includes a first section connected to a remainder of the deck, a second section movable in a common plane with the first section, and a linear actuator connecting the first and second sections and configured to move the second section relative to the first section between an extended position and a retracted position.

According to another aspect of the present invention, a patient support is provided including a mattress support and a mattress. The mattress support includes a main section and an extendable section movable relative to the main section between extended and retracted positions relative to the main section. Movement of the extendable section to the extended position exposes an exposable portion of the mattress support. The mattress has a main portion positioned over the main section of the mattress support and an extension portion positioned over the exposable portion of the mattress support when the extendable section is in the extended position. The

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extension portion has a width that is substantially equal to a width of the main portion adjacent to the extension portion.

According to another aspect of the present invention, a patient support is provided that includes a mattress support and mattress. The mattress support includes a main section and an extendable section movable relative to the main section between an extended position and a retracted position. The mattress support has an extended length when the extendable section is in the extended position. The mattress support has a retracted length when the extendable section is in the retracted position. The extended length is greater than the retracted length. The mattress has a main portion positioned over the main section and an extension portion movable between a first position positioned on the extendable section when the extendable section is in the extended position and a second position spaced apart from the extendable section when the extendable section is in the retracted position with the main portion positioned over the main section. The extension portion of the mattress has a thickness less than a thickness of the main portion.

According to another aspect of the present invention, a patient support is provided including a mattress support, a mattress supported by the mattress support, and a plurality of siderails positioned to block egress of a patient from the mattress. The mattress support includes a main section and an extendable section positioned adjacent to the main section. The mattress support has an extended length when the extendable section is in an extended position. The mattress support has a retracted length when the extendable section is in the retracted position. The extended length is greater than the retracted length. A segment of the main section of the mattress support supports the mattress at a first elevation relative to a floor when the main section is substantially horizontal. The extendable section of the mattress support is configured to support the mattress at a second elevation relative to the floor when the extendable section is substantially horizontal. The second elevation is greater than the first elevation.

Other features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description particularly refers to the accompanying figures in which:

FIG. 1 is a schematic view of a patient on a bed with the foot section/portion fully extended;

FIG. 2 is a schematic view of a patient on a bed with the foot section/portion adjusted and illustrating the heel management according to the principles of the present disclosure;

FIG. 3 is a bottom view of the foot section of a mattress according to the principles of the present disclosure;

FIG. 4 is a perspective top view of the foot section of the deck according to the present disclosure and connected to the remainder of the deck;

FIG. 5 is a bottom exploded view of a foot section of the deck of FIG. 4;

FIG. 6 is a bottom perspective view of 180° with respect to the respective view of FIG. 5 of one section of the deck of FIG. 5;

FIG. 7 is a top perspective view of the detail of the foot prop socket and safety switch according to the principles of the present disclosure;

FIG. 8 is a perspective view of the rotating mechanism according to the principles of the present disclosure;

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FIG. 9 is an exploded perspective view of a mattress according to the principles of the present disclosure;

FIG. 10 is a perspective view of a foam foot portion of a mattress according to the principles of the present disclosure;

FIG. 11 is a bottom view of the foot portion of FIG. 10;

FIG. 12 is a side view of the foot portion of FIG. 10 with a cover according to the principles of the present disclosure;

FIG. 13 is a bottom view of the foot portion of FIG. 12;

FIG. 14 is a partial perspective view of the foot end of a ticking for a mattress according to the principles of the present disclosure;

FIG. 15 is a perspective view of the foot section of the deck and a foot prop;

FIG. 16 is a perspective view of a modified foot section of the deck with a pair of foot prop sockets;

FIG. 17 is a view of the foot section of the deck shortened and the mattress foot section folded;

FIG. 18 is a schematic of the fluid controlled circuit for the foot angle actuator;

FIG. 19 is a perspective view of the bed showing the deck in a chair configuration;

FIG. 20 is a diagrammatic view of the bed showing the deck in the chair configuration.

FIG. 21 is a sectional view of a side rail according to the principles of the present disclosure; and

FIG. 22 is the side rail of FIG. 21 shown being moved away from and stored underneath the deck (in phantom).

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in the Figures, the bed will be discussed with respect to a deck 10 and a mattress 20 thereon. As illustrated in FIG. 4, the deck 10 includes a seat section 12, a thigh section 14 and a foot section 16 mounted to a frame 18. The deck would also include, but not shown, a head section also connected to the frame 18. Since the present disclosure is directed specifically to the foot section 16, the other portion will not be described in detail. The foot portion 16 may be used on any deck structure.

The retracting foot section of the present disclosure can be retracted while the bed is in its horizontal bed position. This permits the caregiver to adjust the overall length of the bed in either the bed position or the chair position as shown in FIGS. 19 and 20. The overall bed length can be shortened by about 12–14 inches to facilitate transport of the bed. In other words, the retracting foot section reduces the bed length so that the bed can fit into smaller elevators. The shorter bed also has a smaller turning radius. The foot section can also be moved to its retracted position to save space during storage of the bed.

The retracting foot section of the present disclosure also decreases patient migration since the foot prop location may be adjusted to the height of the patient. Therefore, the bed size can be customized for the patient. The bed also includes a shearless pivot linkage disclosed in copending application Ser. No. 08/511,711, filed Aug. 4, 1995, the specification of which is incorporated herein by reference. The combination of the shearless pivot with the retracting foot section and foot prop reduces patient migration toward the foot end of the bed as the bed articulates.

The mattress 20 illustrated in FIGS. 1 and 2 includes a body support portion 22 and a foot portion 24. The foot section 24 includes a calf portion 26 which is variable in length and thickness and a heel portion 28 which is variable in thickness. One preferred embodiment of the mattress foot portion 24 is illustrated in FIGS. 1–3 as including a plurality of bladders. A plurality of variable thickness bladders 30 are separated by

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variable length bladders 32. The heel bladder 28 is separated from one of the variable thickness bladders 30 by a variable length bladder 32. The uniaxial variable bladders are produced by gussets in the bladders.

Referring to FIG. 3, a control line 34 is connected to the foot mattress portion 24 and by line 36 to the first variable thickness bladder 30. A line 38 at the other end of the first bladder 30 is connected to the second bladder 30. Line 40 at the opposite end of the second bladder 30 connects the second bladder 30 to the third bladder 30. A control line 42 is connected to line 44 of the foot portion 24 which is connected at its other end to the heel bladder 28. A control line 46 is connected to the first variable length bladder 32. All of the variable length bladders 32 are connected about the periphery of the foot portion 24. A cover 48 for the foot portion is held together by snaps 50. Preferably, the cover 48 is a slip or a shear promoting material, for example, 30 denier ripstop nylon which aids the movement of the foot section in the mattress ticking. This removes the shearing between the occupant and the ticking as the length of the mattress is changed. A strap 51 is secured to the cover 50 by the snaps which are rivets and ties the foot section to an adjacent section 22 of the mattress.

The control lines 34, 42 and 46 are connected to a control module which selectively inflates and deflates the bladders. An example of the control module is that in U.S. Pat. No. 5,666,681 which is incorporated herein by reference. From the connection, all of the variable thickness bladders 30 are inflated and deflated simultaneously, all of the variable length bladders 32 are also inflated or deflated simultaneously. Alternatively, each of the variable length bladders may be individually controlled with additional control lines or other flow control mechanisms. All three types of bladders are independently controlled.

The foot section 16 of the deck includes a first section 52 connected to the frame 18 and the remainder of the deck and a second section 54 movable along the plane of the section 52. A foot prop 56 is mounted to the second foot section 54 and extends transverse to the plane of the foot sections 52 and 54.

To size the bed to the patient and provide heel management, an occupant is placed on the top surface of the mattress 20 as illustrated in FIG. 1 with the calf of the patient resting on the foot mattress portion 24. The foot deck section 54 is retracted onto the deck foot section 52 until the foot prop 56 is adjacent the foot of the occupant as illustrated in FIG. 2. Simultaneously, the length adjusting bladders 32 are deflated so that the length of the portion 26 of the mattress is decreased, placing the heel of the patient above the heel bladder 28. The heel bladder 28 is then deflated, decreasing its thickness such that the interference pressure on the heel of the patient is reduced. By independently controlling the length of the foot section of the deck, the length of the foot portion of the mattress and the thickness of the heel portion of the mattress, appropriate adjustment of the length of the bed is possible as well as heel management.

The foot section 16 of the deck may be pivotally connected to the frame so as to allow the foot section to drop and to be used in various styles of beds or chair beds as shown in FIGS. 19 and 20. A separate and distinct actuator would be provided for the pivotal movement as well as the articulation of the other deck sections. This allows adjustment of the foot section for the length of a patient and heel management independent of articulation of the deck and mattress as well as reducing the length and thickness of the foot portion of the mattress as the deck is converted to a chair.

The foot section 16 of the deck will be explained with respect to FIGS. 4-8. The first foot section 52 includes a top

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wall 58 and a pair of opposed lateral side walls 60. Mounted to the bottom surface of top wall 58 by welding for example, are a pair of guide tubes 62. An intermediate guide tube 64 is telescopically received with tube 62 and an end guide tube 66 is telescopically received in intermediate guide tube 64. As will be discussed below, the end guide tube 66 is secured to the second foot section 54. The pairs of telescopic guide tubes 60, 64 and 66 guide the relative movement of foot section 54 with respect to foot section 52. Plates 68 are connected between the guide tubes 62 and the bottom surface of the top plate 58. Thus, the foot section 52 has a trapezoidal shape. This trapezoidal shape with the larger of the two parallel surfaces being the top wall 58.

Also mounted to the under surface of the top wall 58 of the foot section is a hinge plate 70 which mates with a hinge plate 72 mounted to the deck frame 18. This pivotally mounts the foot section 16 of the deck to the frame 18. Mounted between the guide tube 62 are a pair of spaced end walls 74 and 76.

The second foot section 54 includes a top wall 78, a pair of side walls 80 extending therefrom and a pair of bottom walls 82 extending from side walls 80. The top, side and bottom walls are made from one continuous piece of material. The second foot section 54 is generally U-shaped with bottom flanges 82 forming a C-channel with the side walls 80 and top walls 78. Thus, the top and side walls of the foot section 54 encompass or surrounds a portion of the top and side walls of the foot section 52. The foot section 54 includes an end wall 84 connected to the top wall 78, the side walls 80 and the bottom walls 82. Tube mounting assembly 86 mounts one end of the guide tube 66 to the end wall 84 of the foot section 54.

The end wall 76 of the foot section 52 includes openings 87 and 88, best seen in FIGS. 4 and 6, between the guide tube 62. An actuator 89 shown in phantom in FIG. 5 is connected to end wall 74 and has an input connections. The actuator 89 is preferably an air cylinder, and mounting connection 90 on end wall 74 is connected to a control line (not shown). The other end of actuator 89 is secured to wall 76 by bracket 92 in the opening 88. Arm 94 extending from actuator 89 is secured to wall 84 of the second foot section 54 by bracket 96. The actuator 89 is between the guide tubes 62, 64 and 60. The pair of guide tubes 62, 64 and 66 provide uniform distribution of forces. Also, the guide tubes support the weight of the occupant's feet and minimizes friction between the walls of the foot section 52 and 54. This prevents binding and rubbing between the foot section 52 and 54.

Plastic wipers 98 are also connected to the underside of top wall 78 of the foot portion 54 to protect the sliding joint between the foot sections 52 and 54 and also to prevent the sheet and mattress from intrusion into the joint and jamming the foot section adjustment.

The foot section 54 includes lateral extensions 100. Bushing 102 mounts a bumper or roller 104 to the lateral extension 100. Socket 106 which receives the foot prop 56 is also included in the lateral extension 100. Alternatively, a pair of sockets 106 and 107 may be provided on each extension 100 as shown in FIG. 16. A switch 108 is mounted to the socket 106 by fastener 110 as illustrated in FIG. 7. Switch 108 indicates the presence of the foot prop in the end of the bed and is part of the control system. Alternatively, the switch 108 may be designed to also sense the presence of pressure on the foot prop produced by the foot of the occupant of the bed engaging the foot prop of the occupant of the bed.

Handles 128 are conveniently provided at the foot of the bed connected between the lateral extensions 100 and the foot section 54. A cover 150 is mounted to the end wall 84 of the foot section 54 as shown in FIG. 5. Slots 154 in the top of end

wall **84** receives a stop **156** when the foot portion **24** of the mattress is made of foam as illustrated in FIGS. 10–13.

The width **W1** of the foot sections **52** and **54** is substantially the width of the frame **18** and smaller than the width **W2** of the frame **18** with its support surfaces. This accommodates side rails (not shown) mounted on the frame **18** in their lowered or tucked position as the foot section **16** pivots down. Width **W3** of the foot section **16** with the lateral extensions **100** may be substantially equal to the width **W2**, since the extensions will pivot below the side rails.

The length of the foot deck section **16** as well as the angle of the foot section **16** with respect to the frame **18** are determined by length sensor **114** and angle sensor **116** mounted to the first foot section **52** at tube **62** by bracket **112**. A sensor crank **118** is mounted to the length sensor **114** at one end and its other end is mounted to sensor link **120**. The sensor link **120** extends through the opening **87** in the wall **76** and is connected at its other end to a pivotal connection **122** to the end wall **84** of the foot section **54**. The length sensor **114** may be for example, a potentiometer wherein the crank **118** and link **120** rotate the potentiometer with a change of the length of the foot section **54** with respect to foot section **52**.

A link **124** is connected to the angle sensor **116** at a first end by crank **123** and is pivotally connected at the second end to pivot leg **126** (shown in FIG. 6) mounted to hinge plate **72** (FIG. 4) which is connected to the deck frame **18**. The angle sensor **116** may also be a potentiometer to determine the pivotal position of the foot section **16** with respect to the deck frame **18**.

A pair of links **130** are pivotally mounted at one end to bracket **132** which is mounted to end wall **76** of the first foot section **52**. The other end of links **130** are pivotally connected between brackets **134** and **136** mounted onto rod **138**. The other end of brackets **136** is pivotally connected by brackets **140** to end wall **142** of the frame **18**. Brackets **144** in the midsection of rod **138** connect rod **146** of actuator **148** to the rod **138**. The other end of the actuator **148** is connected to the frame **18**. A cover **150** has one end (not shown) connected to the frame **18** and its other end connected to brackets **152** which are mounted on end face **142** of the frame **18**.

The actuator **148** determines the articulation or angular position of the foot section **16** of the deck. The actuator **148** illustrated in FIG. 18 includes rod **146** connected to piston **147**. A pump **210** is connected to the opposite sides of piston **147** by raising valve **212** and lowering valve **214**. Connected between the pump **210** and the valves **212** and **214** are filters **216**, restriction **218** and check valves **220**. Check valves **220** prevent the pressurized fluid in the actuator **148** from flowing back towards pump **210**. The other side of piston **147** is connected to reservoir **222** by lowering return valve **224** and raising return valve **226**. Filter **228** connects the reservoir **222** to the return valves **224** and **226** and a filter **230** connects reservoir **222** to the pump **210**.

To extend the rod **146**, electrical valves **212** and **226** are actuated to connect the respective sides to the pump **210** and reservoir **222**. This raises the foot section **16**. To lower the foot section **16**, and retract the rod **146**, electrical valves **214** and **224** are activated to respectively connect the opposite sides of the piston **147** to the pump **210** and reservoir **222**. As a safety feature, relief valve **232** is connected between the output of pump **210** and the reservoir **222**. Thus, if the pressure at the output of the pump builds up to an unsafe level, relief valve **232** provides a flow back to the reservoir **222**.

As another safety feature, a relief valve **234** is connected between the output of valve **214** and the reservoir **222**. Since valve **214** provides the output of the pump to the piston **147** to lower the foot section, if the pressure in the lowering should

exceed the setting of relief valve **234**, the excess pressure will be relieved back to reservoir **222**. This is a safety feature in that if the foot section **16** engages an object in its lowering, the piston **147** and rod **146** will stop moving and pressure will build up on that side of the piston. To prevent crushing of an object or a person or part of a person, relief valve **234** will operate. As an alternative to the relief valve **234**, a pressure sensor may also be provided and the valve **214** may be closed or valve **226** opened. By way of example only and not by way of limitation, whereas the relief valve **232** for the pump may be set at 900 PSI, the relief valve **238** for the actuator **148** may be set at approximately 180 PSI.

The electronics portion **160** of the controller as illustrated in FIG. 4 is mounted to the frame **18** below the seat section **12** and the thigh section **14** of the deck. The controller **160** is connected to the length sensor **114** by wire **162**, to angle sensor **116** by wire **164** and to the prop sensor switch **108** by wire **166**. The sensor crank **118** and sensor link **120** are hollow or U-channel and the wire **166** for the prop traverses the foot section **116** through the channel in the sensor crank **118** and sensor link **120**. As the length sensor **114** sense the position of the end of the bed or its length, the appropriate inflation or deflation of the bladders is made to adjust the length of the foot portion of the mattress. The angle sensor **116** in combination with the foot prop sensor **108** does not allow the foot section to pivot to an angle, for example in the range of 65° to 90° degrees from the horizontal, which will allow egress from the end of the bed without removal of the foot prop. This prevents the occupant from standing on the foot prop. Any angle less than this range will provide foot support in a chair position which is not selected for ease of egress.

Details of the mattress **20** is illustrated in FIG. 9. Ticking **170** receives the body portion **22** and a foot portion **24**. Two examples of each portion is illustrated. The body portion **22** could include a foam seat portion **172** and a foam back portion **174**. Alternatively, it may include a bladder seat section **176** and a bladder back section **178**. The foot section **24** could include a foam foot portion **180** or the bladder foot portion **28**, **30** and **32** of FIG. 3. The control lines **34**, **42** and **44** have a bend which corresponds to the juncture of the back and seat section of the mattress where a majority of the bending of the mattress occurs. Any combination of feet section may be used with any combination of seat and back section.

The body portion **22** and the foot portion **24** fit within the ticking **170**. The ticking **170** is a stretchable, breathable thermal plastic which is impervious to bacteria. The seams of the outer ticking of the mattress are formed by continuous ultrasonic welding. Therefore, the seams do not require any stitches which can permit fluid leakage. The ultrasonically welded seams are impermeable to fluids and bacteria so that the seams of the ticking prevent leakage into an interior region of the mattress.

Magnets **182** are provided at the foot end and the head end of the ticking **170** in interior pockets **184** as illustrated in FIG. 14. These magnets secure the foot and head end of the bed to the frame or deck. If the frame is metal, no additional magnets are needed. If not, magnets are also provided on the supporting deck or frame.

The details of the foam foot portion **180** is illustrated in FIGS. 10–13. A foam core **186** is corrugated along its length or longitudinal axis. Preferably, the foam is low-ILD, visco elastic foam. Its ILD is in the range of 8–12 and is preferably 10. The length of the foam foot portion **186** may be, for example, 27 inches and is capable of being shortened to 13.5 inches. This is an example of one foot portion. The corrugation allows the foot portion to diminish in length. Also, the

load-ILD allows the foot portion to compress upon the weight of the patient. This will help reduce the pressure on the heel. Also, by providing one of the valleys adjacent to the foot end of the foot portion **186**, the heel may rest in the valley and therefore offer a valley or decreased area under the heel.

A portion of the foam **186** adjacent to the remainder of the deck is tapered at **188**. This mates with a tapering **173** of the foam seat portion **172**. This is to accommodate articulation between the foot portion and the seat or thigh portion. The foot end of the foam **186** has tapered corners **190**. This allows them to lay adjacent to the foot prop **56**.

Bonded to the bottom of the core **186** adjacent to the deck end is a torque plate **192**, as illustrated in FIG. **11**. Prior to bonding, half of a male/female snap rivets **194** are inserted through the torque plate **192**. An attachment plate **196** is also bonded to the bottom of the core **186** adjacent to the foot end. Only the cross-half section is bonded and the ends are left free as flaps.

The core **186** is provided within a slip cover **198** which includes a zipper **200** as illustrated in FIGS. **12** and **13**. The cover **198** preferably is a shear promoting material, for example, 30 denier ripstop nylon which aids the movement of the foam foot portion in the ticking **170**. The flaps of attachment plate **196** extend through slots **202** in the bottom of the slip cover **198**. This secures the foot end of the core **186** to the slip cover **198**. The other end of the core **186** is secured within the cover **198** by snap rivets **206** extending through straps **204** and to be received in the mating snap **194** of the torque plate **192**. The straps **204** secure the foam of the foot portion **180** to the adjacent seat portion of the mattress within the ticking **170**. The flap ends of the attachment plates **196** extending through the cover **198** are also received in slots **208** of pockets **184** as are the magnets **182** of FIG. **14**.

As illustrated in FIG. **15**, the foot prop **56** has opposed foot support surfaces **55** and **57**. The general shape of the foot prop **56** is trapezoidal in cross-section. The distance D between the parallel surfaces **55** and **57** may be, for example, 2½ inches. A pair of rods **59** extend from the bottom surface of the foot prop **56** and are received in sockets **106** in the second foot section **54**. Although the foot section **16** is shortened or retracted when the deck rotates from its flat or planar position to the chair position, for very short occupants, the foot prop **56** would still not provide support for the feet of the short occupant. In such a case, the foot prop **56** can be rotated 180° with respect to that shown in FIG. **15** such that the planar surface **57** would be the foot support surface. It would be 2 inches closer to the patient than if surface **55** was the foot support surface.

As an alternative, a pair of sockets **106** and **107** spaced along the length of the foot section may be provided in each extension **100** as illustrated in FIG. **16**. The distance E between the sockets **106** and **107** again, may be, for example, 2½ inches. This will allow the foot prop **56** to be moved from sockets **106** to sockets **107** and thereby shortening the end by 2½ inches. Rotating the foot prop **56** such that the surface **57** becomes a support surface, would shorten it an additional 2 inches. Thus, an adjustment of 4½ inches can be obtained using the configuration of FIG. **16**. Additional sockets may be provided to give additional adjustments.

It should also be noted that although the cross section of the foot prop **56** is shown as trapezoidal, any cross sectional configuration which provides a differential between the two opposed supporting foot surfaces may be used.

It is important that the foot prop **56** has the parallel surface **55** as a support surface when the deck is in its planar position and that it is in sockets **106**. Otherwise, it would overlap the mattress and prevent the end section from inflating to the

appropriate height. Sensors and controls can be provided in the sockets **106** and **107** as well as some sensible indicia on **59** to indicate which socket it is in and which surface, **55** or **57** is adjacent the foot. Once this is sensed, the inflation of the foot section would be prevented until either the foot prop **56** has been removed or it is in socket **106** with surface **55** being the foot support surface. Also, as previously discussed, the control should not allow the foot section to rotate beyond, for example, 65° with respect to the horizontal if the foot prop is mounted in either of the sockets **106** or **107**. This allows the foot prop to be available when the foot section is in a chair position while preventing it from being used when the foot section is lowered to permit egress.

Another method of changing the position of the foot support surface of the foot prop **56** greater than that achieved by the adjustment of the foot section **16** of the deck is illustrated in FIG. **17**. While the foot section **16** is adjusted from its extended to its contracted shortened position, the mattress foot portion **24** is not shortened nor made thinner. The non-shortened portion of the foot portion **24** of the mattress then extends up one of the support surfaces of the foot prop **56** and forming a foot support surface. If the thickness of the foot portion **24** of the mattress **20** is, for example, five inches, this will shorten the length of the foot section by five inches. Also, if the reversible foot prop, as illustrated in FIGS. **15** and **16** is used, this would add an additional 7½ to 9½ inches of adjustment.

Although FIG. **17** illustrates further decreasing the length of the deck in the planar or total horizontal position, the same adjustment can be made as the foot section of the deck and mattress are rotated down from the horizontal position towards the chair position. The controller would have to be modified so as to not simultaneously adjust the height or length of the foot section of the mattress **24** during the rotational and shortening of the foot section of the deck.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken by way of limitation. The spirit and scope of the present invention are to be limited only by the terms of the appended claims.

The invention claimed is:

1. A patient support having an articulating deck, the patient support comprising:

- a foot portion pivotally coupled to the deck, the foot portion including a first section and a second section;
- an adjustable-length guide connecting the first section to the second section; and
- an actuator configured to move the second section relative to the first section from a first position to a second position, wherein the actuator is disposed underneath the deck.

2. The patient support of claim 1, further comprising a mattress support including a main section and an extendable section movable relative to the main section between extended and retracted positions, wherein movement of the extendable section to the extended position exposes an exposable portion of the mattress support.

3. The patient support of claim 1, further comprising first and second siderails movable between a raised position and a lowered position, the lowered position being underneath the deck.

4. The patient support of claim 1, wherein the first section of the foot portion is trapezoidal in cross section and has opposed surfaces, one of which includes a large surface and the other of which includes a small surface, the top side of the first section including the large surface.

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5. The patient support of claim 1, wherein the actuator is operably coupled to one of the first and second sections.

6. The patient support of claim 1, further comprising a second actuator configured to move the deck between a plurality of orientations.

7. The patient support of claim 6, wherein one of the plurality of orientations is a chair orientation.

8. A patient support having an articulating deck, the patient support comprising:

a foot portion pivotally coupled to the deck, the foot portion including a first section and a second section;

an adjustable-length guide connecting the first section to the second section; and an actuator configured to move the second section relative to the first section from a first position to a second position; and

a mattress having a main portion positioned over the main section of the mattress support and an extension portion positioned over the exposable portion of the mattress support when the extendable section is in the extended position, the extension portion having a width that is substantially equal to a width of the main portion adjacent to the extension portion.

9. A patient support having an articulating deck, the deck comprising:

a first section pivotally connected to the remainder of the deck;

a first actuator operably connected to the first section to pivot the first section relative to the remainder of the deck, [wherein the first actuator is a fluidly driven piston and the relief mechanism is a relief valve connected to the piston;] and a relief mechanism to deactivate the first actuator when the first actuator encounters a predetermined resistance, *wherein the first actuator is a fluidly driven piston and the relief mechanism is a relief valve connected to the piston.*

10. The patient support of claim 9, further including a second section movable in a plane relative to the first section; and a second actuator connected to the second section to move the second section relative to the first section.

11. The patient support of claim 9, wherein the relief mechanism is fluidically responsive to fluid pressure on the piston.

12. The patient support of claim 9, further comprising a sensor to sense the pressure on the piston and wherein the relief mechanism is an electro-fluid valve responsive to fluid pressure on the piston sensed by the sensor.

13. An adjustable-length patient support, comprising:

a articulatable frame including a head end, a seat section and a longitudinal axis, the articulatable frame being moveable to assume at least a bed position and a chair position, and

a foot section pivotally coupled to the seat section, the foot section including a first section and a movable second section, the second section being retractable over the first section along the longitudinal axis to adjust the length of the patient support when the frame is in at least one of the bed position and the chair position, wherein the length of the foot section automatically extends when the frame is assuming the bed position and wherein the actuator includes a first end and a second end, the first end is coupled to the first section of the foot section, and the second end is coupled to the second section of the foot section.

14. The patient support of claim 13, wherein the patient support automatically retracts the second section of the foot section when the frame is assuming a chair position.

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15. The patient support of claim 13, further comprising an actuator coupled to the foot section, the actuator being operable to move the second section relative to the first section.

16. The patient support of claim 13, further comprising at least one guide mounted to the first section of the foot section.

17. The patient support of claim 16, further comprising at least one telescoping guide received by the at least one guide.

18. An adjustable-length patient support comprising:

an articulatable frame including a head end, a seat section and a longitudinal axis, the articulatable frame being moveable to assume at least a bed position and a chair position,

a foot section pivotally coupled to the seat section, the foot section including a first section and a movable second section, the second section being retractable over the first section along the longitudinal axis to adjust the length of the patient support when the frame is in at least one of the bed position and the chair position, wherein the length of the foot section automatically extends when the frame is assuming the bed position, and a pair of guides coupled to the foot section, wherein the actuator is located between the guides.

19. An adjustable length patient support comprising:

an articulatable frame including a head end, a seat section and a longitudinal axis, the articulatable frame being moveable to assume at least a bed position and a chair position,

a foot section pivotally coupled to the seat section, the foot section including a first section and a movable second section the second section being retractable over the first section along the longitudinal axis to adjust the length of the patient support when the frame is in at least one of the bed position and the chair position, and a length sensor coupled to the foot section.

20. An adjustable length patient support comprising:

an articulatable frame including a head end, a seat section and a longitudinal axis, the articulatable frame being moveable to assume at least a bed position and a chair position,

a foot section pivotally coupled to the seat section, the foot section including a first section and a movable second section, the second section being retractable over the first section along the longitudinal axis to adjust the length of the patient support when the frame is in at least one of the bed position and the chair position, and controller electronics coupled to the frame to automatically adjust the length of the foot section.

21. A patient support comprising:

an articulating deck including a pivotally adjustable foot portion, the foot portion including a first section and a second section;

an adjustable-length guide connecting the first section to the second section; and

an actuator configured to move the second section relative to the first section from a first position to a second position, wherein the actuator is disposed substantially underneath the articulating deck.

22. The patient support of claim 21, further comprising a mattress support including a main section and an extendable section movable relative to the main section between extended and retracted positions, wherein movement of the extendable section to the extended position exposes an exposable portion of the mattress support.

23. The patient support of claim 22, further comprising a mattress having a main portion positioned over the main section of the mattress support and an extension portion positioned over the exposable portion of the mattress support

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when the extendable section is in the extended position, the extension portion having a width that is substantially equal to a width of the main portion adjacent to the extension portion.

**24.** The patient support of claim **21**, further comprising first and second siderails movable between a raised position and a lowered position, the lowered position being underneath the deck.

**25.** The patient support of claim **21**, wherein the first section of the foot portion is trapezoidal in cross section and has opposed surfaces, one of which includes a large surface and

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the other of which includes a small surface, the top side of the first section including the large surface.

**26.** The patient support of claim **21**, wherein the actuator is operably coupled to one of the first and second sections.

**27.** The patient support of claim **21**, further comprising a second actuator configured to move the deck between a plurality of orientations.

**28.** The patient support of claim **27**, wherein one of the plurality of orientations is a chair orientation.

\* \* \* \* \*