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Biondo et al.

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(54) **PULMONARY THERAPY APPARATUS**

(75) Inventors: **John P. Biondo**, Aurora, IN (US); **Kenneth L. Kramer**, St. Paul, IN (US); **Carl W. Riley**, Milan, IN (US); **Gregory W. Branson**, Batesville, IN (US); **Richard W. Chance**, Greenwood, IN (US); **Tatiana Leblanc**, Columbus, OH (US); **Barry P. Markwick**, Columbus, OH (US); **Peter A. Koloski**, Columbus, OH (US); **Troy D. Acton**, Saint Paul, IN (US); **Michael E.**

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(73) Assignee: **Hill-Rom Services, Inc.**, Wilmington, DE (US)

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(21) Appl. No.: **09/906,561**

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(65) **Prior Publication Data**

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Related U.S. Application Data

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(52) **U.S. Cl.** **128/845**; 128/869; 128/870

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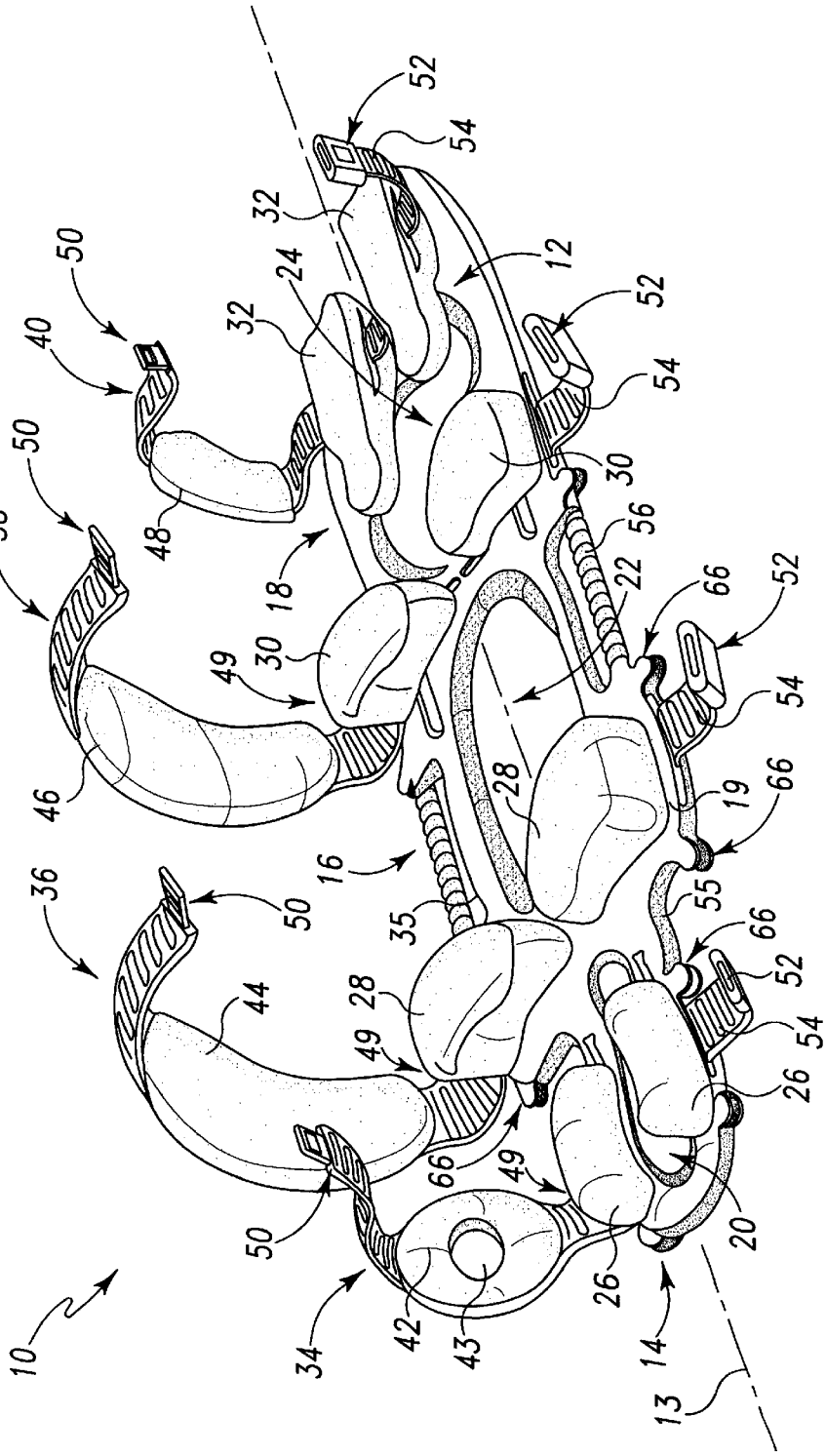
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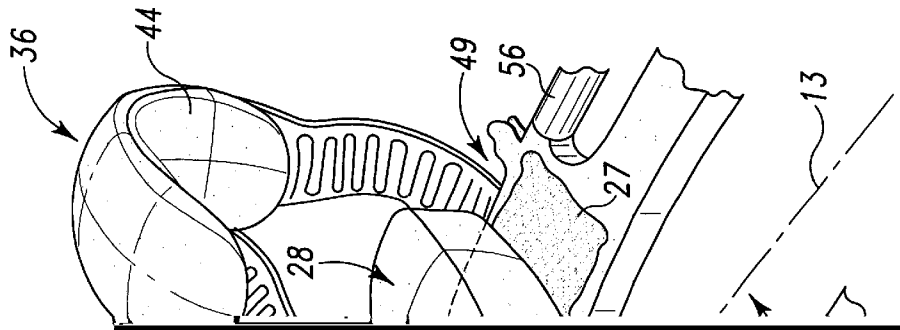
Fig. 1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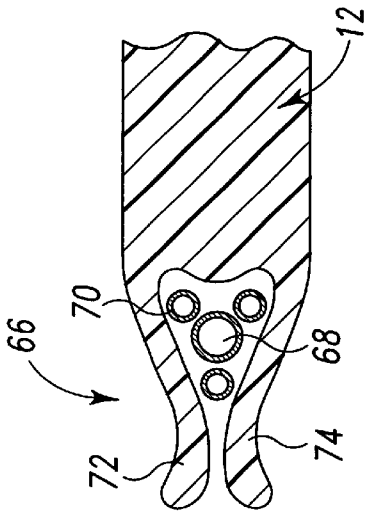
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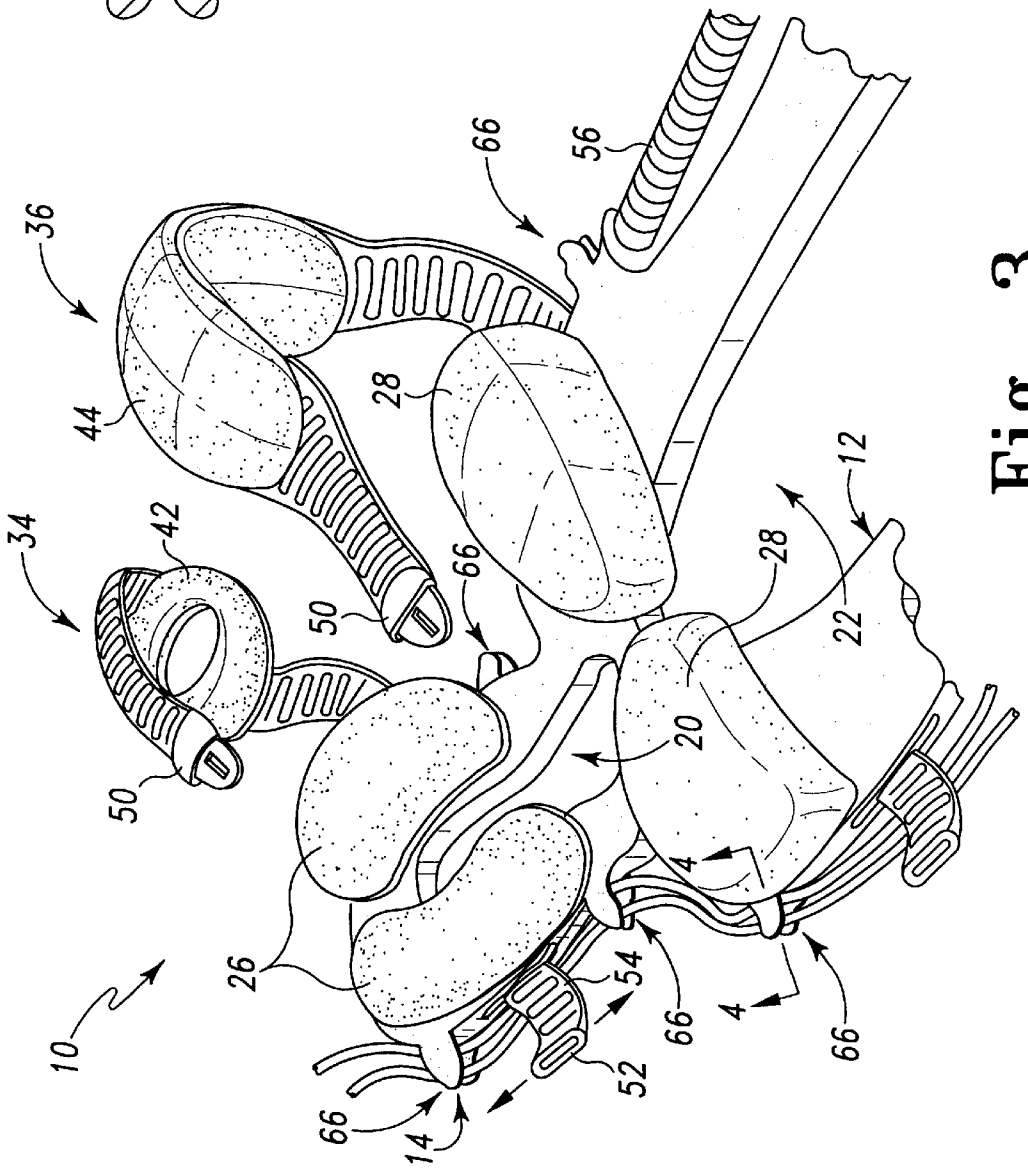
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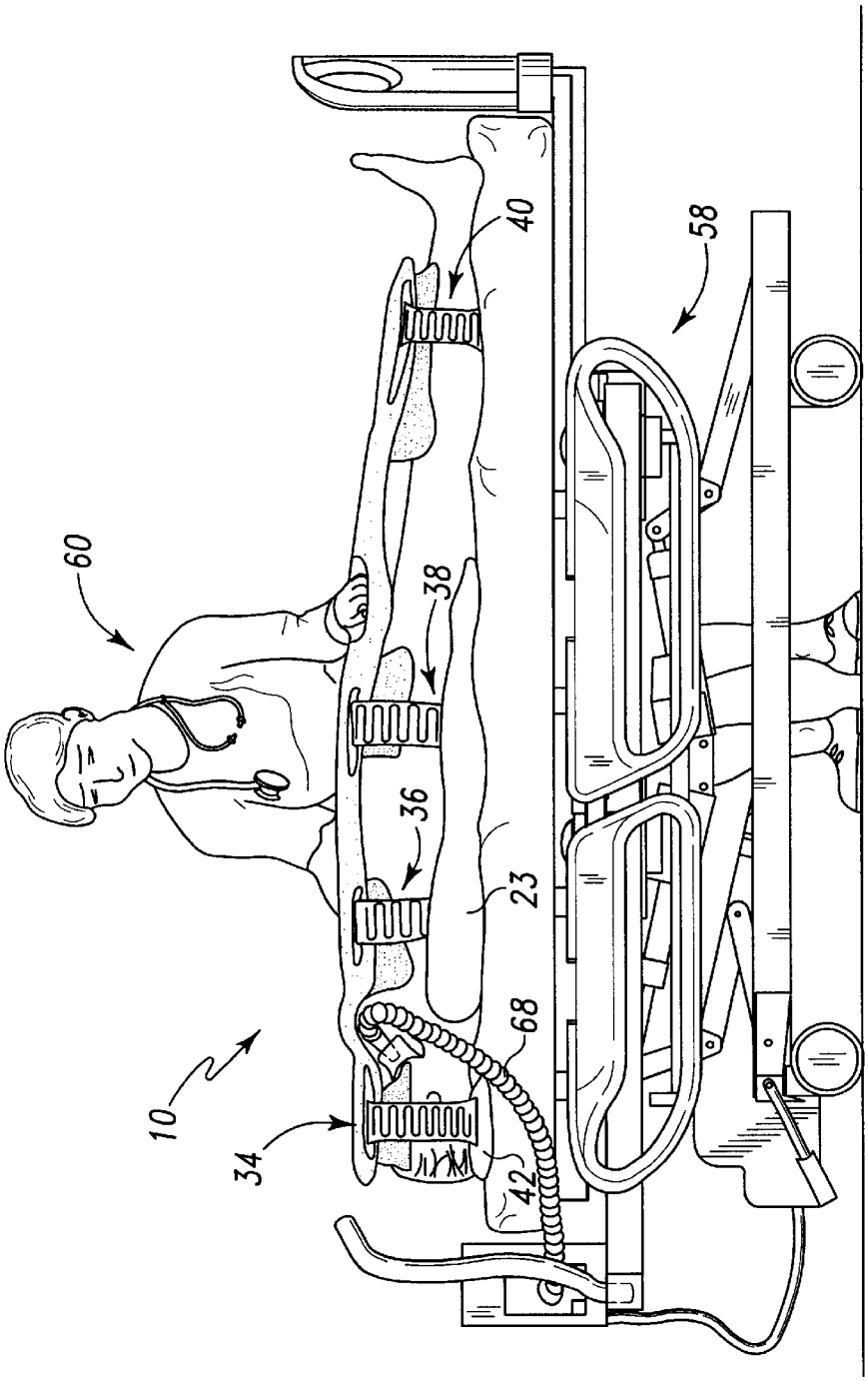
Fig. 3



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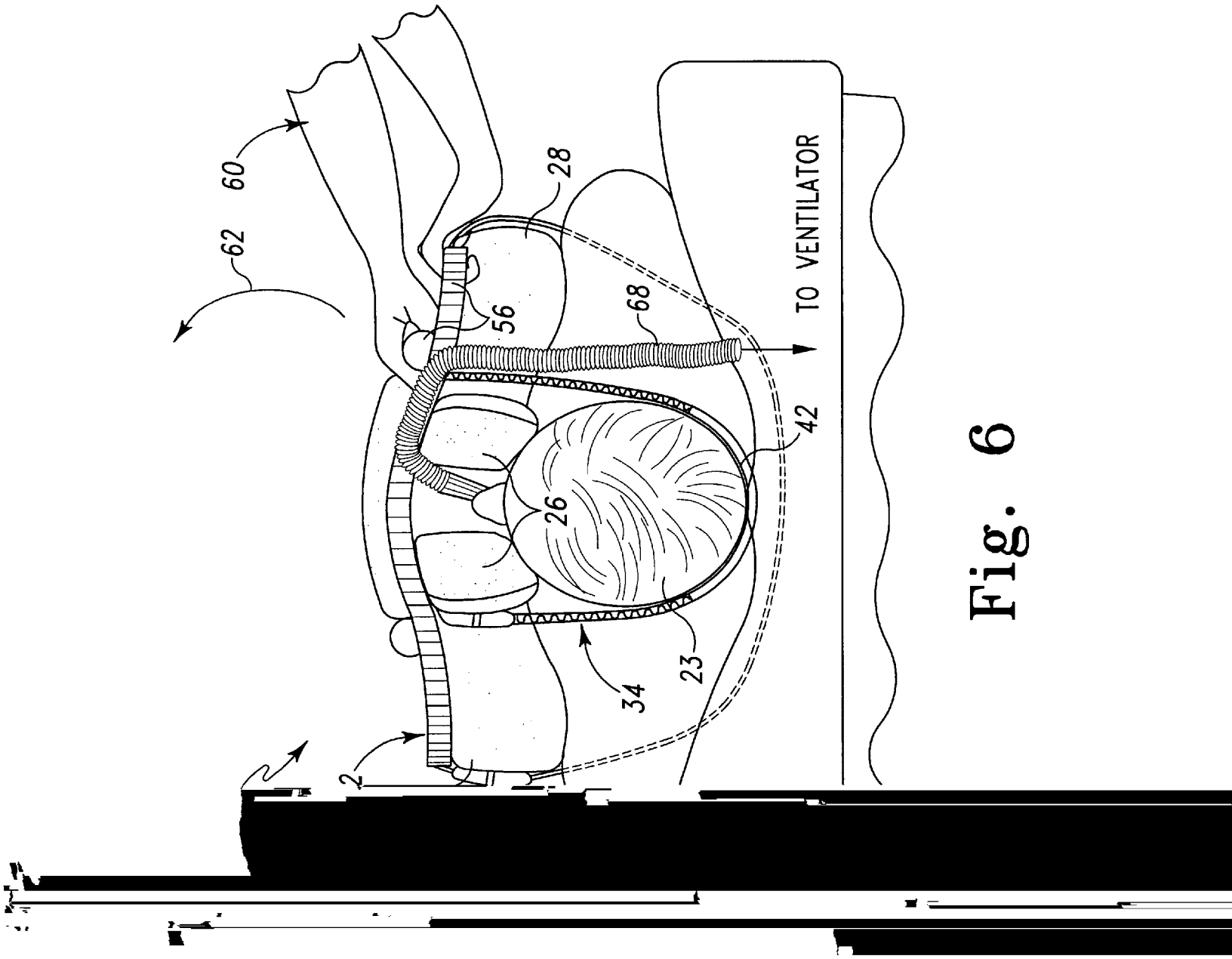

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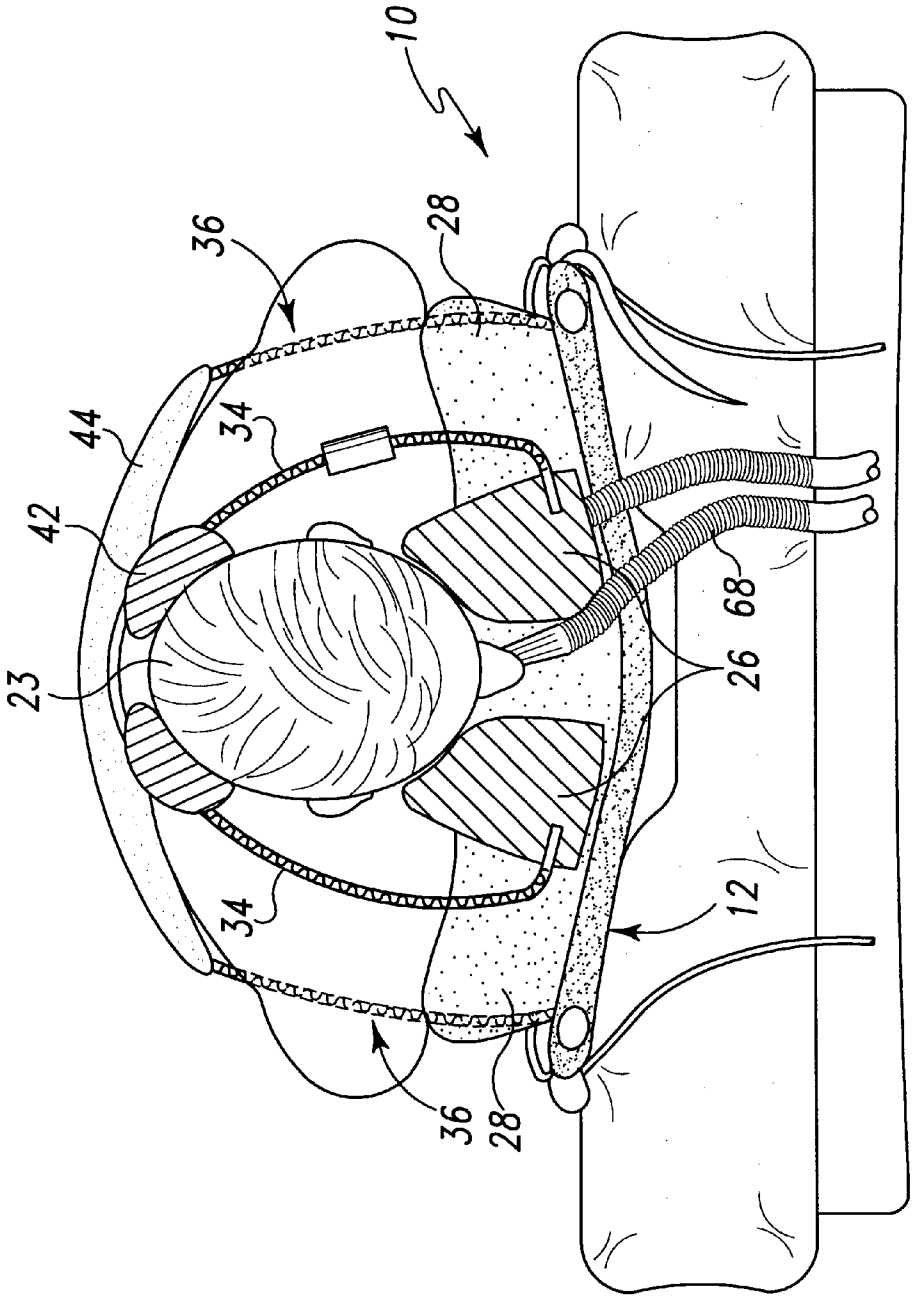

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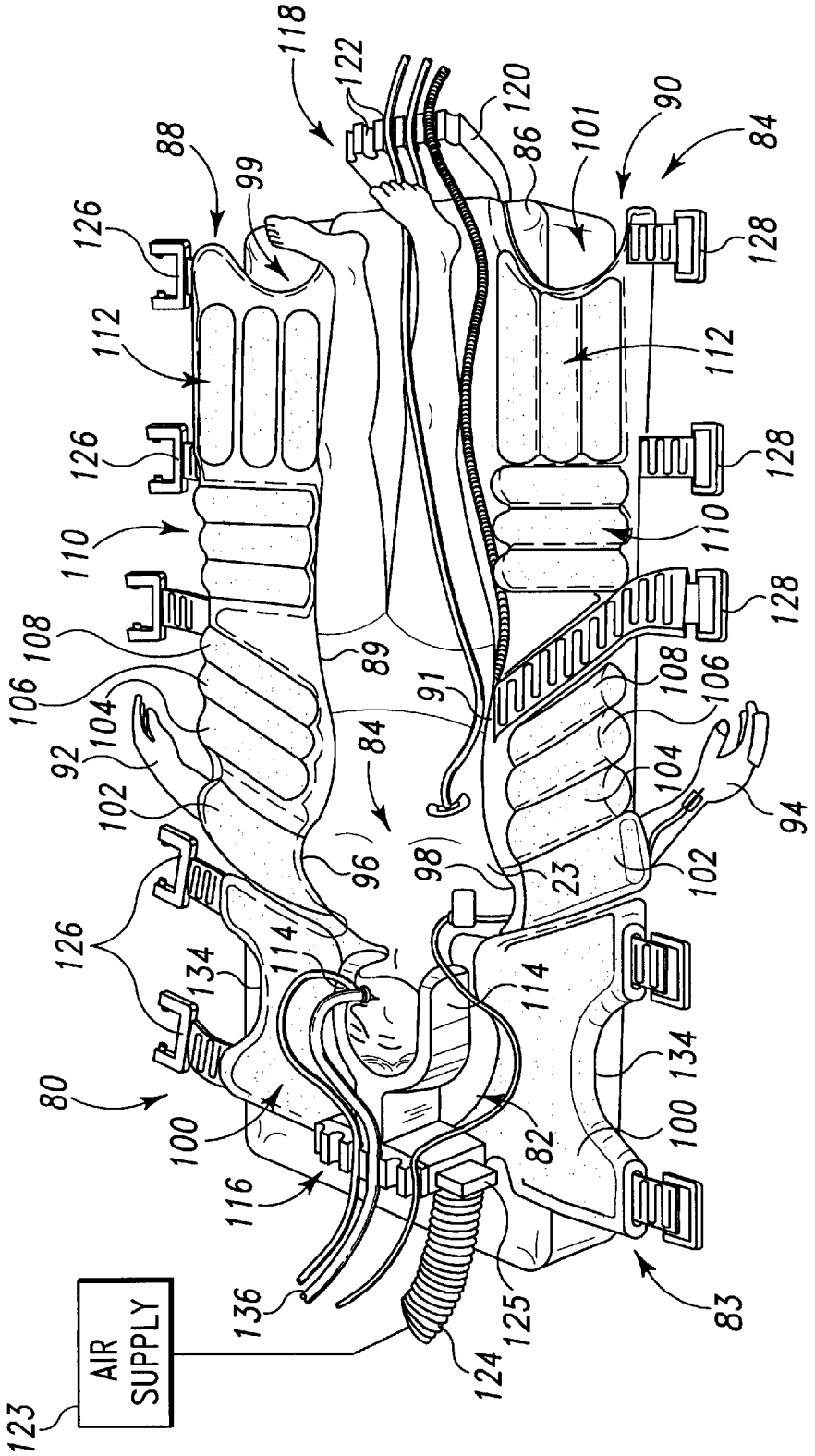
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Fig. 8

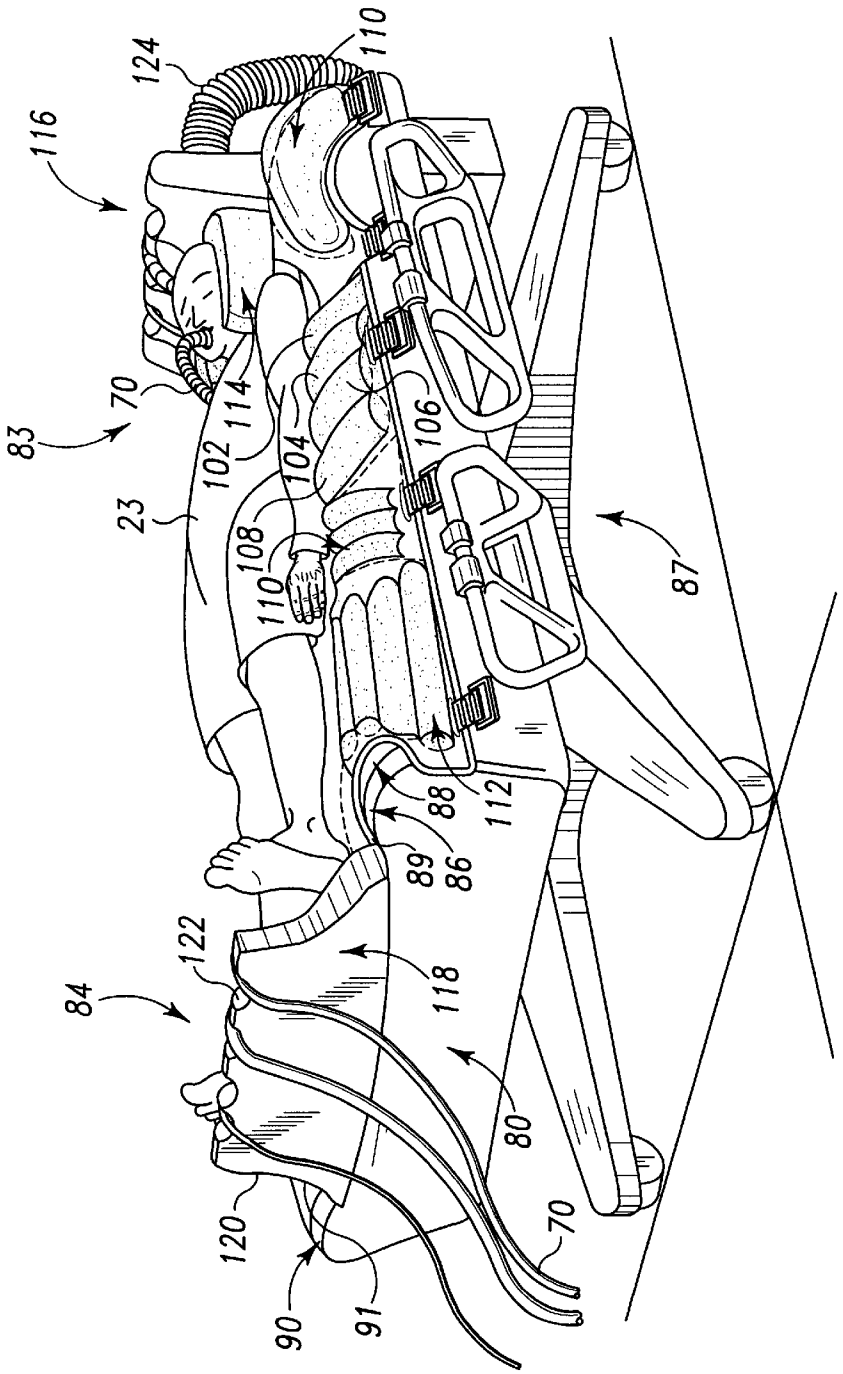
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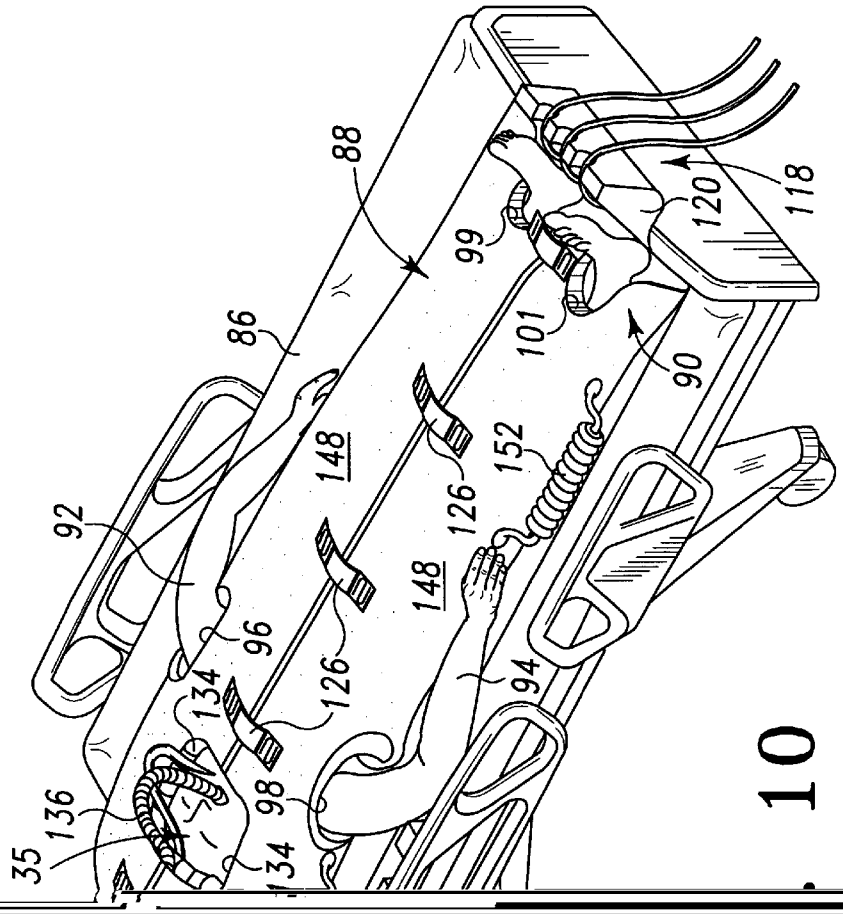
Fig. 9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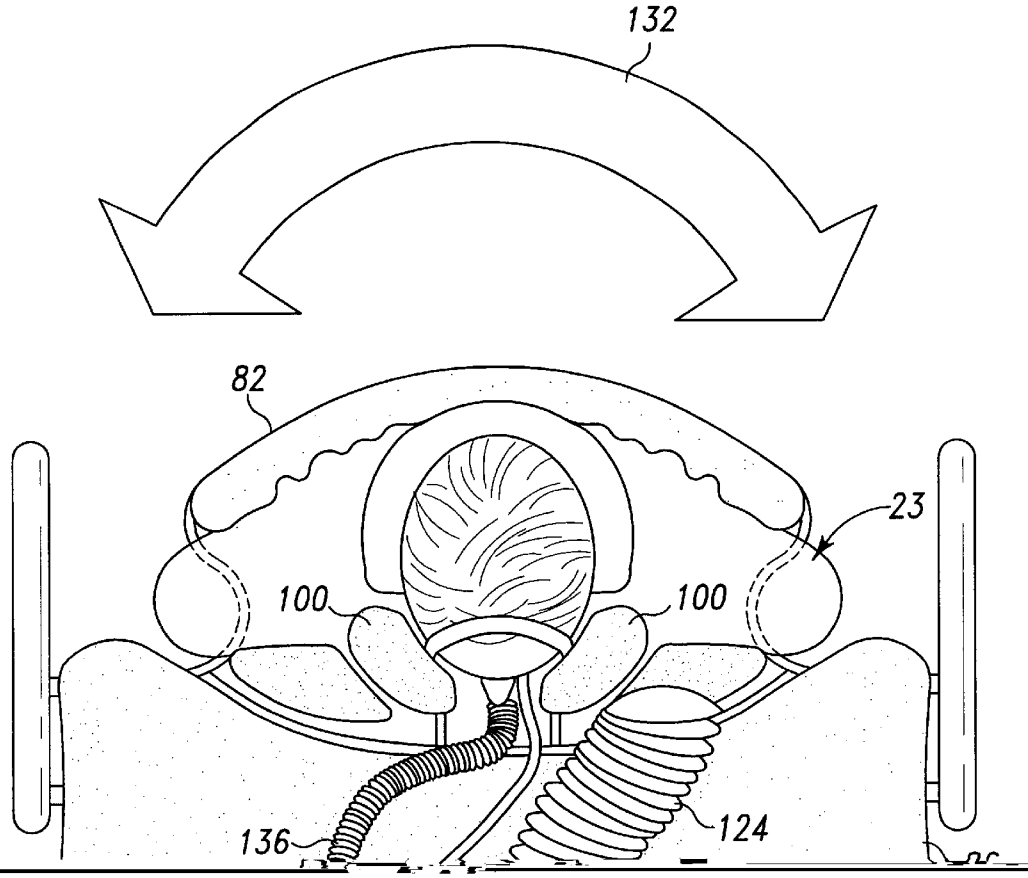
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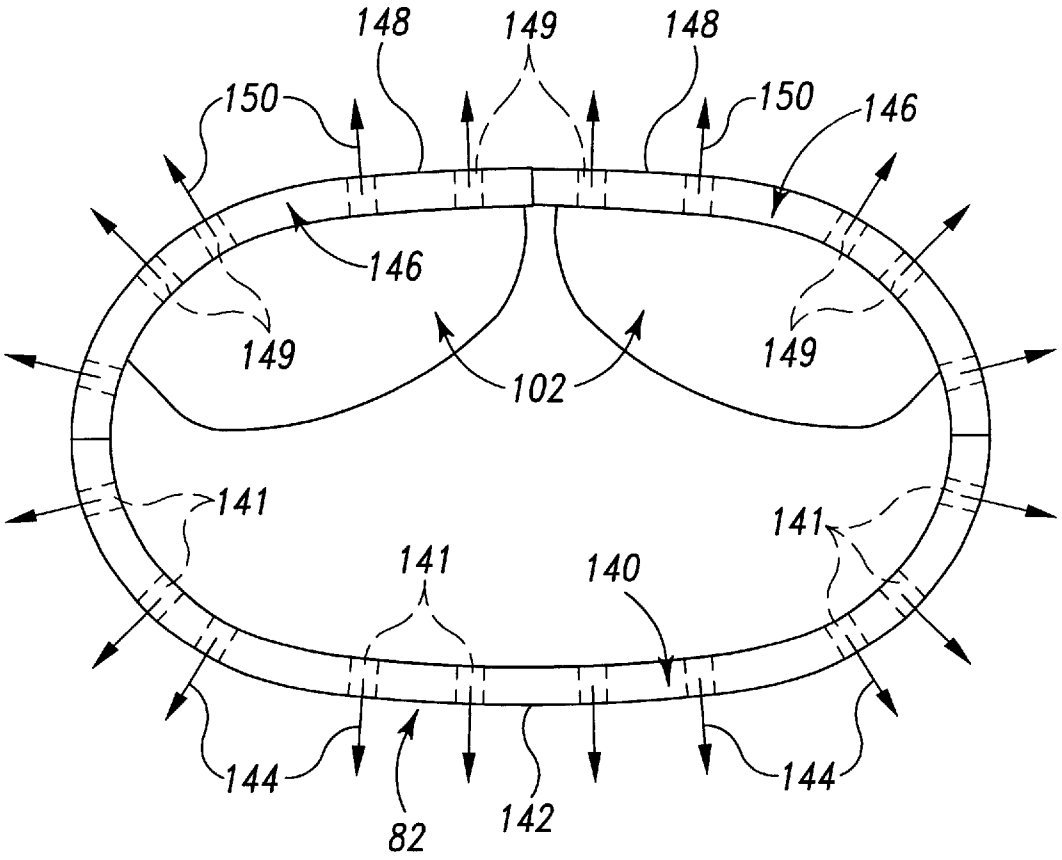
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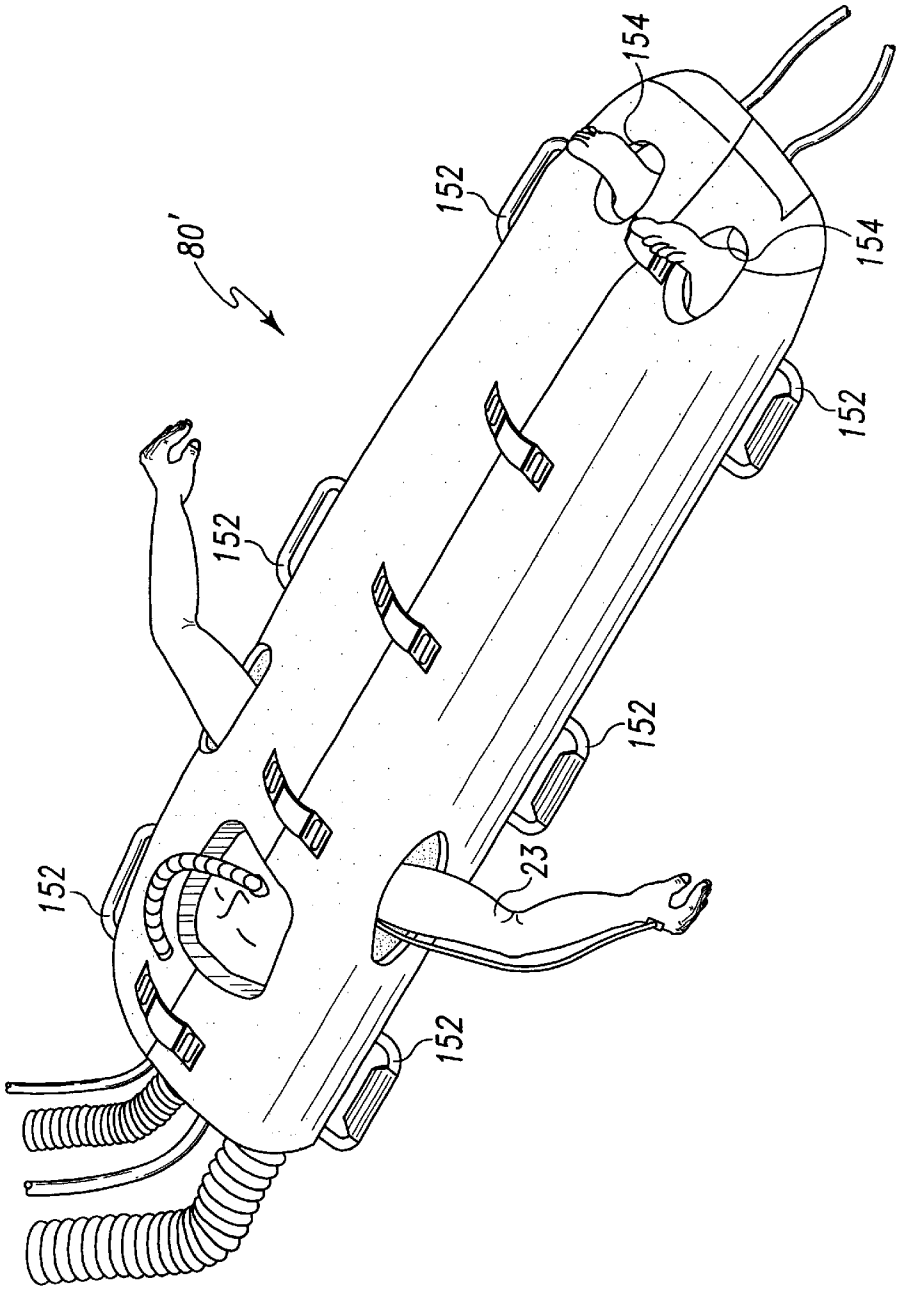
Fig. 12



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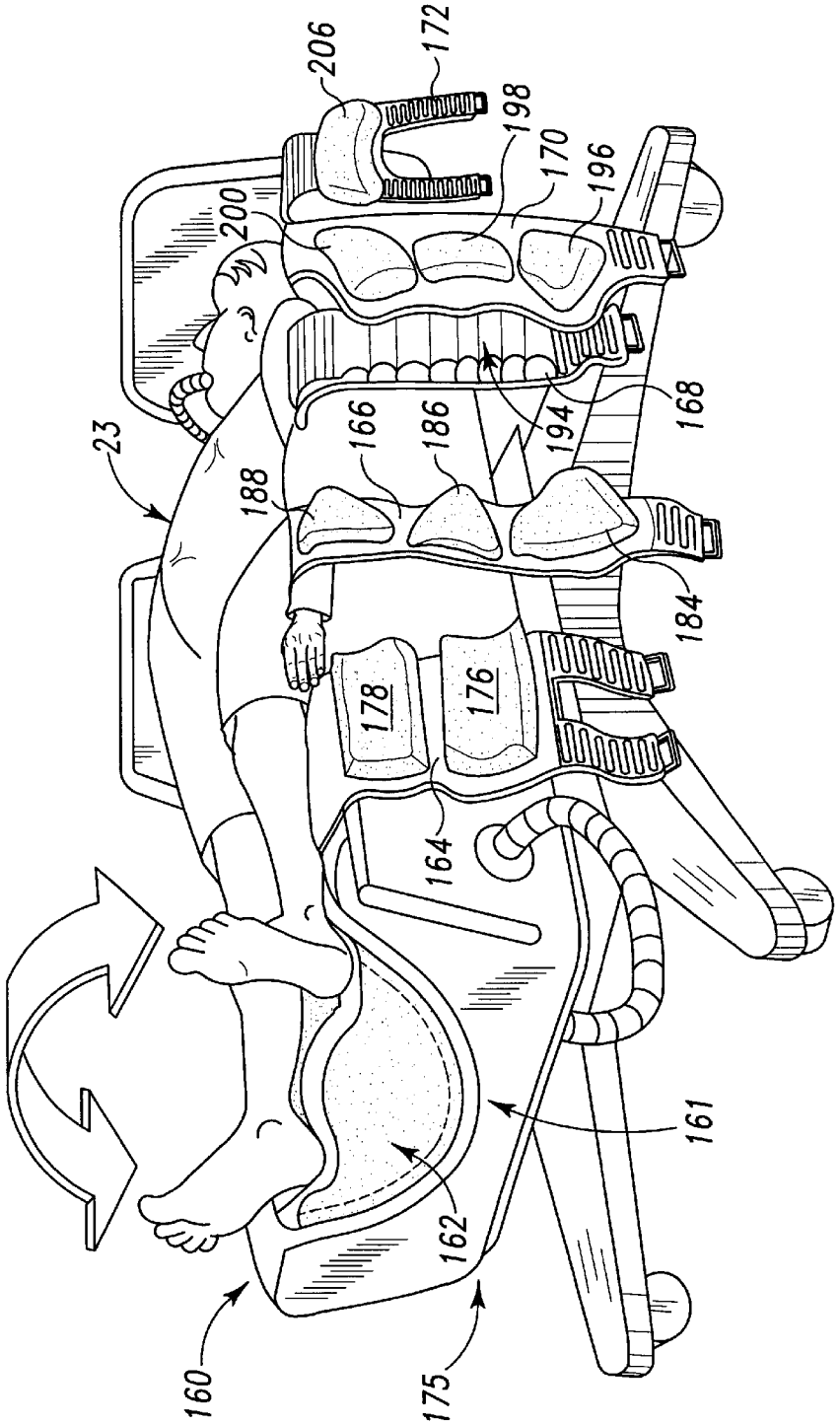
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Fig. 14

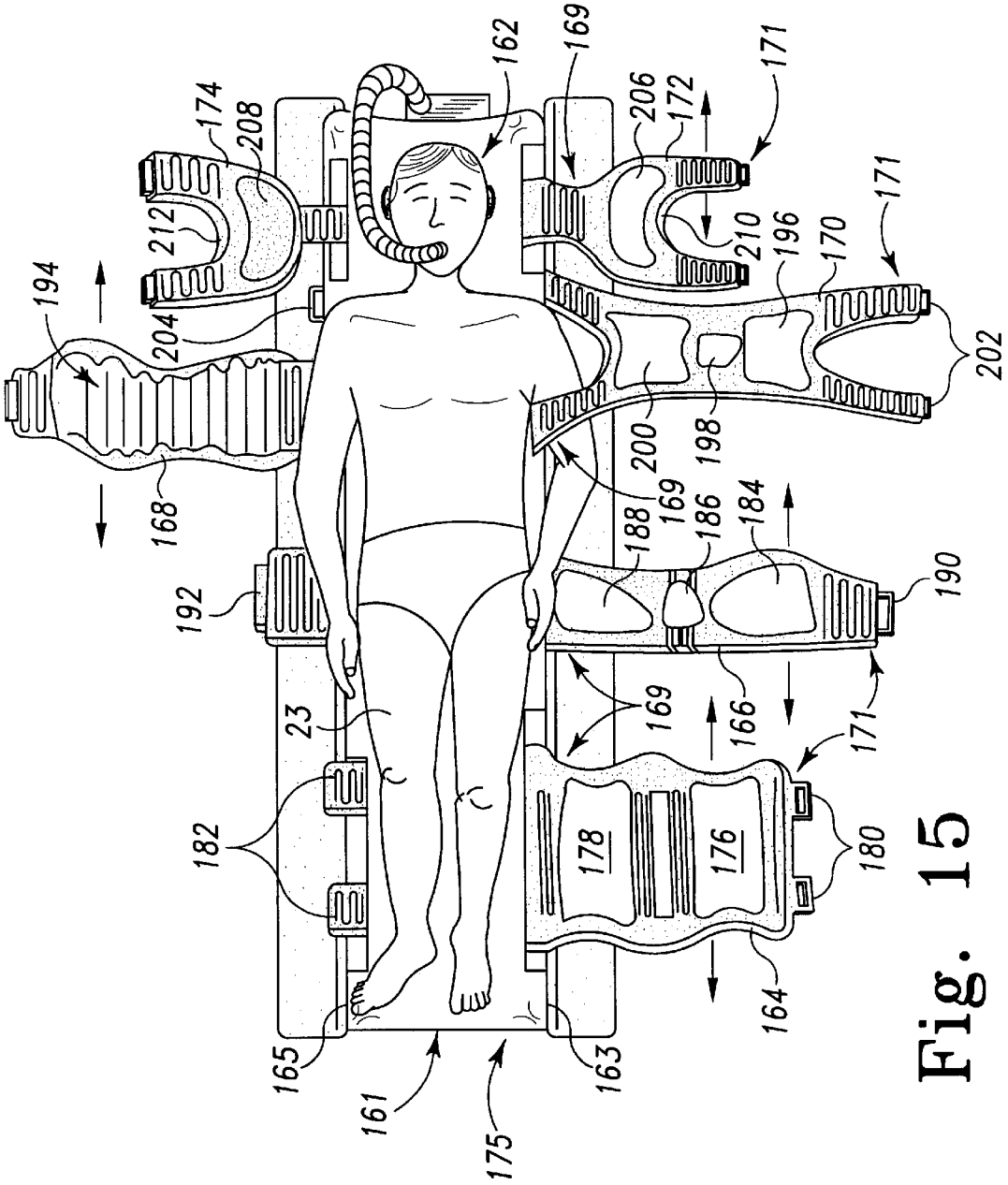
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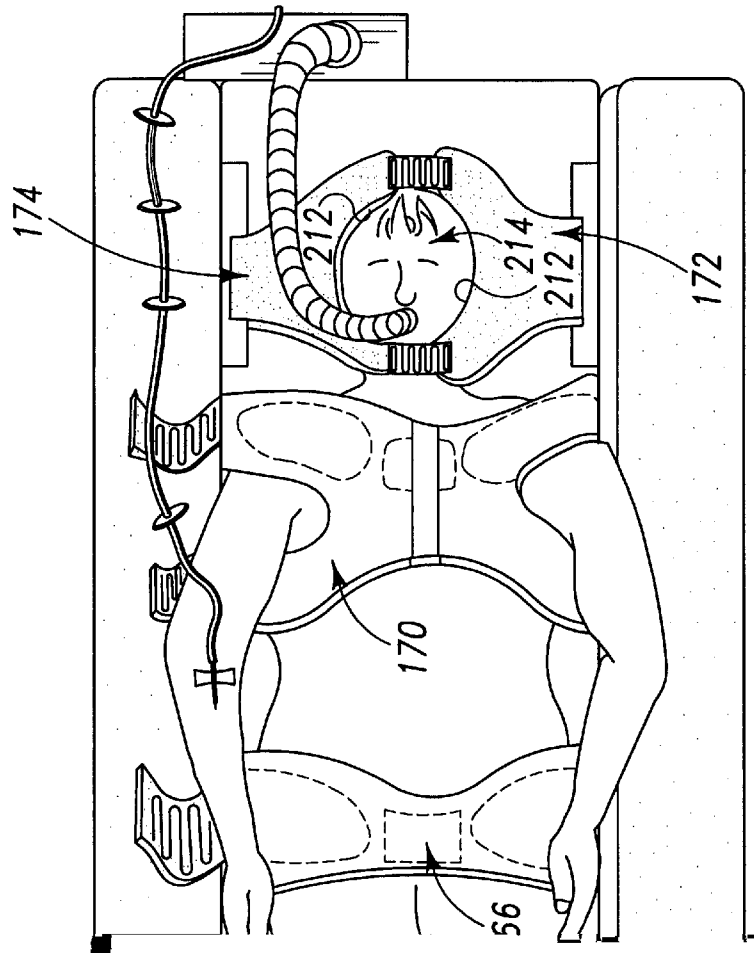
Fig. 15



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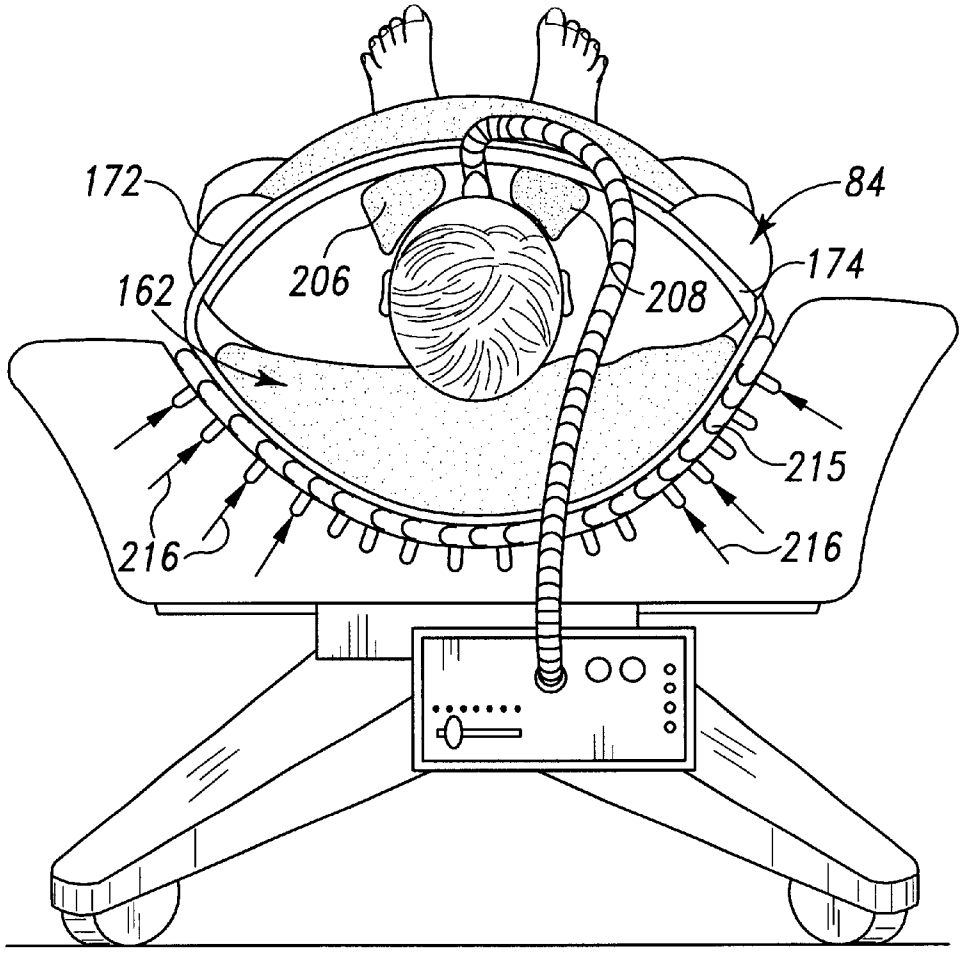

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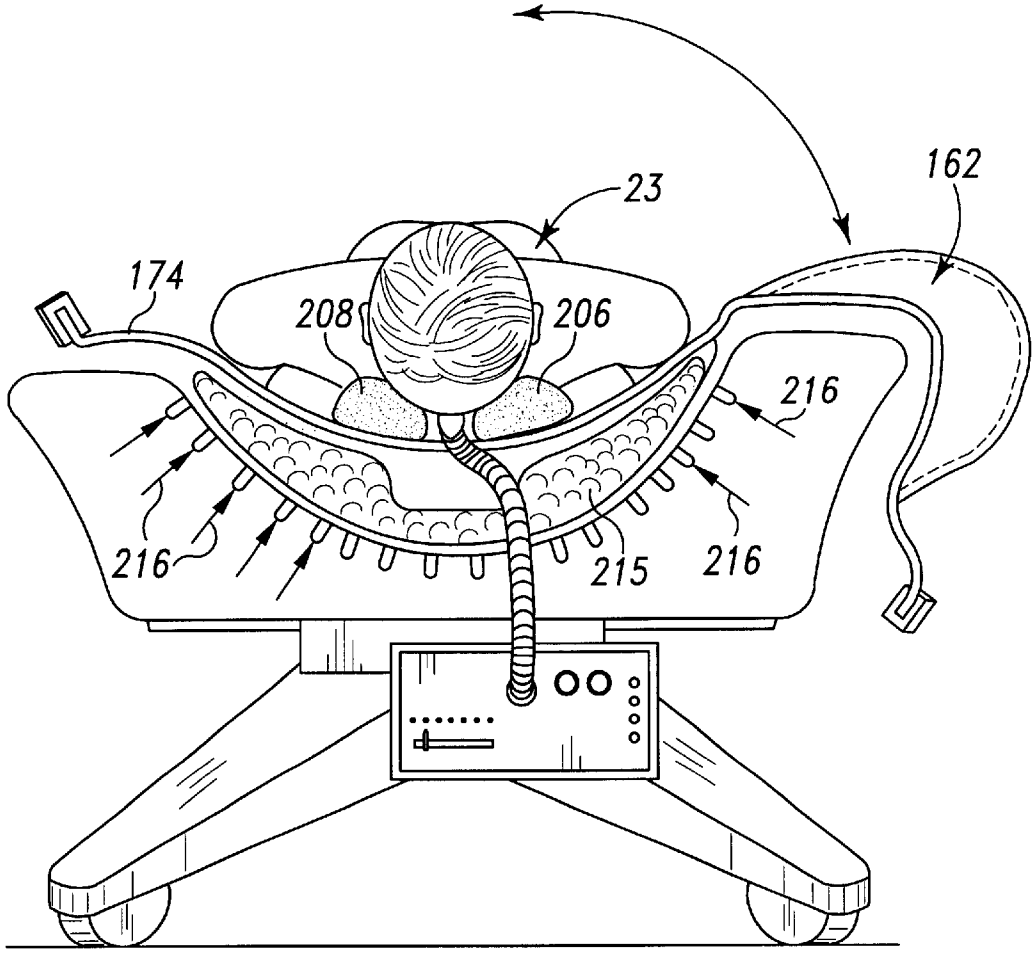

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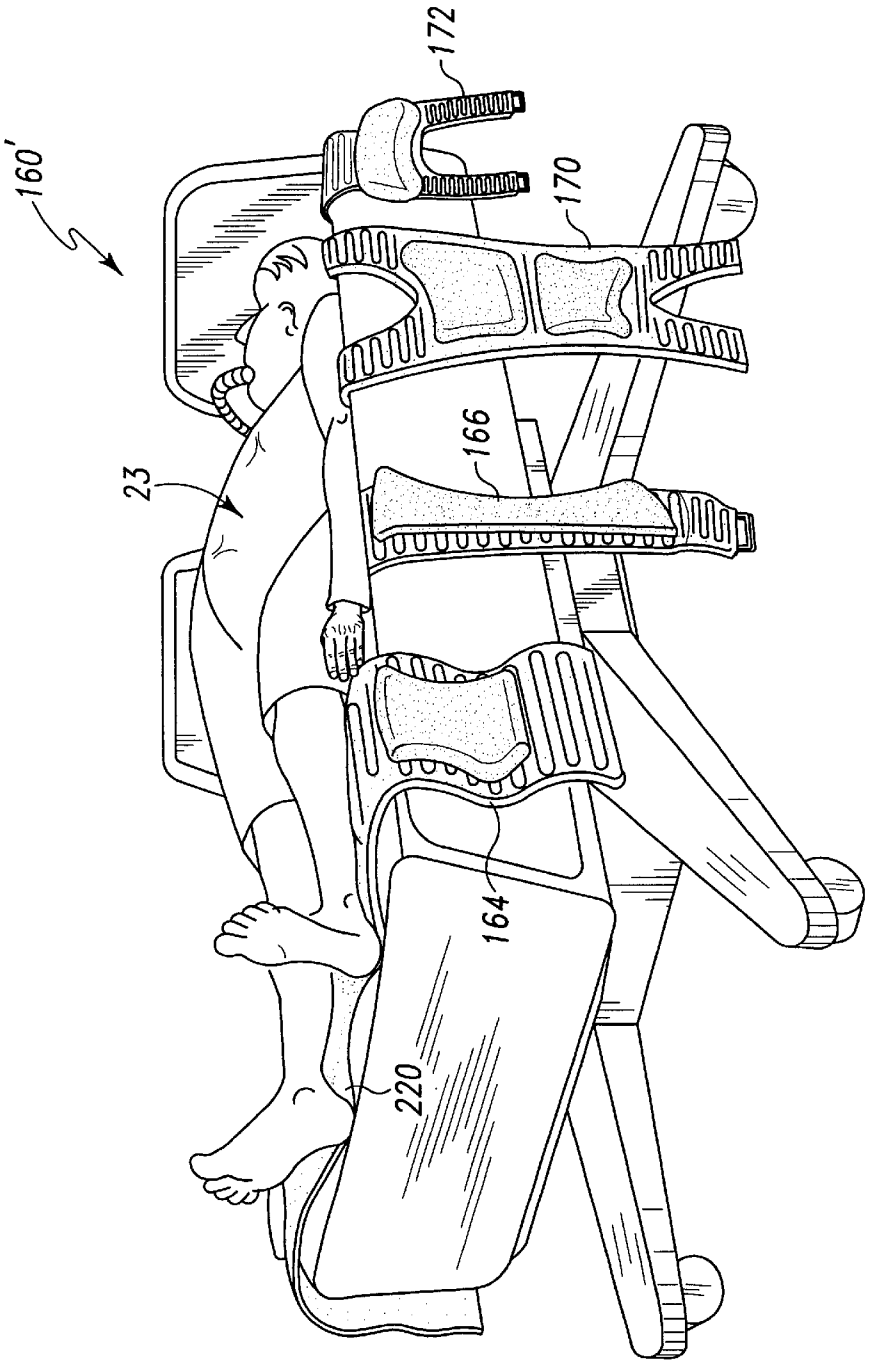

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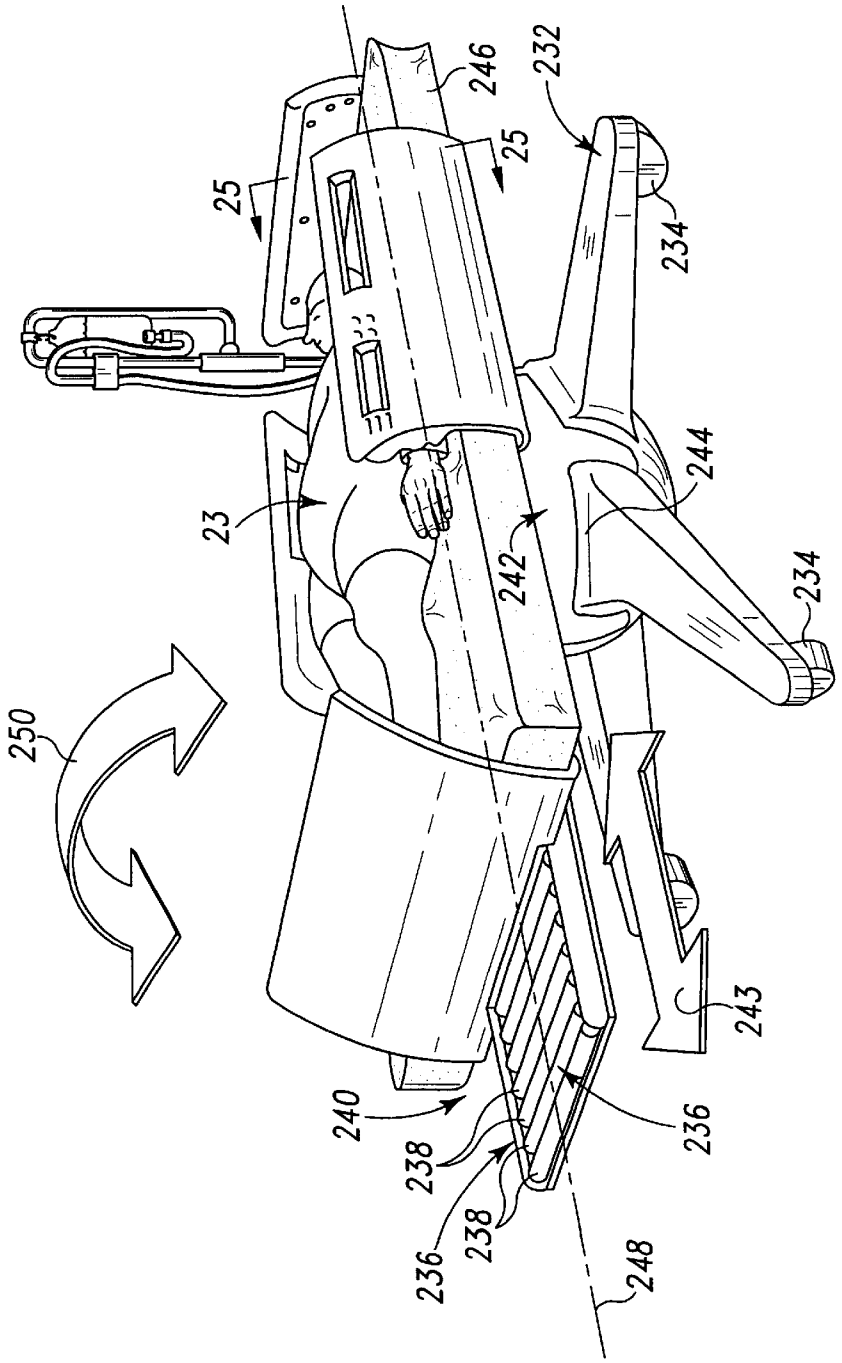


Fig. 20

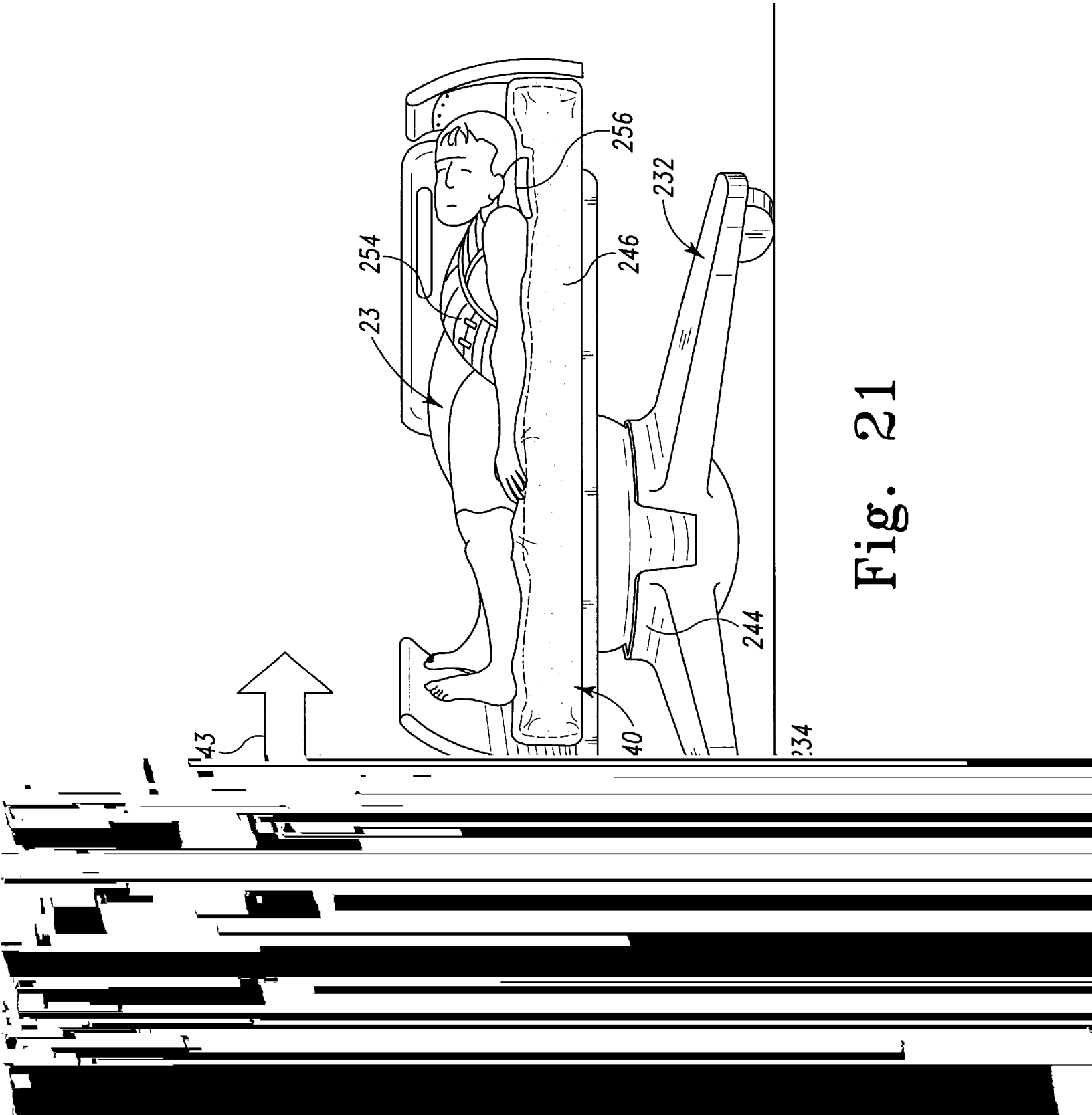


Fig. 21

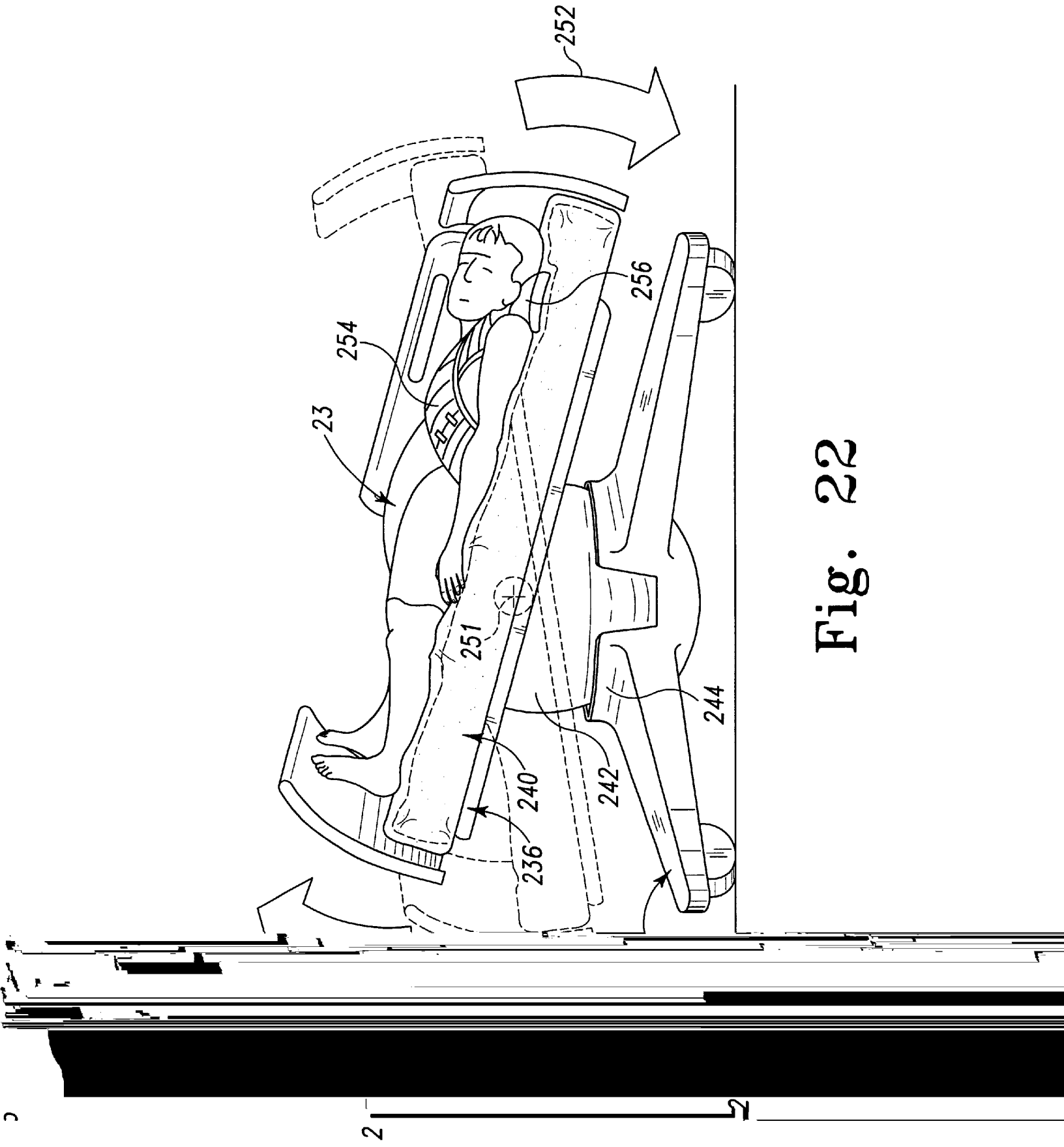


Fig. 22

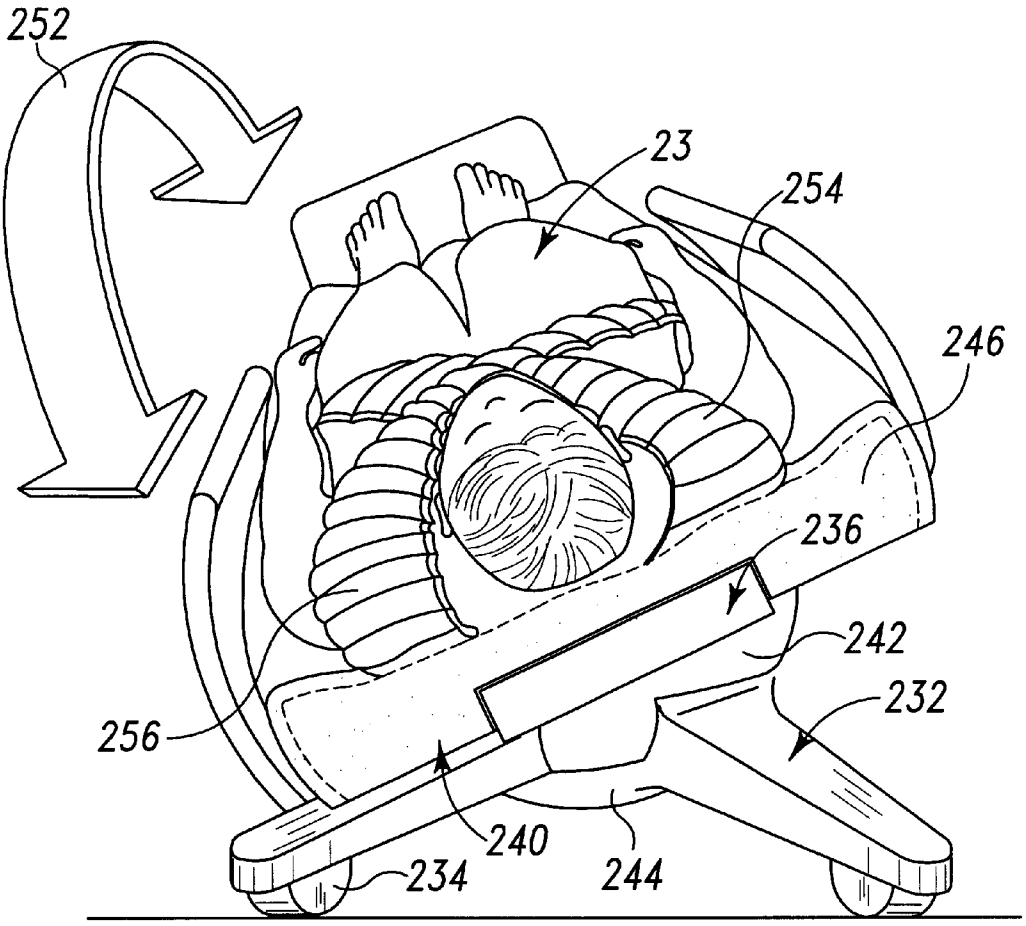


Fig. 23

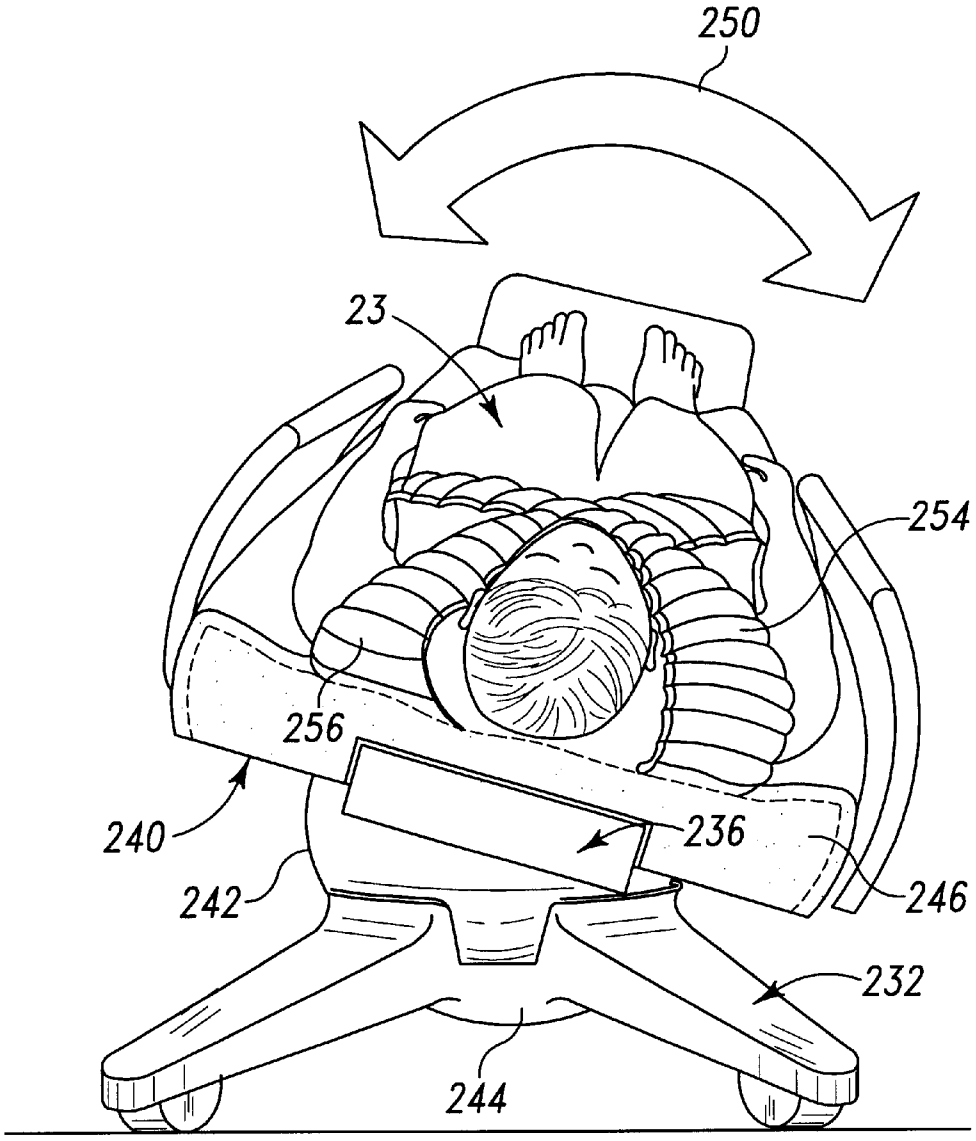
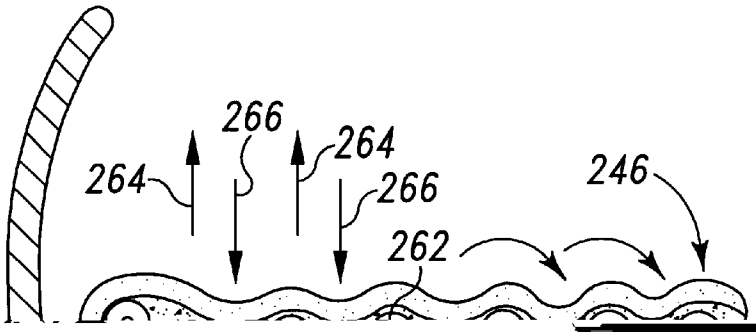


Fig. 24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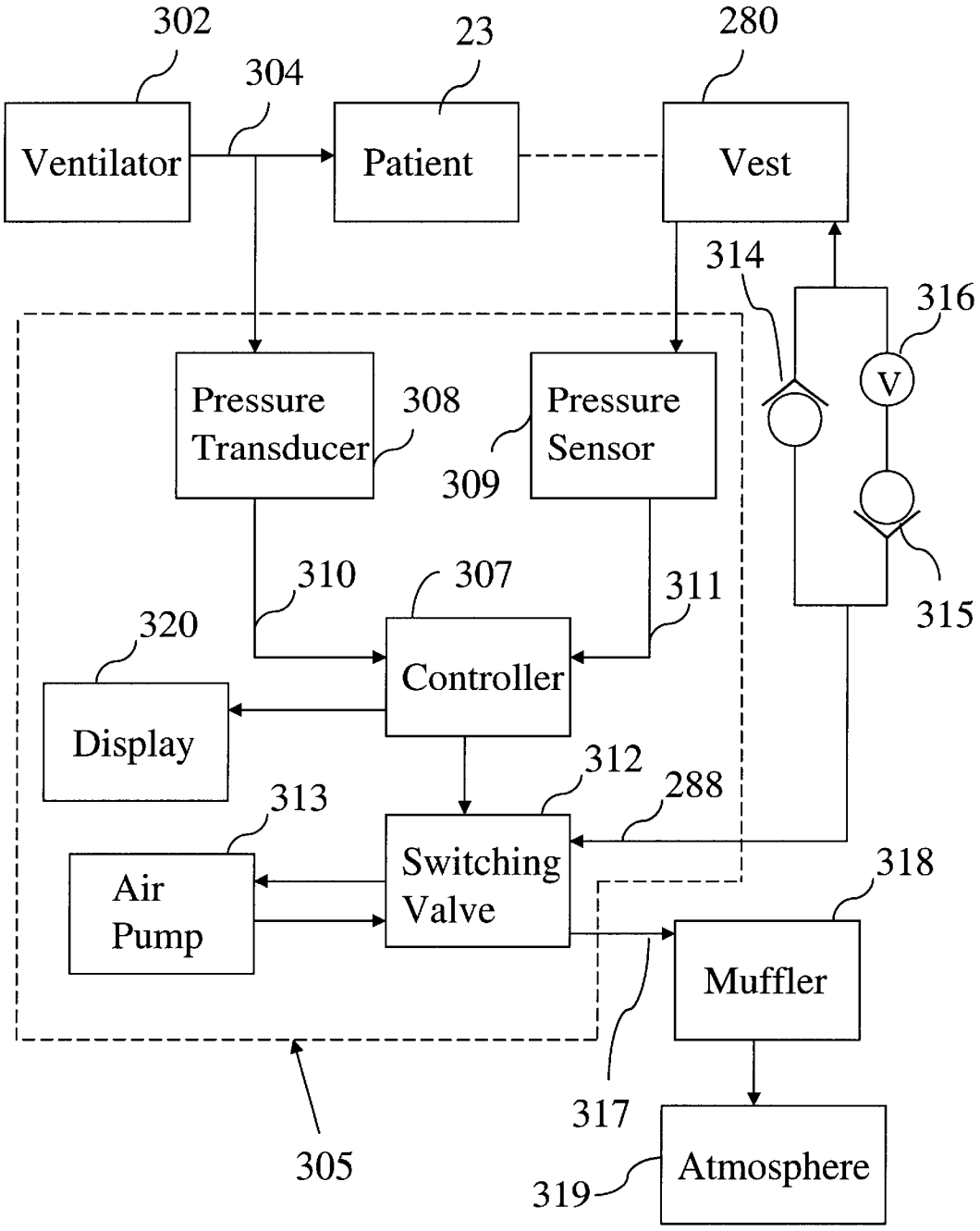

302
304
23
280
Ventilator
Patient
Vest
314
316
V
Pressure Transducer
308
Pressure Sensor
309
310
307
311
315
320
Controller
Display
312
288
313
Air Pump
Switching Valve
318
Muffler
317
305
319
Atmosphere

FIG. 26

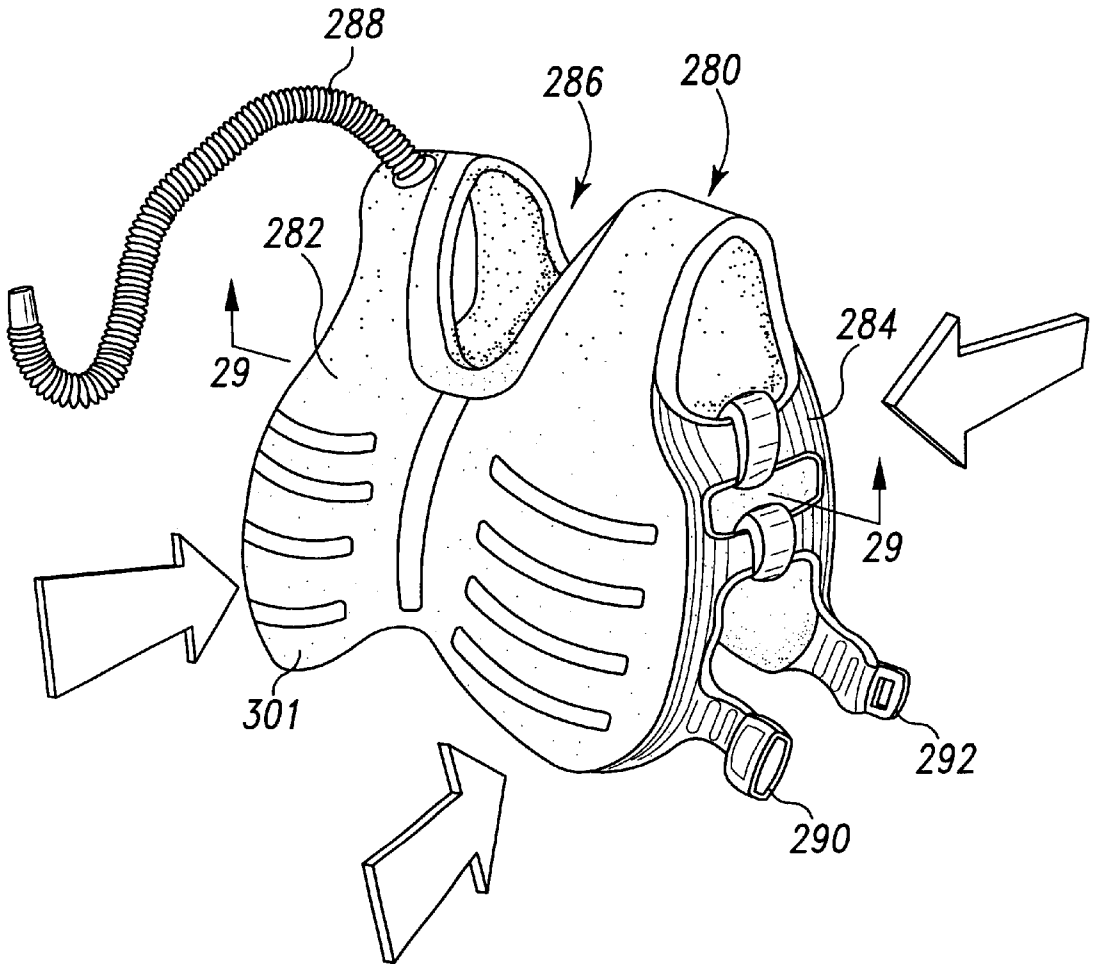
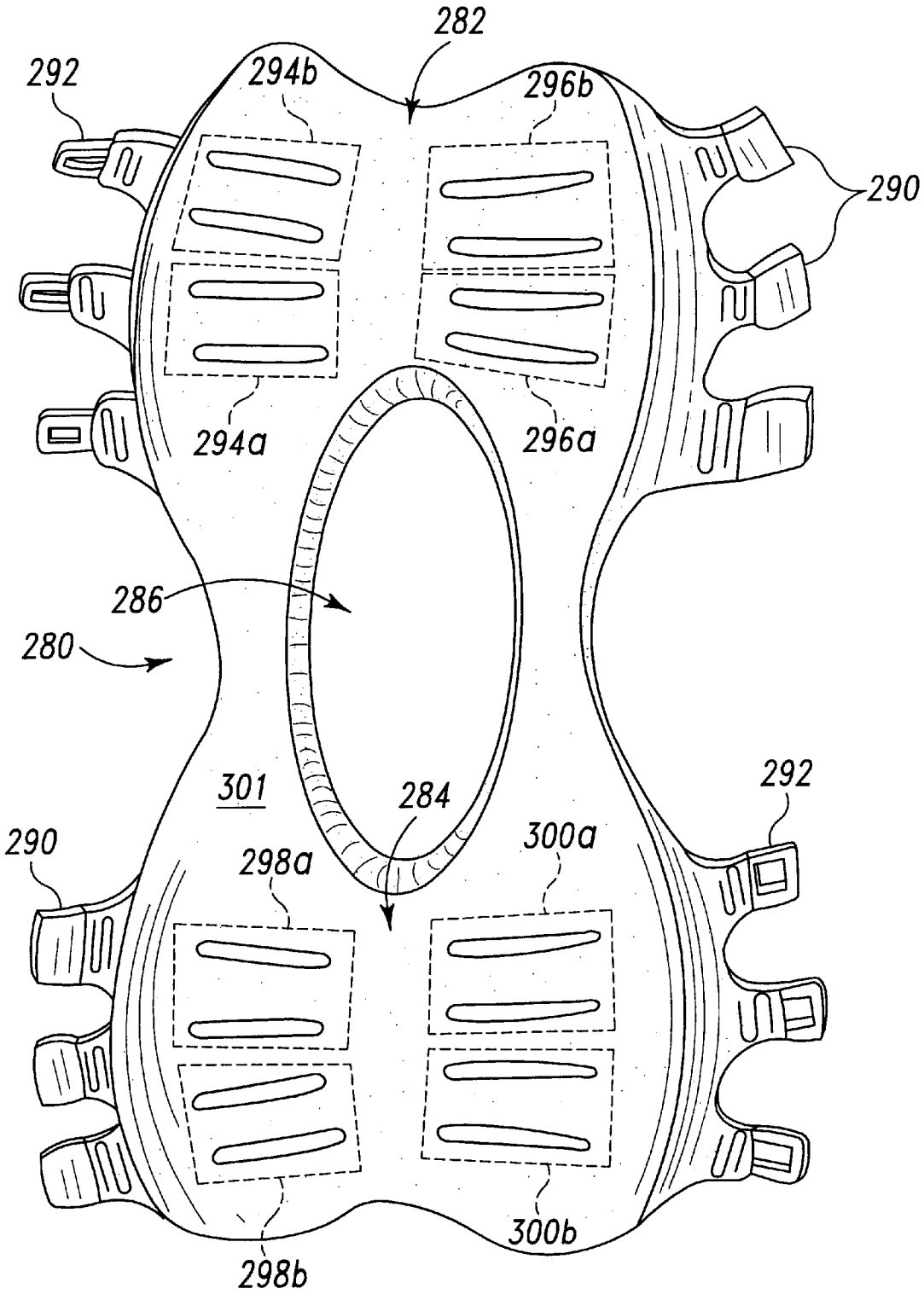


Fig. 27


282
292
294b
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290
294a
296a
286
280
301
284
292
290
298a
300a
300b
298b

Fig. 28

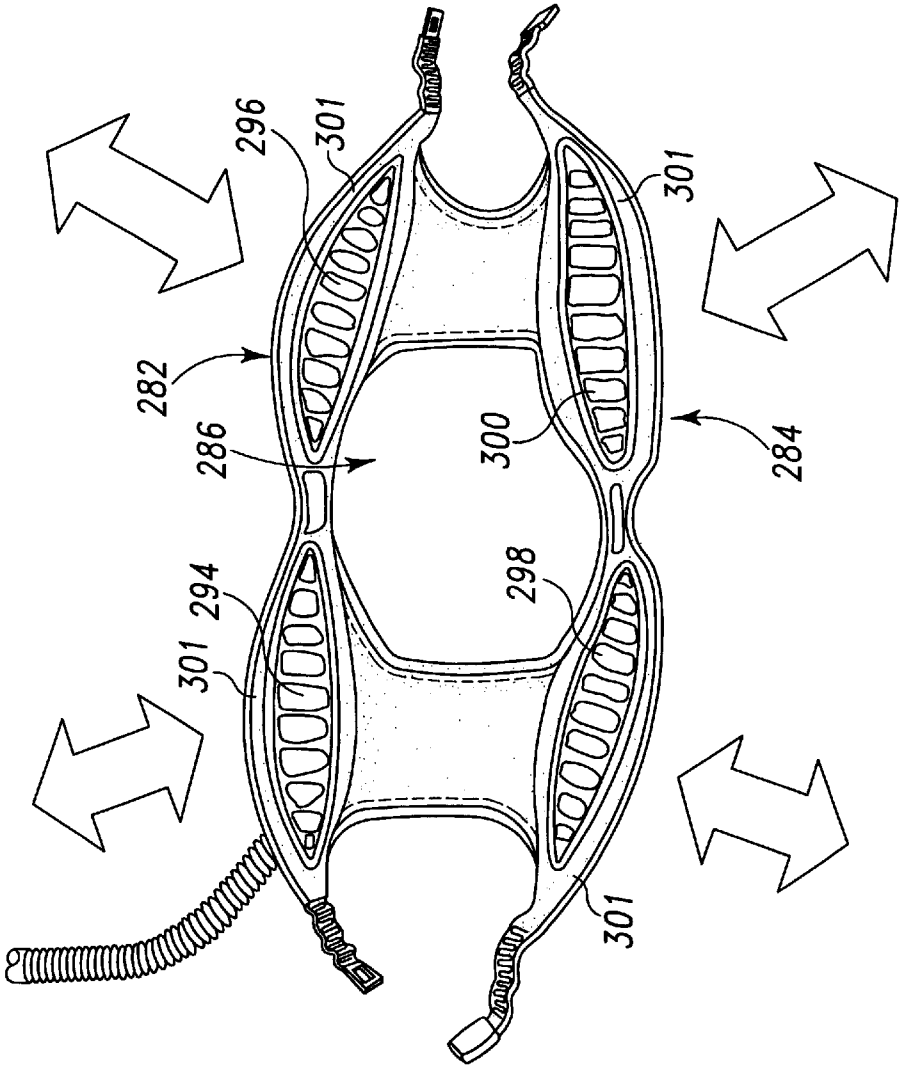
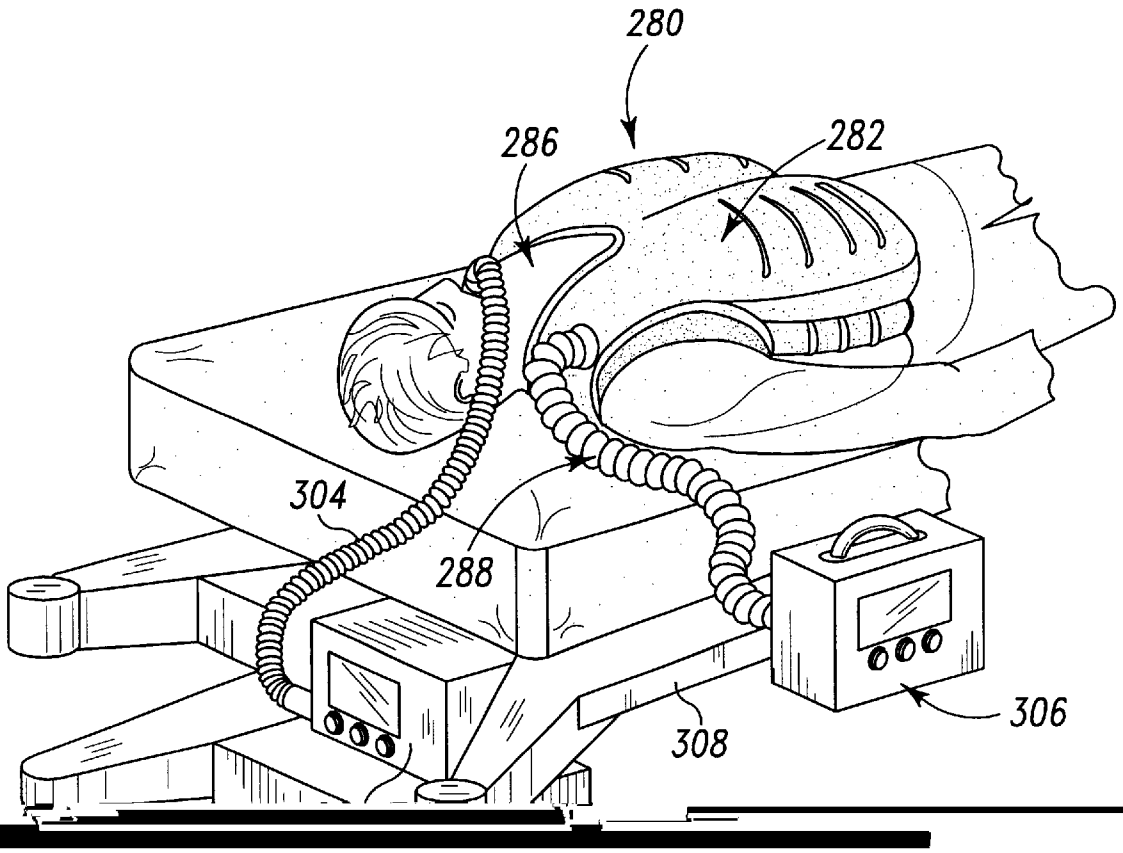


Fig. 29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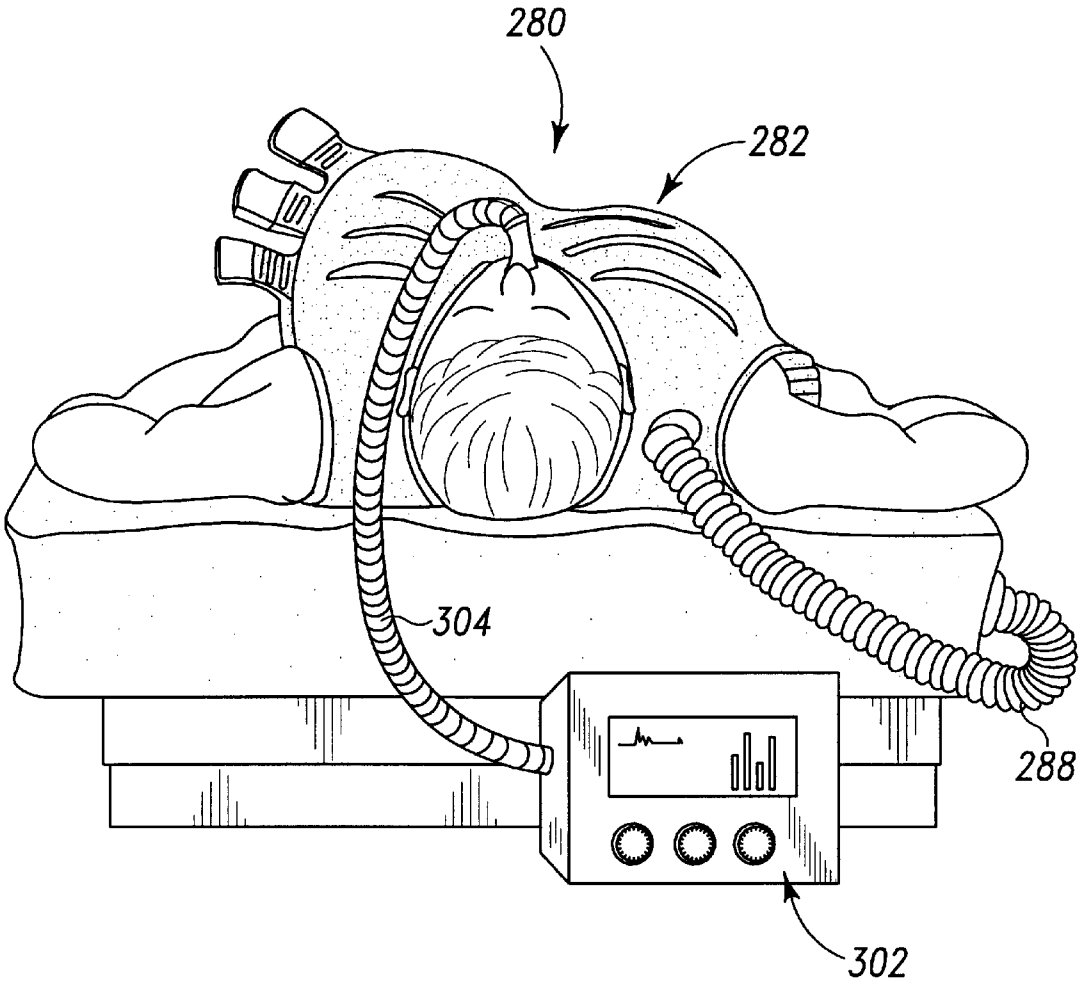


Fig. 31

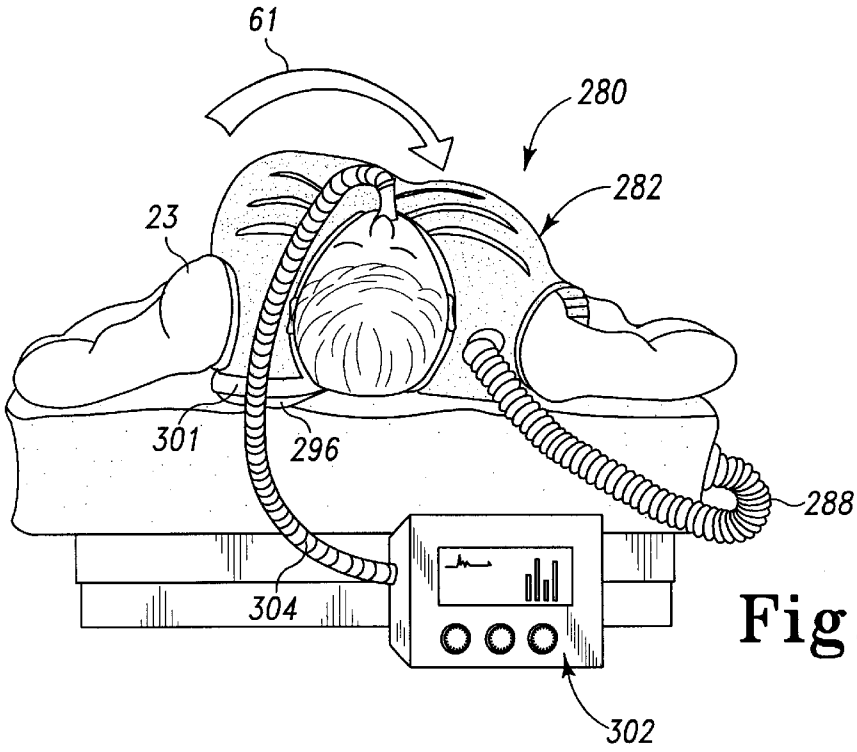
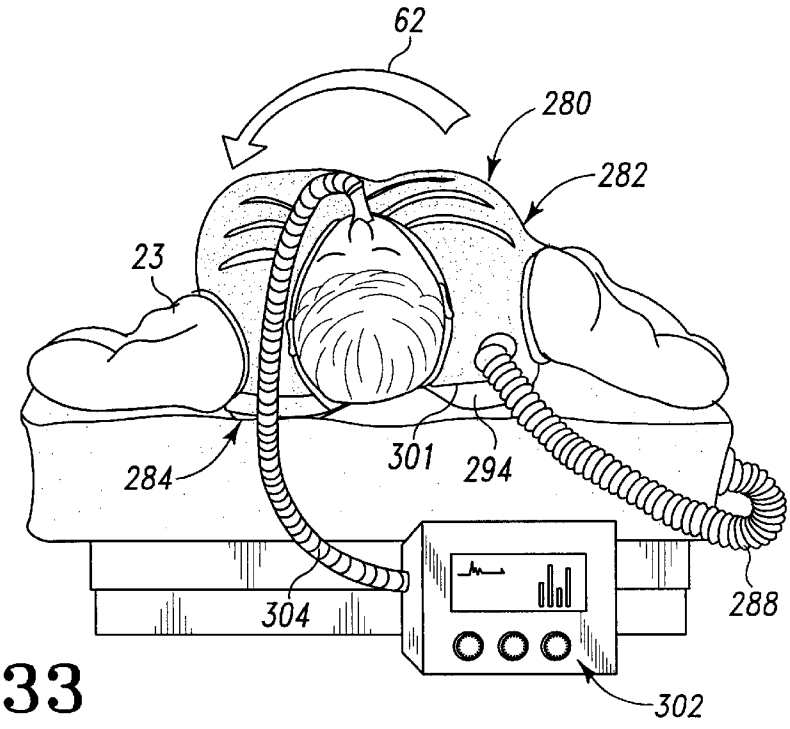

61
280
282
23
301
296
288
304
302

Fig. 32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280
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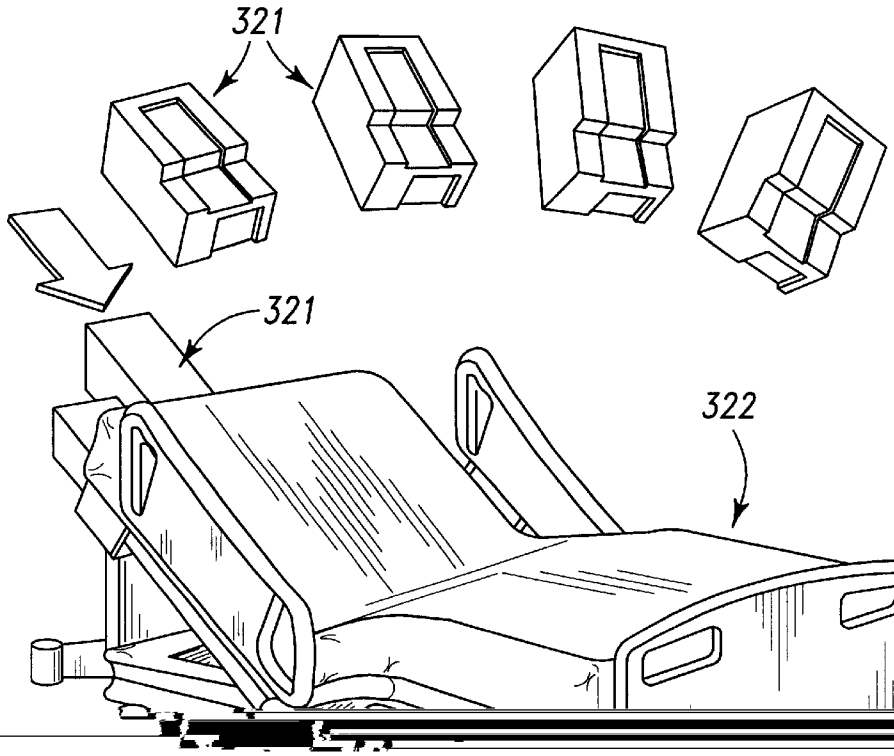
23
284
301
294
304
288
302

Fig. 33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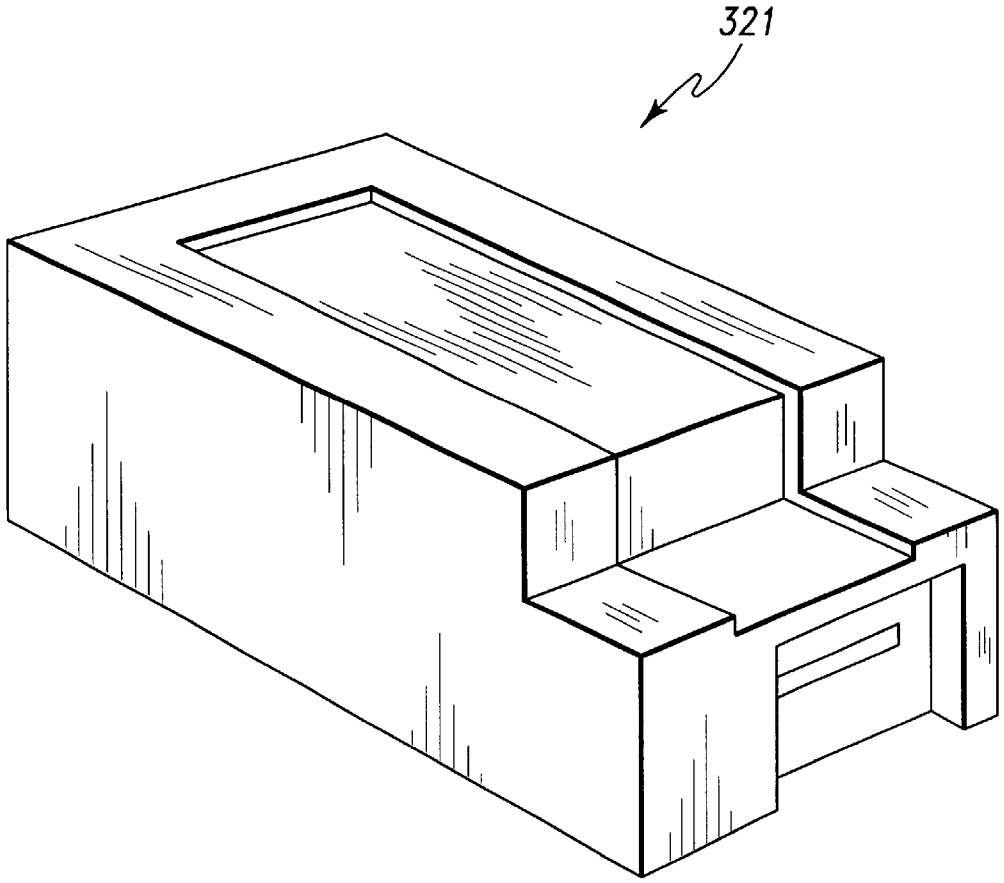


Fig. 35

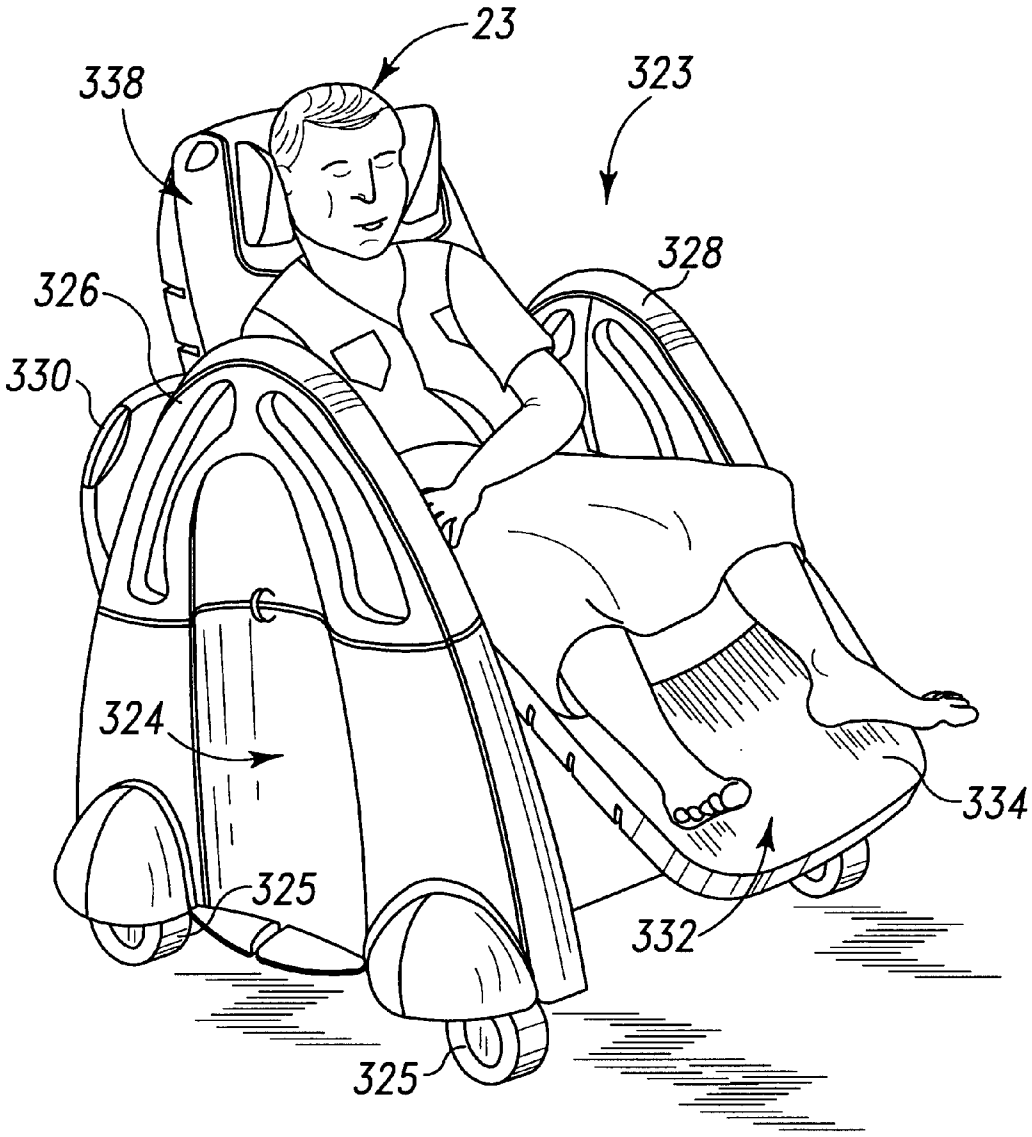


Fig. 36

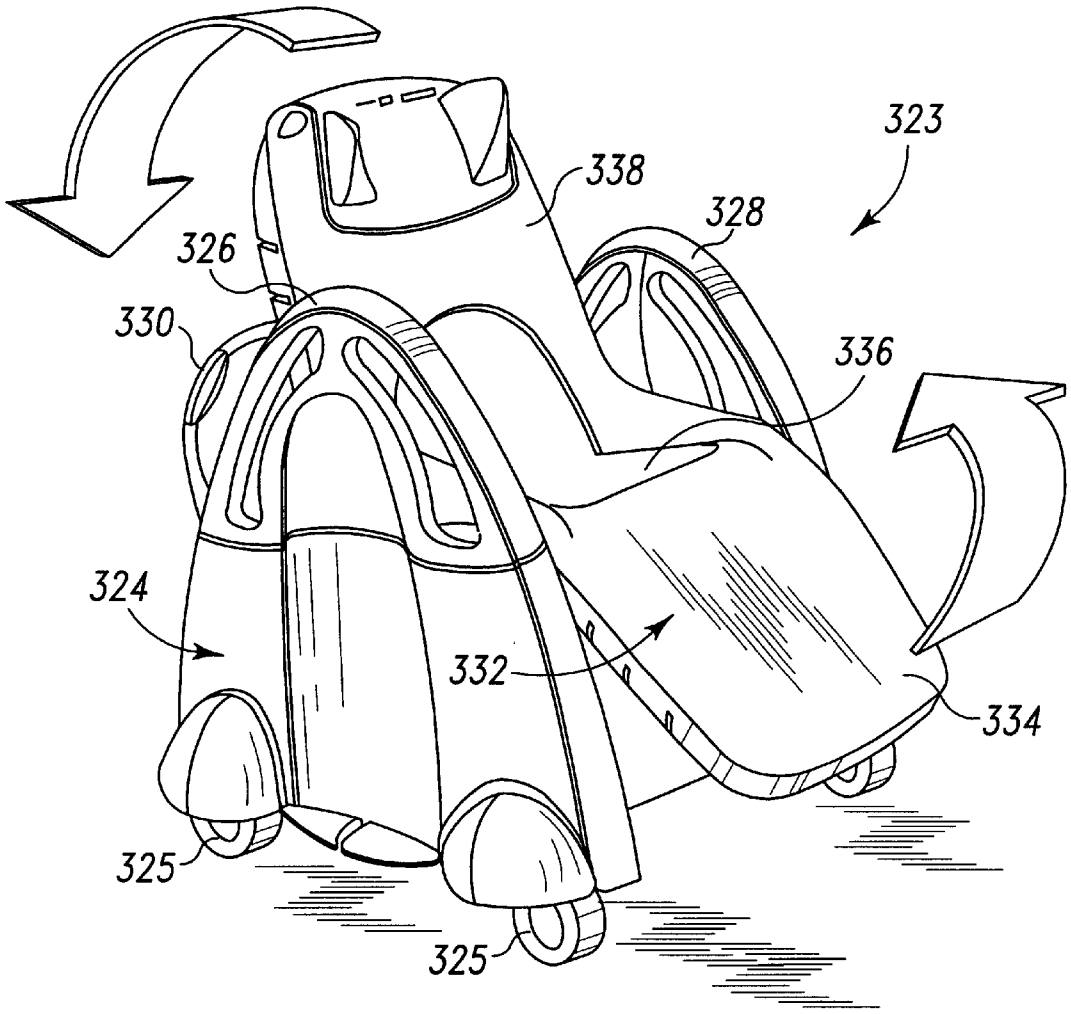


Fig. 37

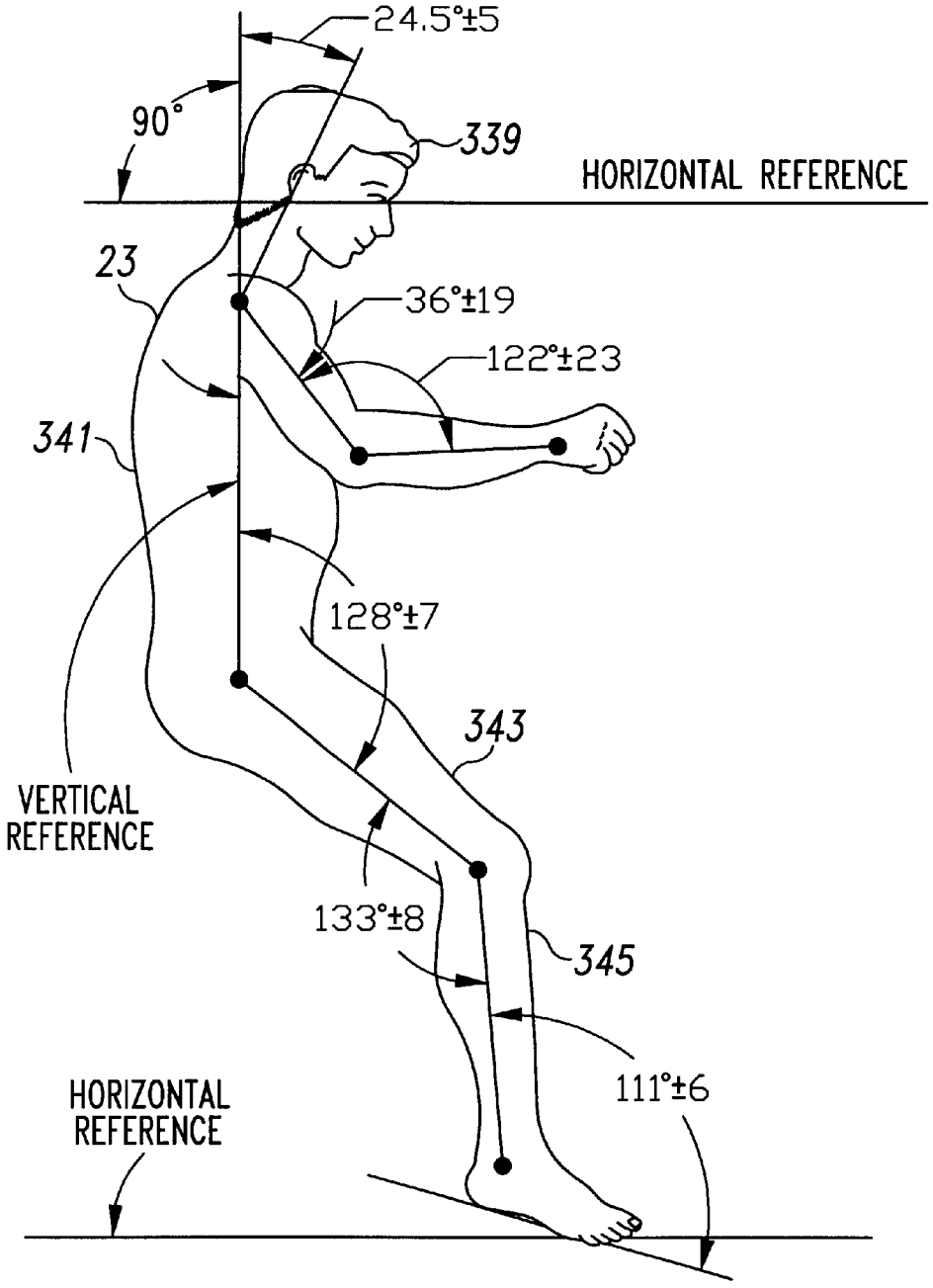

24.5°±5
90°
339
HORIZONTAL REFERENCE
23
36°±19
122°±23
341
128°±7
343
VERTICAL REFERENCE
133°±8
345
111°±6
HORIZONTAL REFERENCE

Fig. 38

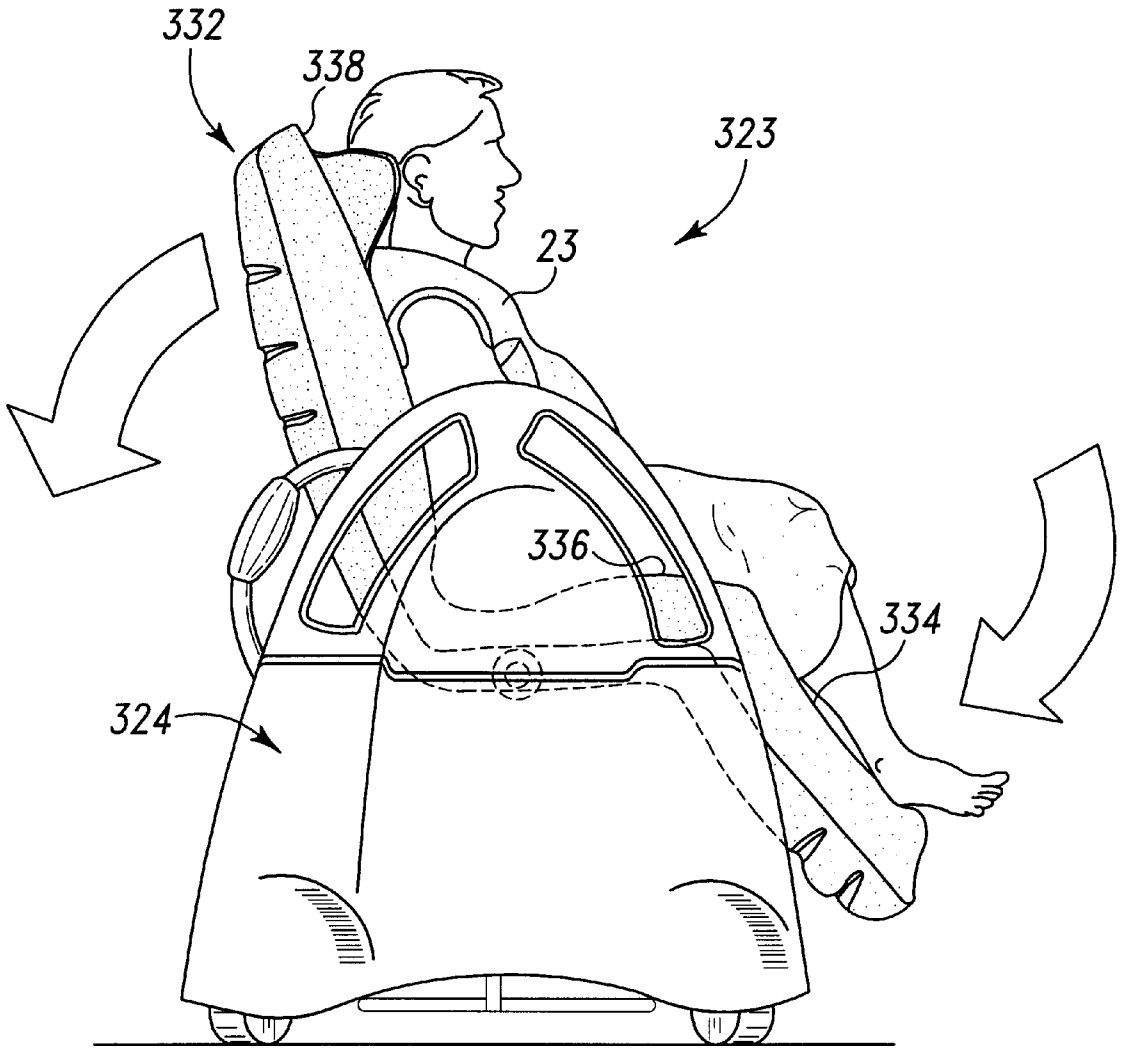


Fig. 39

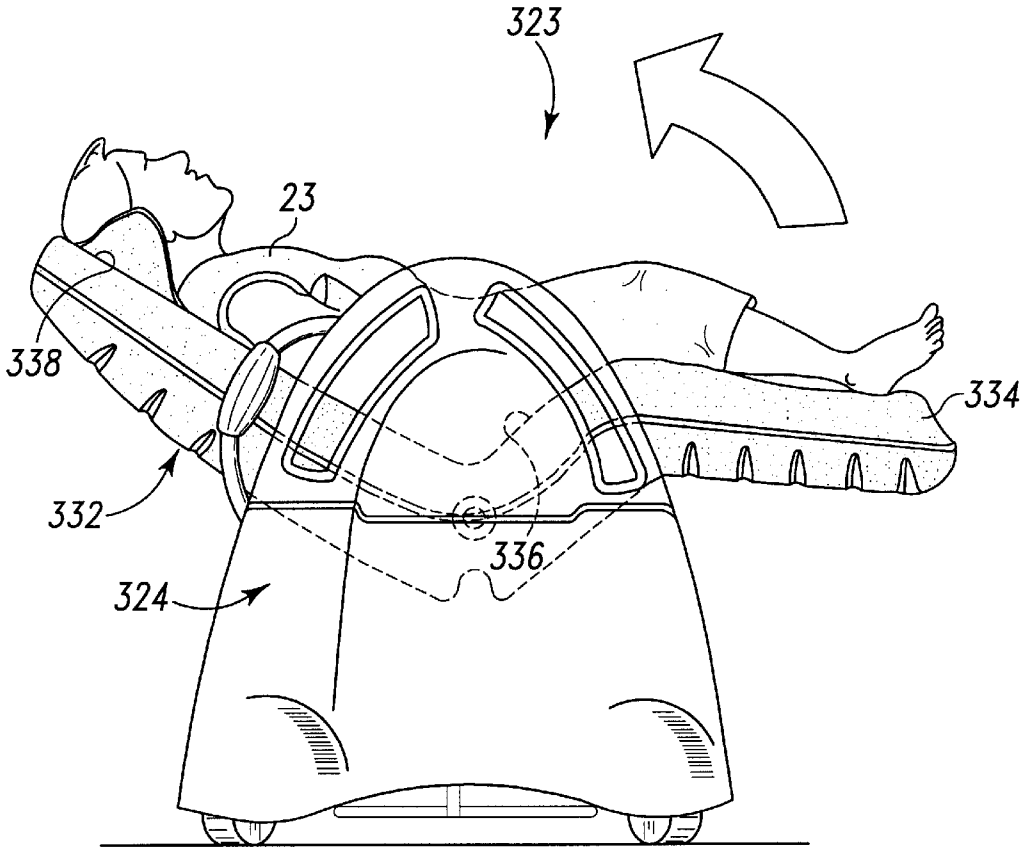


Fig. 40

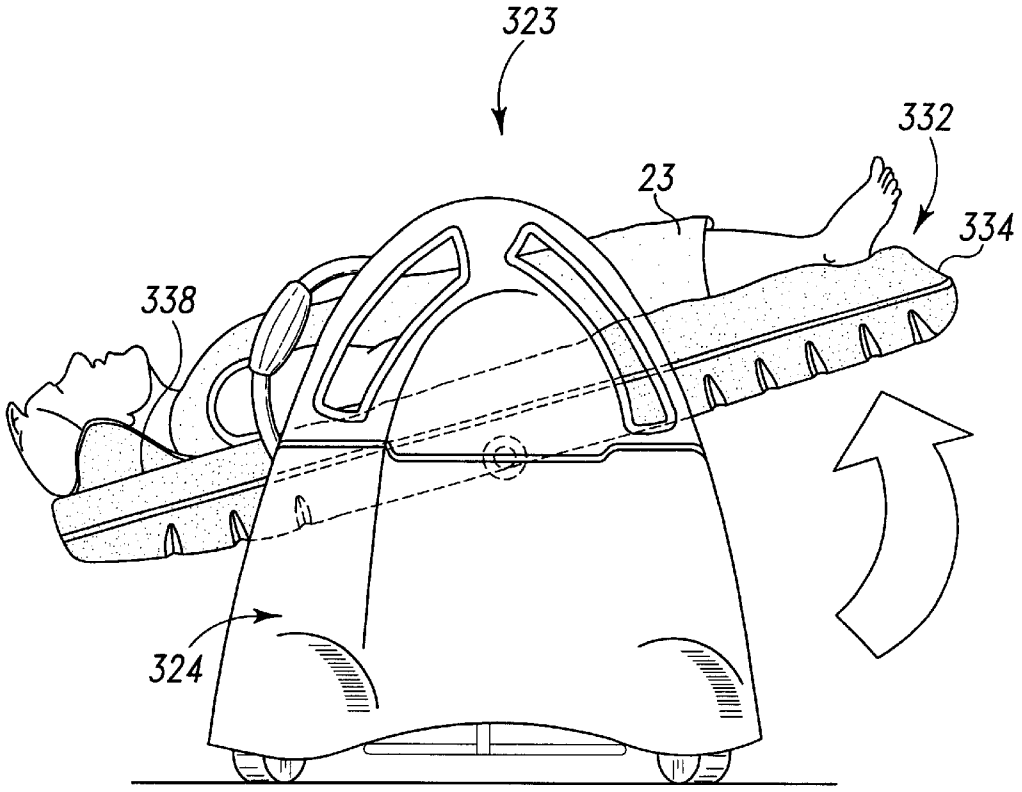


Fig. 41

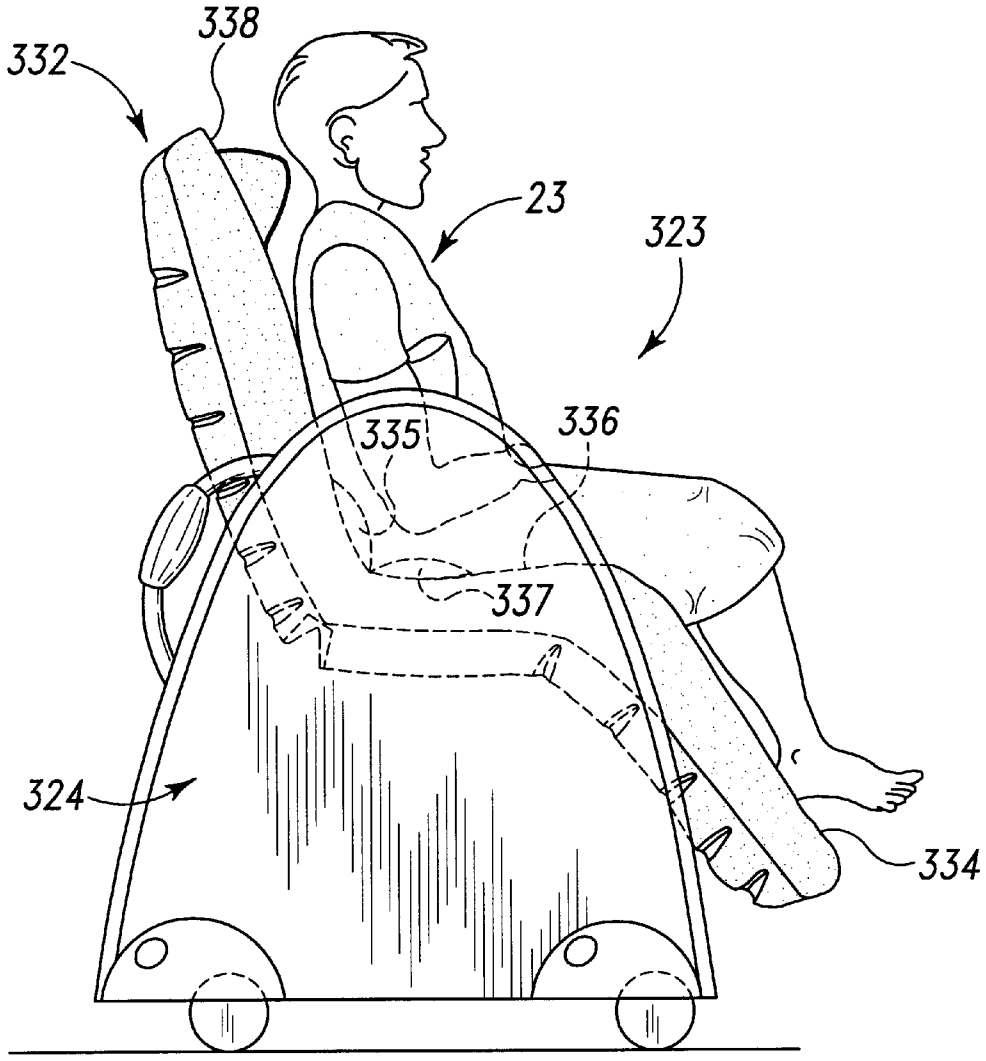


Fig. 42

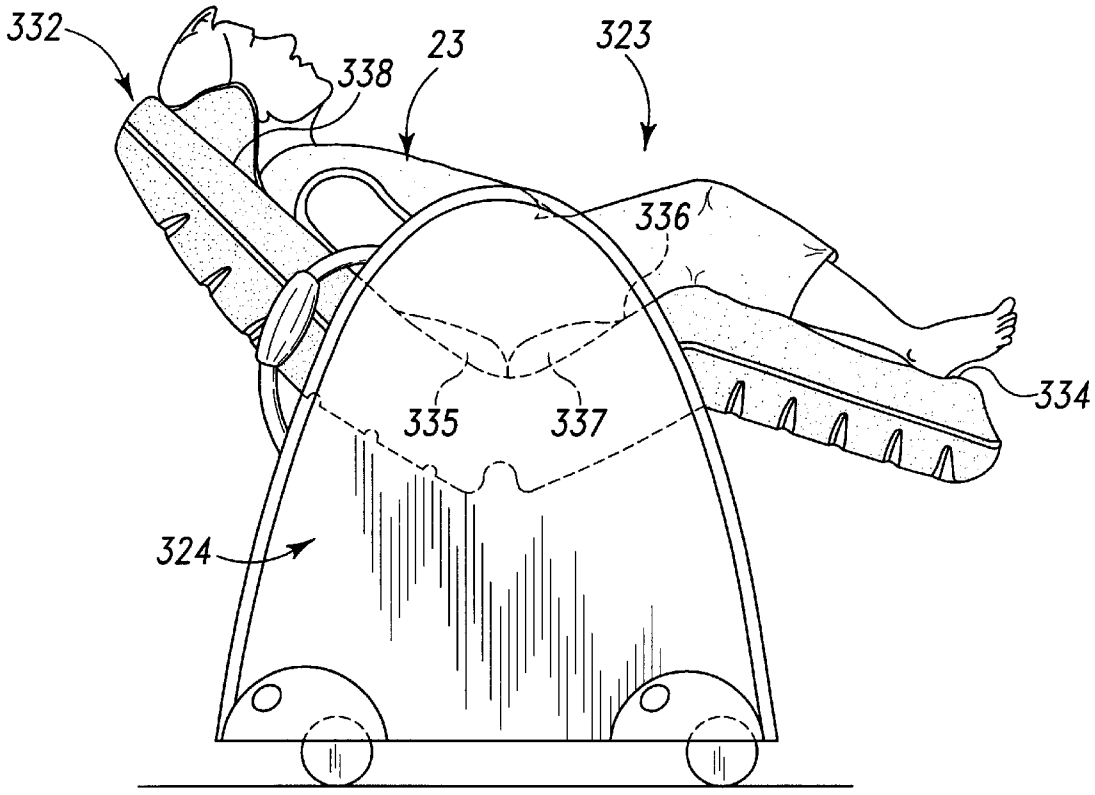


Fig. 43

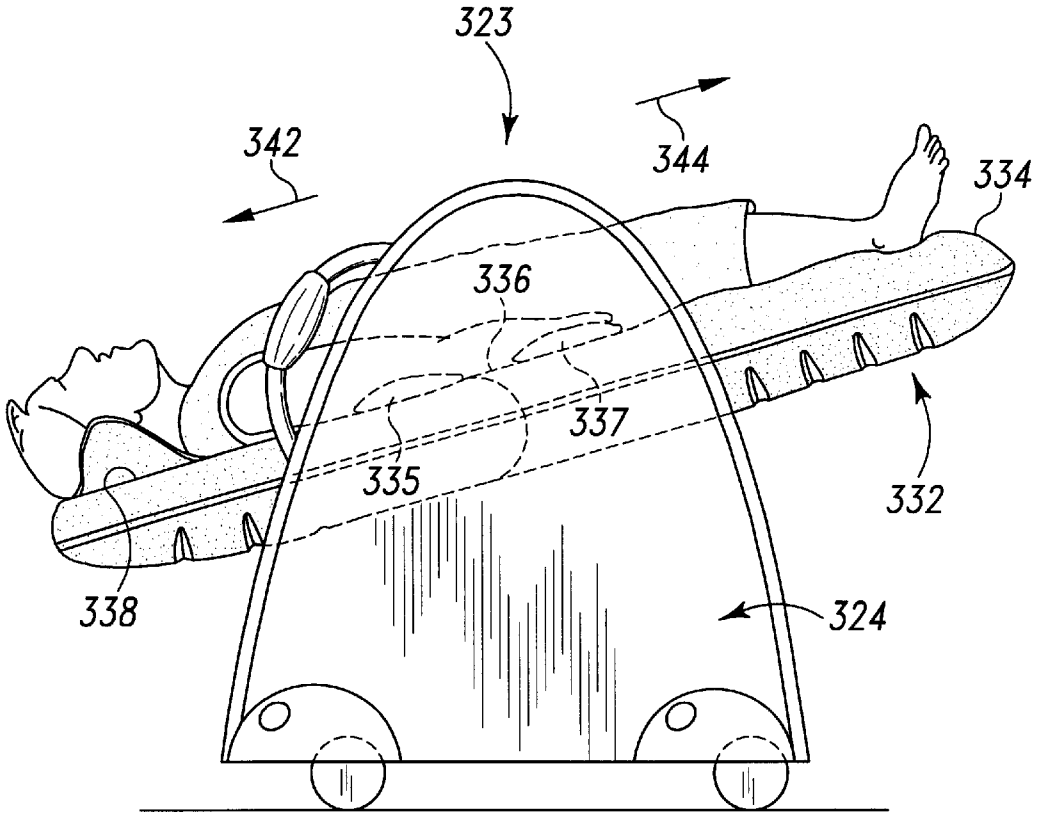


Fig. 44

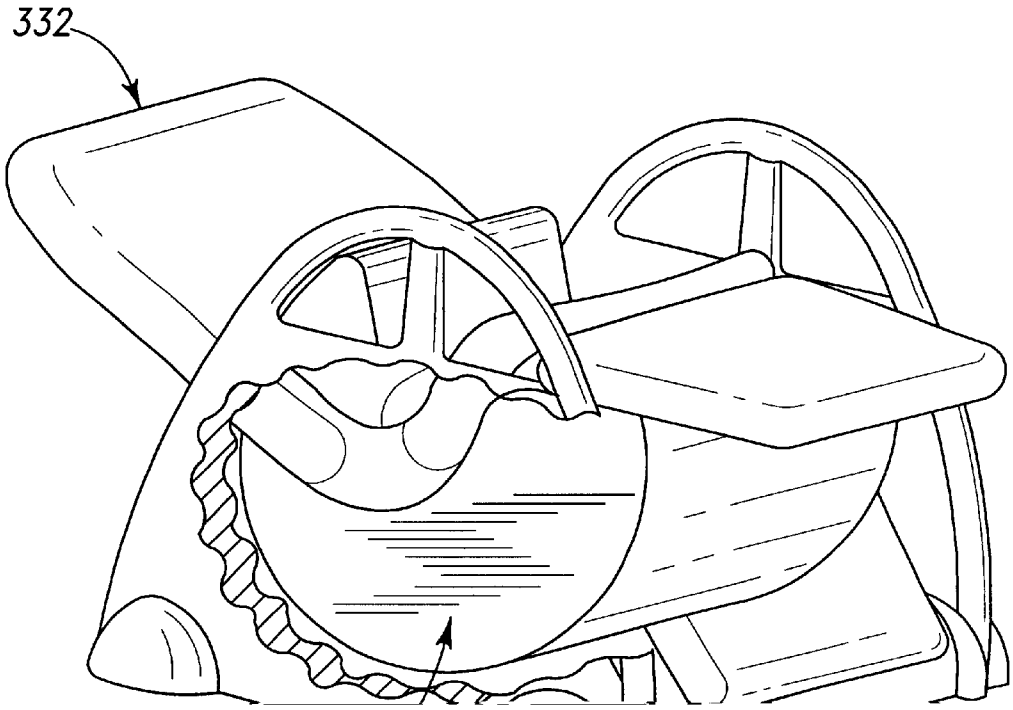
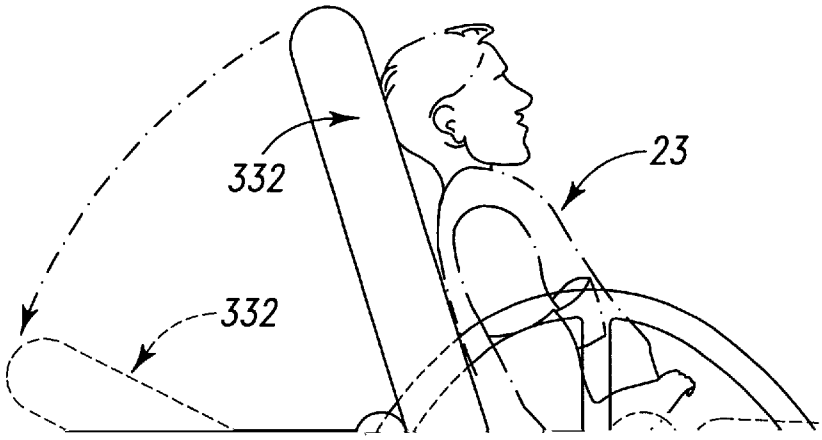


Fig. 45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332

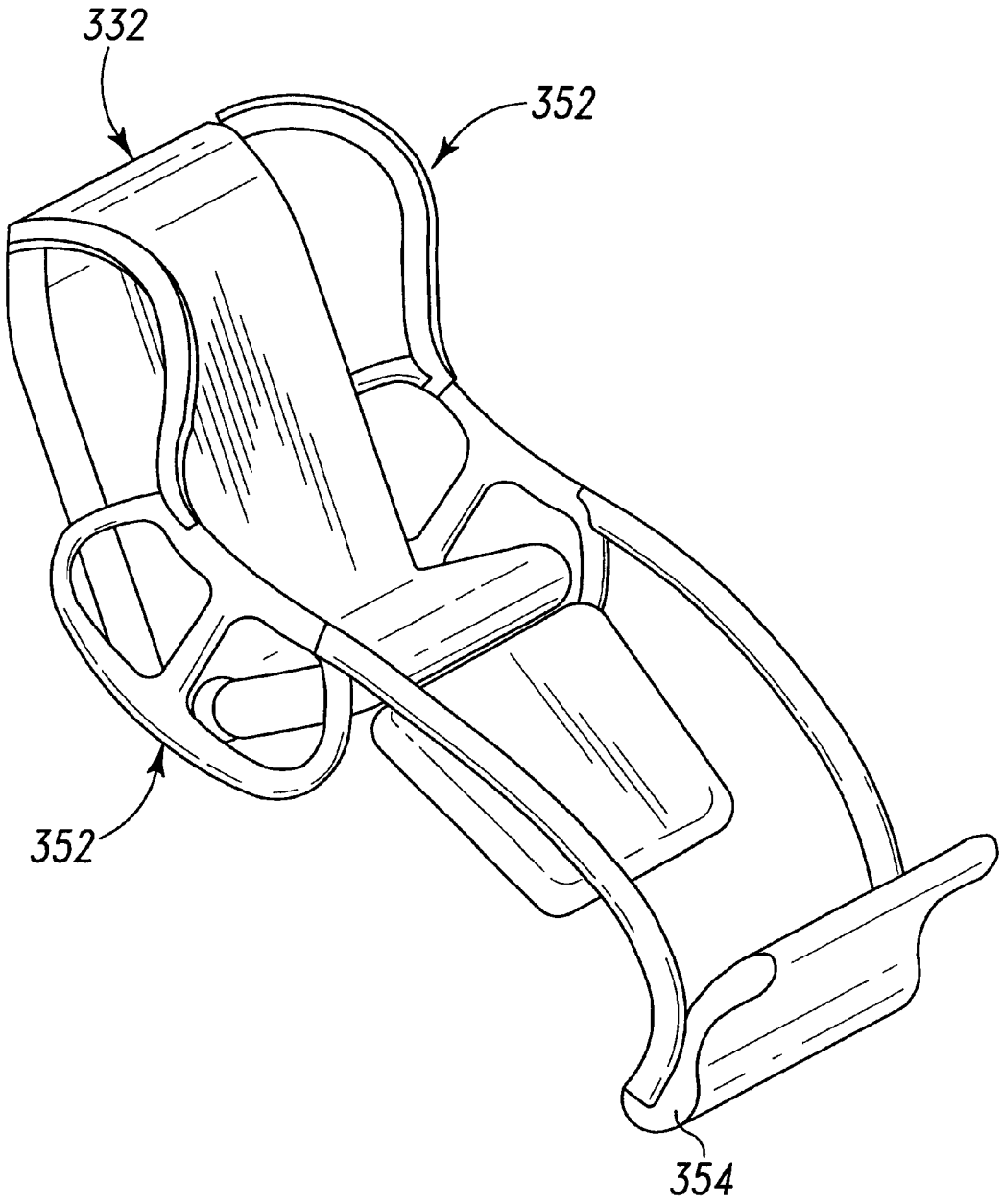
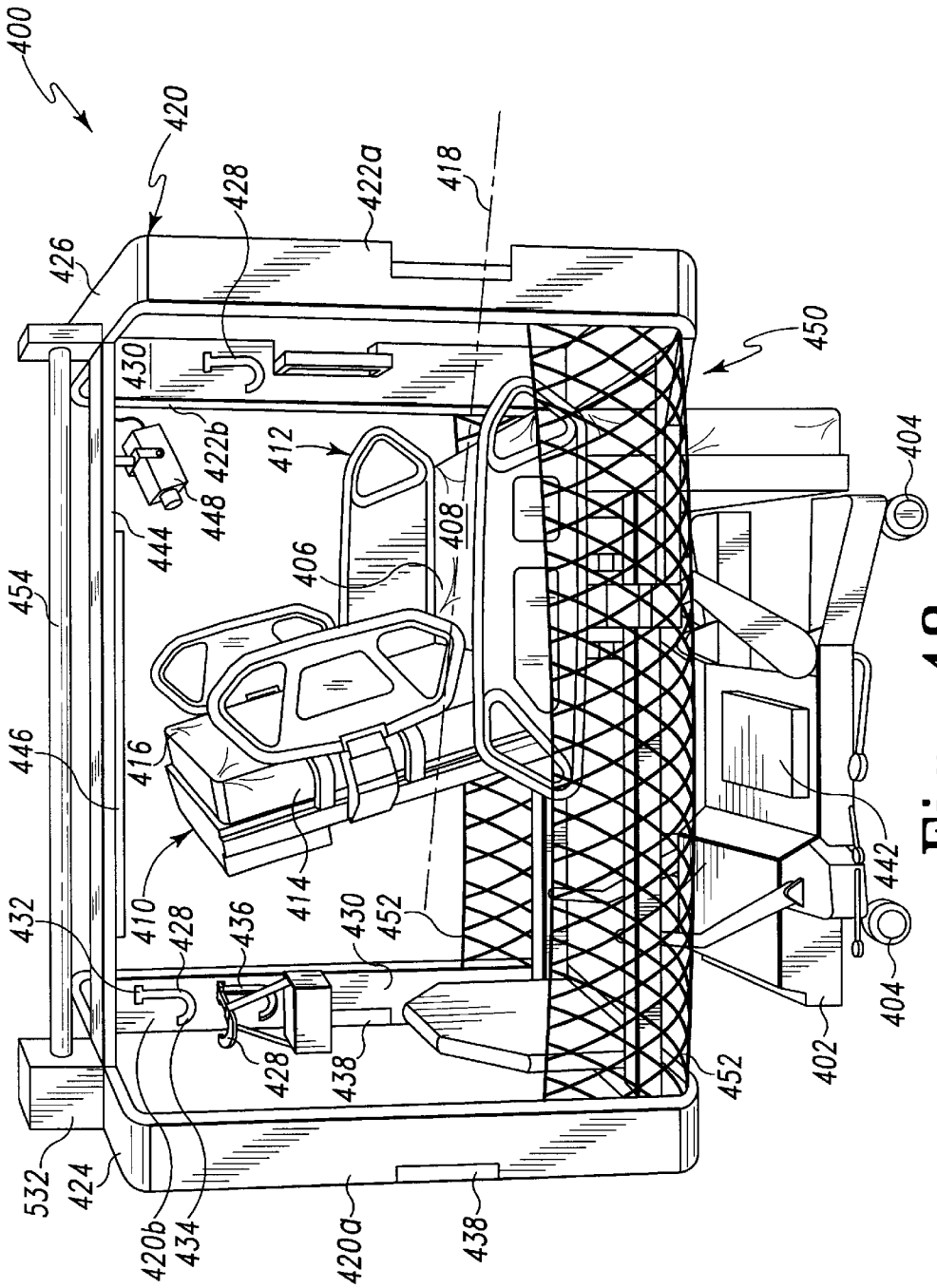


Fig. 47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422a
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426
450
430
422b
412
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448
444
408
406
454
446
416
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452
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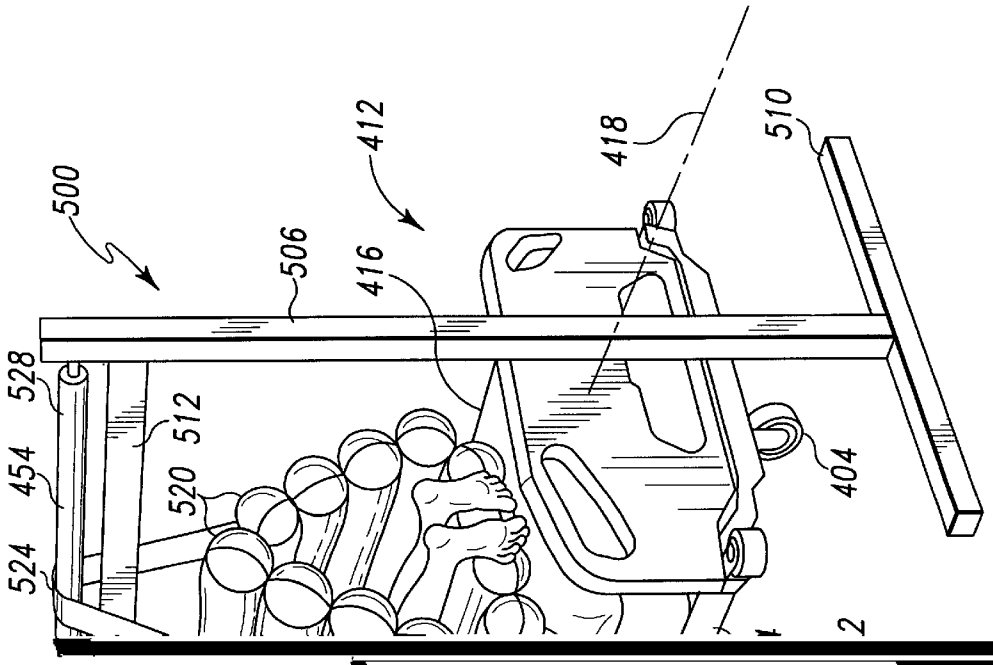
402
532
424
420b
434
420a
438

Fig. 48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506
412
416
418
510
528
512
454
520
524
404
2

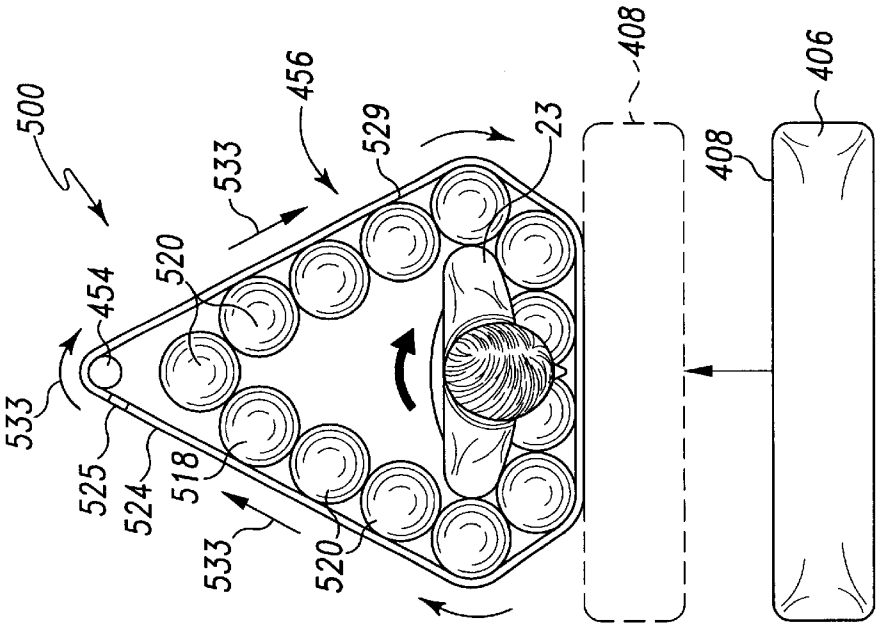

500
533
454
525
524
518
520
533
456
529
23
408
406

Fig. 51

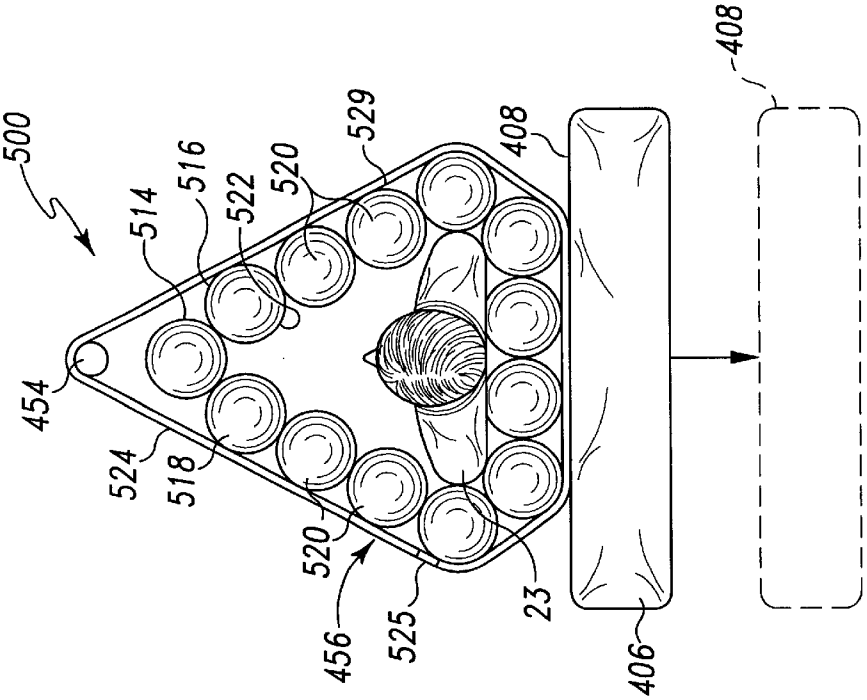
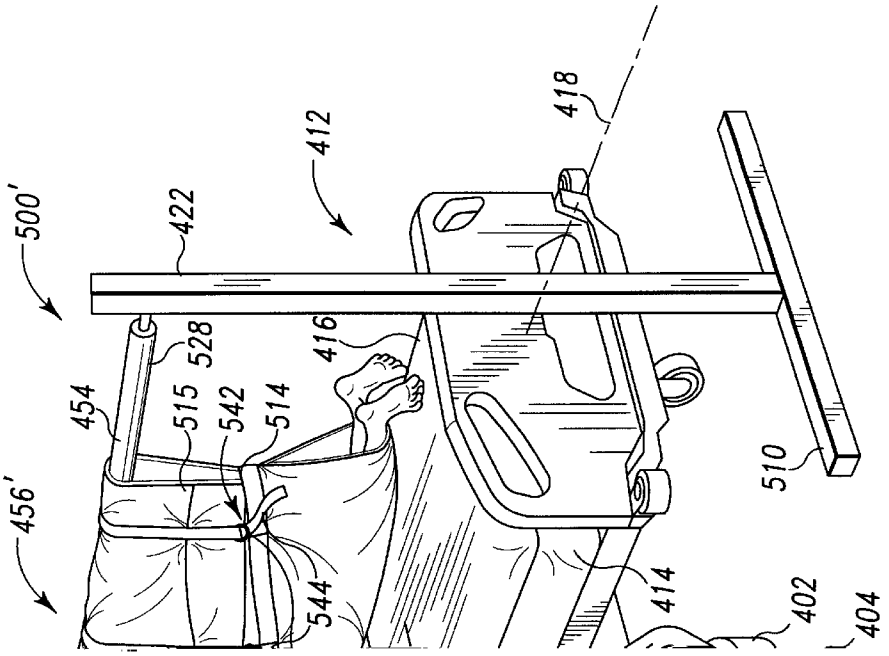

500
454
524
518
514
516
522
520
529
408
456
525
23
406

Fig. 50


500'
422
412
418
528
416
454
515
542
514
510
456'
544
414
402
404

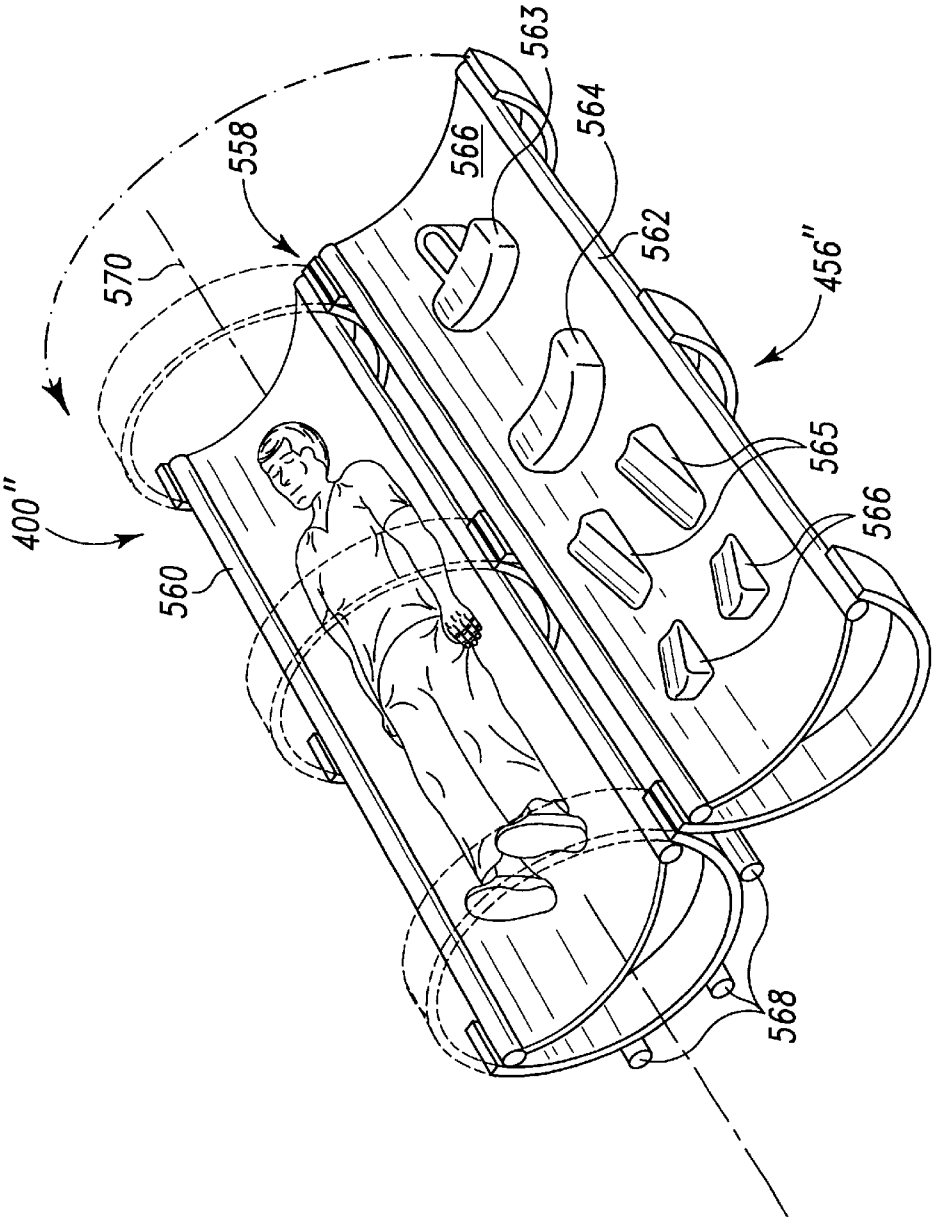
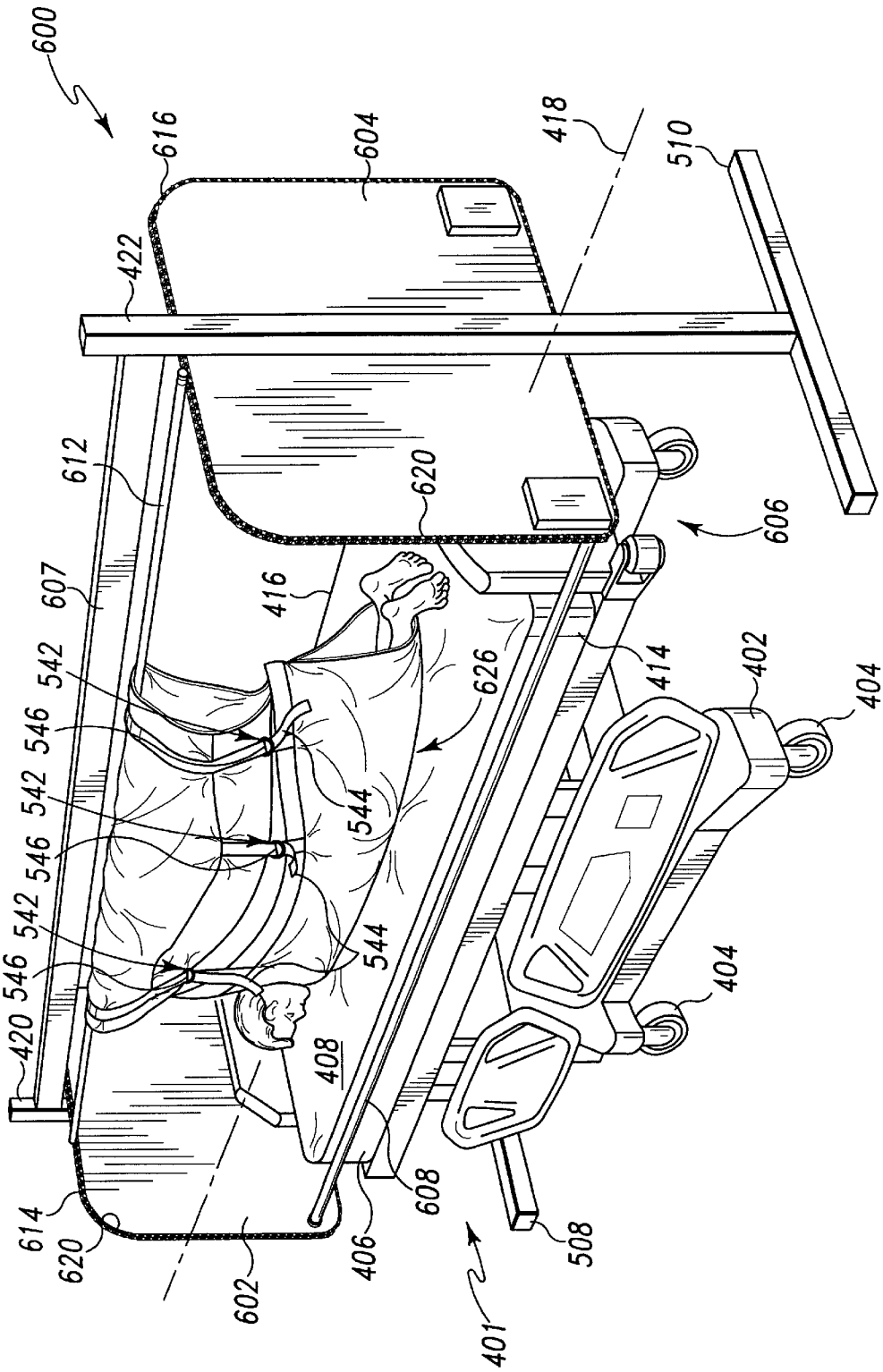


Fig. 53


600
616
604
418
510
422
612
620
606
607
416
542
626
414
402
404
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542
546
542
546
544
404
420
408
614
620
602
406
608
508
401

Fig. 54

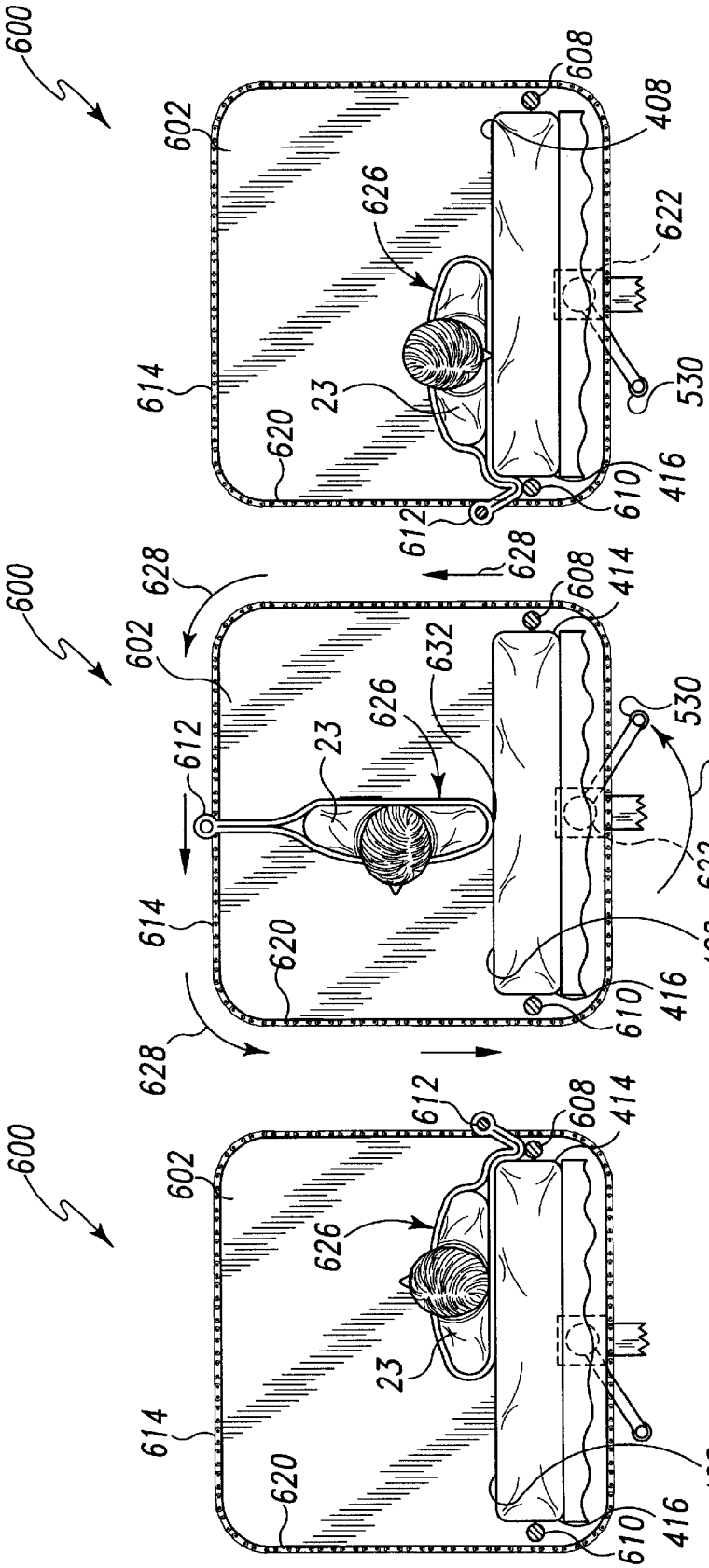
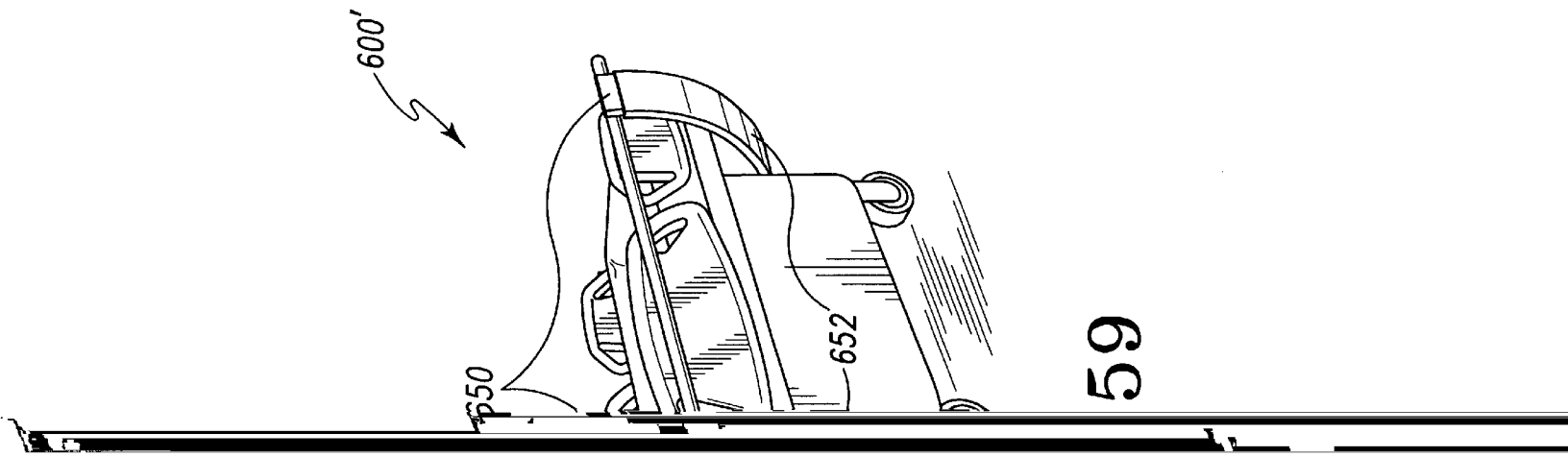


Fig. 55

Fig. 56

Fig. 57



59

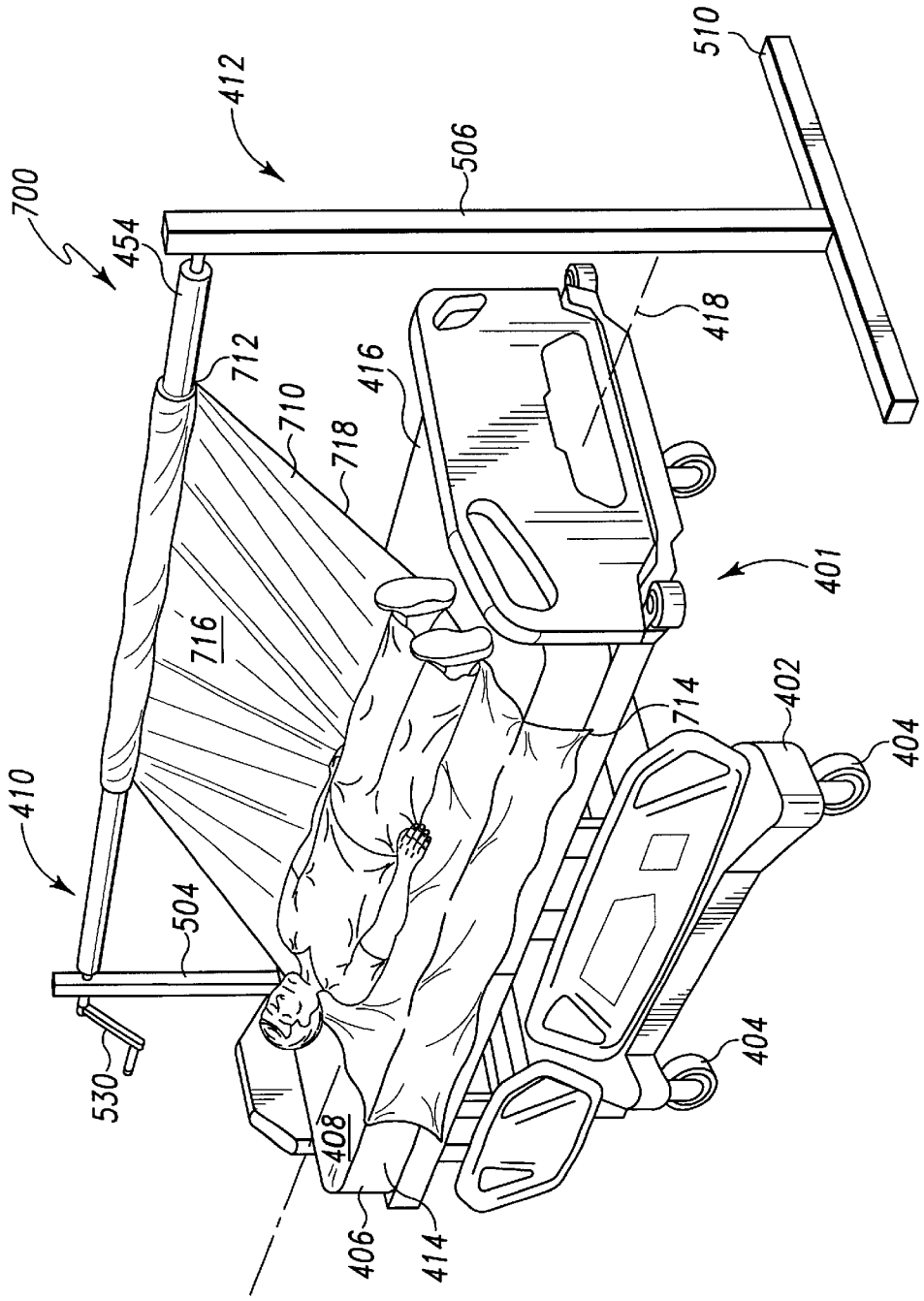

700
454
412
506
510
418
712
710
718
416
716
401
714
402
404
410
504
530
408
406
414

Fig. 60

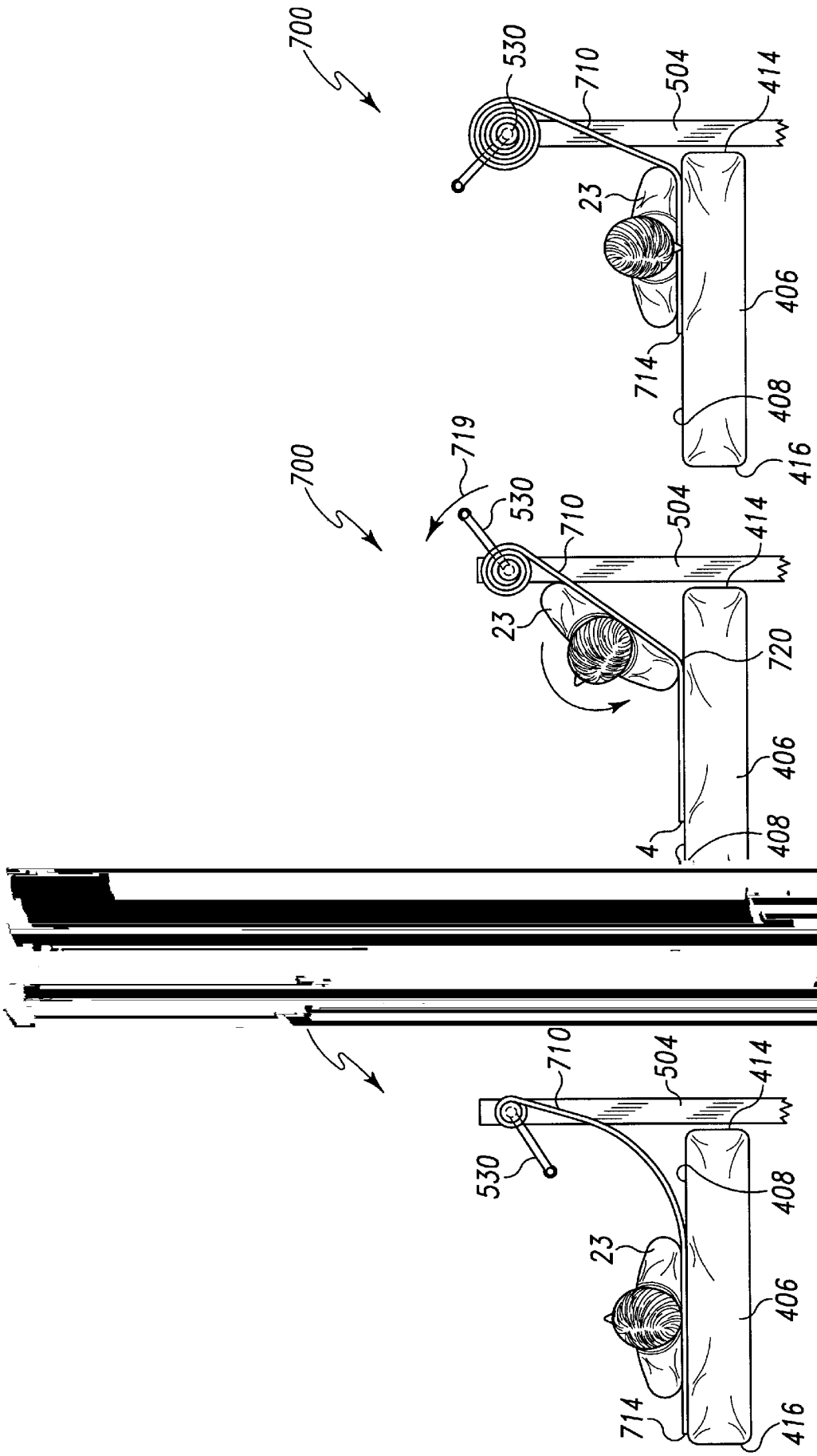


Fig. 63

Fig. 62

Fig. 61

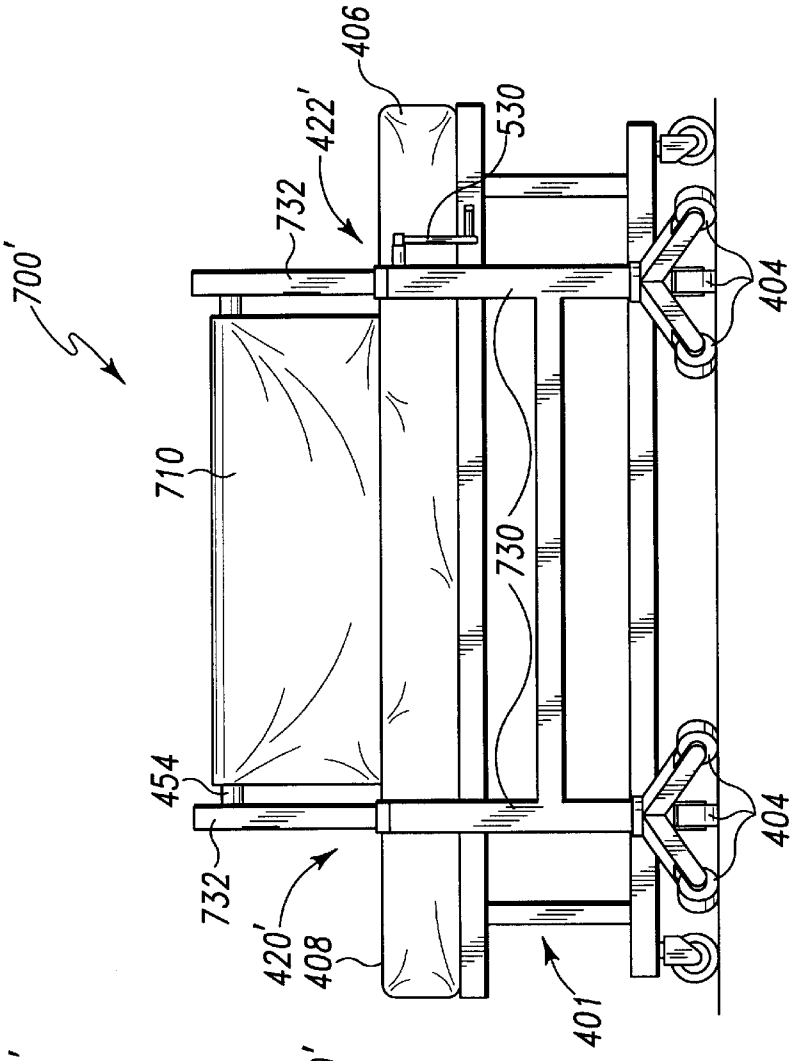

700'
710
454
732
420'
408
401
730
530
422'
406
404

Fig. 65

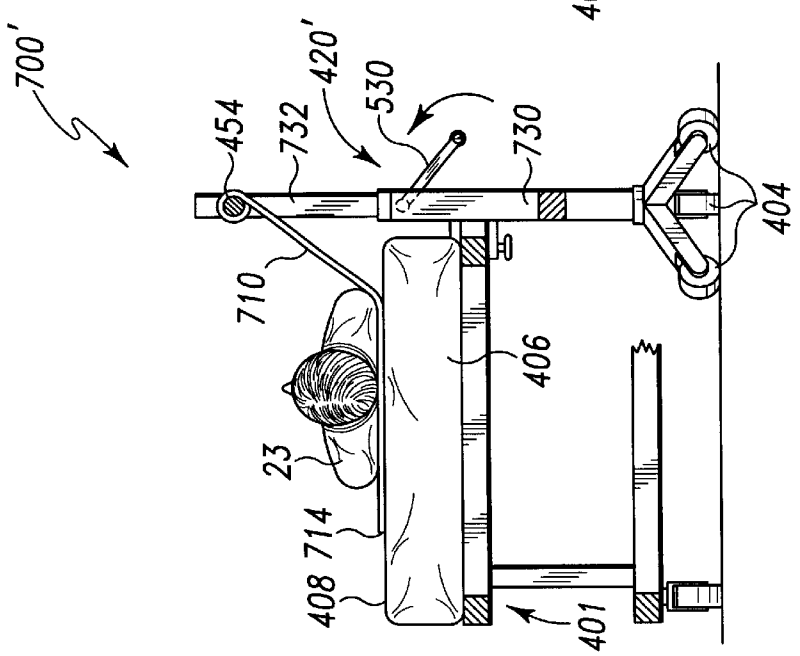
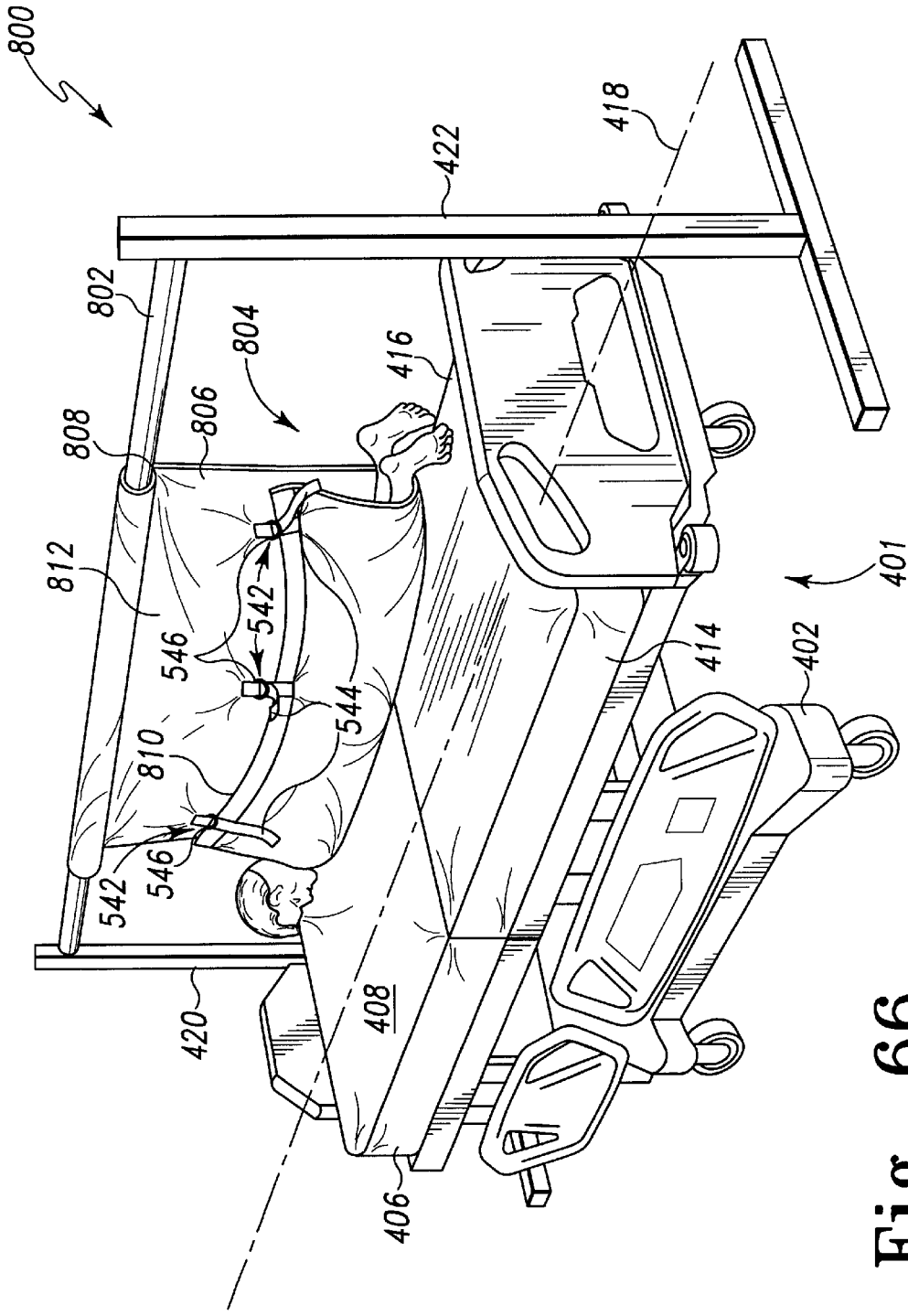

700'
454
732
420'
530
730
710
406
404
23
714
408
401

Fig. 64


800
418
422
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804
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806
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812
542
546
544
810
546
542
414
402
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420
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406

Fig. 66

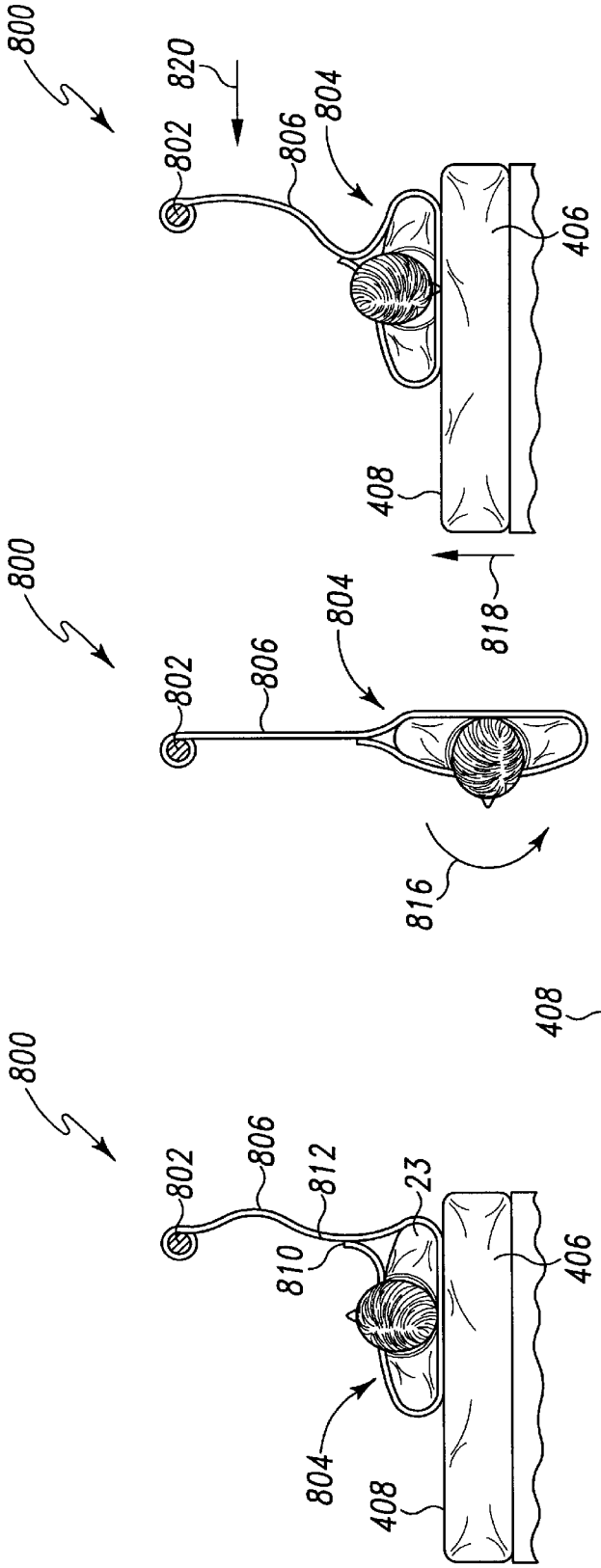

Fig. 69

Fig. 68

Fig. 67

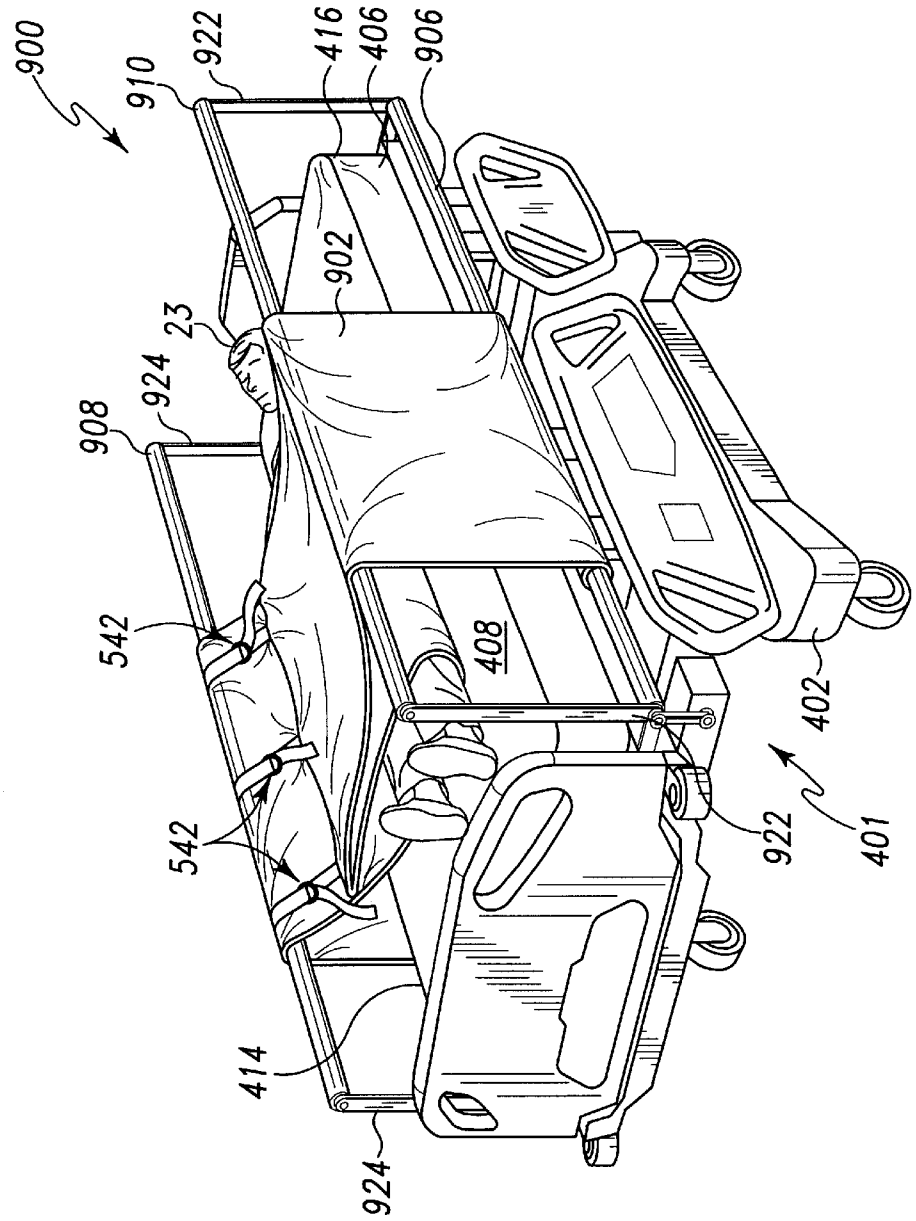
900
910
922
416
406
906
902
23
924
908
542
408
542
414
924
402
922
401

Fig. 70

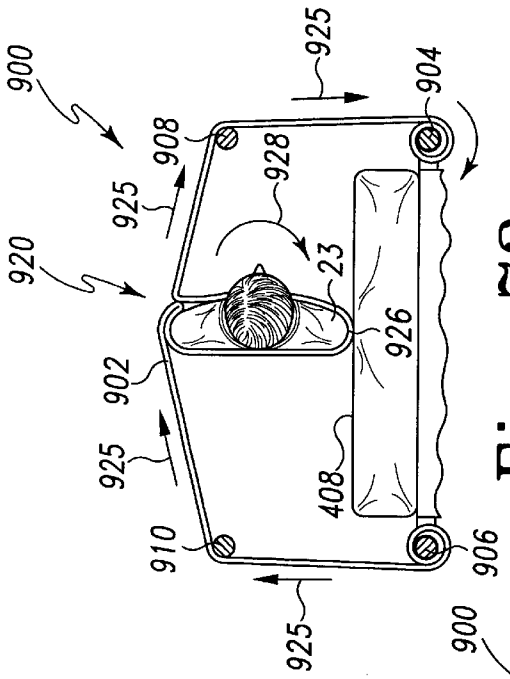

Fig. 72

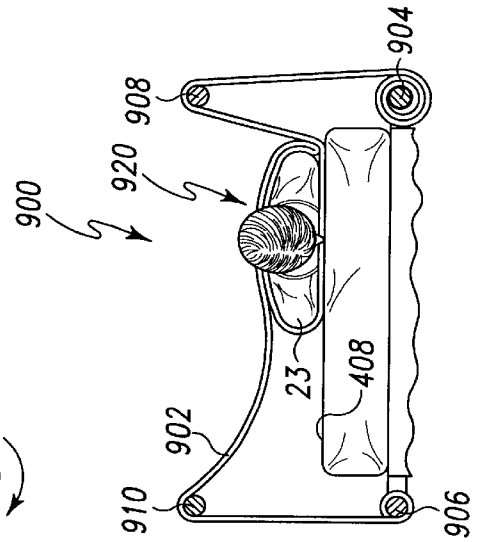

Fig. 73

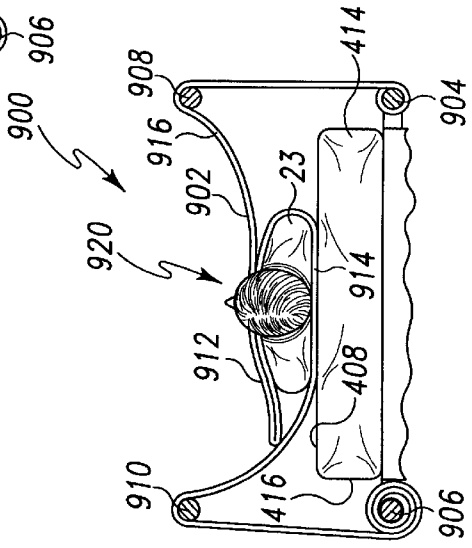

Fig. 71

PULMONARY THERAPY APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application Serial No. 60/218,923, filed Jul. 14, 2000, which is expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates to pulmonary therapy apparatus and, more particularly, to chest compression and proning devices which provide pulmonary therapy on a patient. Moreover, the present invention relates to a pulmonary therapy apparatus which incorporates one or more of the following components: a proning apparatus, a chest compression or binding apparatus, an oscillating motion therapy apparatus and a longitudinal rotation therapy apparatus.

The positioning of patients in a prone position (i.e., face down) typically results in improved oxygenation to the patient as opposed to a supine position (i.e., face up). More particularly, it is believed that prone positioning reduces the occurrence of acute respiratory distress syndrome (ARDS). ARDS historically has had a mortality rate often exceeding sixty percent. Additionally, bed ridden patients with diseases or infirmities not necessarily requiring improved oxygenation often require that they be rotated between supine and prone positions in order to avoid the formation of bed sores.

Traditionally, the re-positioning and, moreover, the turning of patients about their longitudinal axes, has been accomplished only with considerable effort. The turning of patients from a supine position to a prone position often requires assistance from at least three caregivers. Additionally, patients often have a plurality of tubes and lines connected to their bodies for a variety of medical reasons, including intravenous supply and ventilation. The turning process is often further complicated by intermingling or tangling of the tubes or lines.

In short, proning has proven to be an effective intervention to increase oxygenation in the ARDS patient. Ease in attaining the prone position obviously facilitates its utilization. As such, there remains a need for a prone positioning apparatus which reduces the manual labor required, increases caregiver efficiency, and improves line management.

It is also believed that chest binding or compression may prove to be an effective method of pulmonary therapy and, more particularly, alveolar recruitment. It is believed that

referred to as a "zero gravity" position, optimizes such therapy. Therefore, there is a need for a longitudinal rotation apparatus which facilitates improved ventilation and lung drainage.

SUMMARY OF THE INVENTION

In an illustrated embodiment of the present invention, a proning apparatus comprises a base including a head portion, a leg portion, and a body portion positioned intermediate the head portion and the leg portion. The base further includes an opposing pair of longitudinal side edges, a patient support surface extending between the side edges, and a longitudinal axis. A face-receiving aperture is formed within the head portion and is adapted to receive a face of a patient therein. An abdomen-receiving aperture is formed within the body portion in longitudinally spaced relation to the face-receiving aperture, the abdomen-receiving aperture being adapted to expose the abdomen of a patient when the face is in the face-receiving aperture. A groin-receiving aperture is formed within the leg portion in longitudinally spaced relation to the abdomen-receiving aperture, wherein the groin-receiving aperture is adapted to expose the groin of the patient when the face is in the face-receiving aperture.

A plurality of supports are coupled to the patient surface of the base. The plurality of supports include at least one head support cushion coupled to the head portion, at least one shoulder support cushion coupled to the body portion, and at least one leg support cushion coupled to the leg portion. The plurality of supports further include at least one hip support cushion positioned intermediate the abdomen-receiving aperture and the groin-receiving aperture. A plurality of line management devices are supported by the base adjacent to the side edges, wherein the line management devices configured to releasably secure hoses and lines adjacent the base. A plurality of straps are coupled to the base adjacent one of the side edges, each of the straps including a padded section adapted for engaging the patient.

In another illustrated embodiment of the invention, a proning therapy sleeve comprises a bottom support portion including a head end and a foot end, the bottom support portion configured to be located on a mattress of a bed. A pair of opposing side portions extend outwardly from the bottom support portion. An aperture is formed in each of the pair of opposing side portions, wherein the aperture is configured to receive the arms of a patient. A head support bladder is supported in each of the side portions. At least one inflatable chest support bladder is supported in each of the side portions in spaced relation to the head support bladder. A thigh-engaging bladder is supported in each of the side

one chest bladder may be inflated to provide chest binding or compression when a ventilator is used to supply air or oxygen to the patient through a ventilator tube. As air is blown into the patient's lungs through the ventilator tube, the at least one chest bladder is inflated to force air downwardly into the patient's lungs.

The bottom support surface may include a plurality of apertures forming an air zone and coupled to an air supply. When air is supplied to the air zone, the air is forced outwardly through the holes to provide an air pallet or bearing to assist in rotational movement of the patient. Additionally, the side portions may each include an outer bladder coupled to the air supply. An outer surface of the side portions include a plurality of apertures so that air flows outwardly through the outer surface for providing an air pallet or bearing. As such, the entire outer circumference of the sleeve may be provided with an air bearing to facilitate the proning of the patient.

In yet another illustrated embodiment of the present invention, a proning apparatus comprises a bottom support bladder including opposing first and second sides, an outer surface, an air chamber, and a plurality of apertures formed within the outer surface and in fluid communication with the air chamber. A plurality of side flaps include a first end coupled to the bottom support bladder proximate the first side. A plurality of fasteners are supported by the second ends of the side flaps and are releasably secured proximate the second side of the bottom support bladder. The plurality of side flaps include a first head flap coupled to the bottom support bladder proximate the first side and a second head flap coupled to the bottom support bladder proximate the second side. A head bladder is connected to each of the first and second head flaps. The side flaps further include a chest support flap supporting a plurality of chest support bladders. A bottom prone bladder is positioned to alternatively support the bottom support bladder and the plurality of side flaps. The bottom prone bladder is configured to be inflated with air when it is supporting the plurality of side flaps.

In a further illustrated embodiment of the present invention, a patient support includes a base, an inner frame supported by the base, a plurality of rollers rotatably supported by the inner frame, and a movable outer frame defining a longitudinal axis and a transverse axis. The outer frame is supported by the inner frame for longitudinal movement relative thereto. A patient support surface is supported by the outer frame, and a drive mechanism is operably connected to the movable outer frame for driving the outer frame in motion. A coupling is provided intermediate the base and the inner frame for facilitating rotation of the outer frame about the longitudinal axis and the transverse axis. A massage mechanism is supported adjacent the patient support surface. The massage mechanism includes a plurality of rollers configured to move vertically relative to the patient support surface.

In still another illustrative embodiment of the present invention, a pulmonary therapy system comprises a chest binding apparel apparatus including a plurality of air bladders and configured to be supported proximate the chest of the patient. An air supply is in fluid communication with the plurality of air bladders and is operably connected to a controller. A ventilator supplies air to the lungs of the patient and is coupled to a ventilator pressure sensor for sensing a pressure of air supplied to the patient and generating a ventilator pressure signal indicative thereof. The ventilator pressure sensor is in communication with the controller for supplying the ventilator pressure signal thereto. The controller controls air flow to the plurality of air bladders in response to the ventilator pressure signal. An apparel pressure sensor is coupled to the binding apparel apparatus for sensing a pressure applied by the binding apparel apparatus to the chest of the patient and generating an apparel pressure signal indicative thereof. The apparel pressure sensor is in communication with the controller for supplying the apparel pressure signal thereto.

A switching valve is coupled to the air supply for alternating between a first mode of operation wherein air is supplied to the air bladders and a second mode of operation wherein air is evacuated from the air bladders. An exhaust line is coupled to the switching valve for exhausting evacuated air from the air bladders to atmosphere. A bladder supply line is provided for supplying air from the air supply to the air bladders. The switching valve alternatively connects the air supply to the exhaust line and the bladder supply line.

The chest binding apparel apparatus includes a vest having a front portion, a rear portion and a head receiving aperture intermediate the front portion and the rear portion. At least one front bladder is supported by the front portion and at least one rear air bladder is supported by the rear portion. The front portion and the rear portion preferably include a substantially rigid shell wherein the at least one front air bladder and the at least one rear air bladder are supported either on an inner surface of the shell or an outer surface of the shell depending upon the desired functionality. The at least one front bladder and the at least one rear bladder each include a plurality of independently inflatable pressure zones.

In a further illustrated embodiment of the present invention, a longitudinal rotation therapy method comprises the steps of supporting a patient on a patient support surface including a head section, a back section, a seat section, and a leg section, the patient support surface further including a longitudinal axis and a transverse axis. The method further comprises the steps of positioning the head section upwardly relative to the back section, positioning the back section upwardly relative to the seat section, and positioning the leg section downwardly relative to the seat section. The method further includes the steps of rotating the patient support surface about the transverse axis in a first direction, stopping rotation of the patient support surface upon reaching a first limit, rotating the patient support surface about the transverse axis in a second direction opposite the first direction, stopping rotation of the patient support surface upon reaching a second limit, and repeating the rotating and stopping steps, thereby providing oscillating rotational movement to the patient support surface. The positioning steps comprise the steps of placing the patient in a weightless, neutral body, or zero gravity, position.

In another illustrative embodiment of the present invention, a proning apparatus includes a frame, a patient support supported by the frame and including a head end and a foot end, the patient support defining a longitudinal axis. A first upright extends substantially vertical and is positioned proximate the head end, and a second upright extends substantially vertical and is positioned proximate the foot end. A movable support member is rotatably supported intermediate the first and second uprights. A wrap is supported for movement by the movable support member, the wrap including first and second longitudinally extending side edges defining an access opening therebetween and configured to receive a patient in a set up mode of operation, and to close the access opening in a turning mode of operation. A drive mechanism is coupled to the movable support member for rotating the movable support member and the wrap.

In still another illustrative embodiment of the present invention, a proning apparatus comprises a patient support surface extending between opposing first and second side edges, the patient support surface including a head end and a foot end and defining a longitudinal axis. A first drive support member is positioned proximate the head end and a second drive support member is positioned proximate the foot end. A drive mechanism is supported by the first and second drive support members. A sleeve support member is coupled to the drive mechanism for lateral movement above the patient support surface. A sleeve is supported by the support member, the sleeve including an inner surface

outer surface of the sleeve is in spaced relation to the patient support surface, and raising the patient support surface into contact with a portion of the outer surface of the sleeve, thereby defining a pivot point on the sleeve. A further step comprises rolling the sleeve about the pivot point thereby placing the patient in a prone position on the patient support surface.

In another illustrative embodiment of the present invention, a proning device is provided comprising a patient support surface extending between opposing first and second longitudinal side edges, a drive roller supported adjacent the

including a proning surface formed integrally with an air bearing platform on a bed;

FIG. **15** is a top plan view of the proning apparatus of FIG. **14**;

FIG. **16** is a top plan view similar to FIG. **15**, with the proning surface located over the patient;

FIG. **17** is an end view of the proning apparatus of FIG. **16**, illustrating the patient in a supine position on the bed;

FIG. **18** is an end view of the bed and proning apparatus of FIG. **16**, illustrating the patient in a prone position on the bed;

FIG. **19** is a perspective view of another embodiment a proning apparatus according to another embodiment of the present invention, in which a proning sleeve is located on a conventional support surface of a bed;

FIG. **20** is a perspective view of a multi-directional rotation platform according to another embodiment of the present invention;

FIG. **21** is a side elevational view of the platform of FIG. **20**, illustrating longitudinal movement of a patient support surface relative to a base;

FIG. **22** is a side elevational view similar to FIG. **21**, illustrating pivotable movement of the patient support surface about a transverse pivot axis between a Trendelenburg position and a reverse Trendelenburg position;

FIG. **23** is an end view of the platform of FIG. **20**, illustrating rotation of the patient support surface about a longitudinal axis when the support surface is in the Trendelenburg position;

FIG. **24** is an end view similar to FIG. **23** in which the support surface is rotated in an opposite direction;

FIG. **25** is a partial sectional view taken along line **25**—**25** of FIG. **20**, illustrating a massaging mattress supported on the bed;

FIG. **26** is a block diagram illustrating a pulmonary therapy system of the present invention;

FIG. **27** is a perspective view illustrating a vest for providing pulmonary therapy, including chest binding, percussion and vibration therapy on a patient;

FIG. **28** is a bottom plan view of the vest of FIG. **27**;

FIG. **29** is a sectional view taken along line **29**—**29** through the vest of FIG. **26**;

FIG. **30** illustrates the vest of FIG. **27** on a patient located on a bed;

FIG. **31** is an end view illustrating the vest of FIG. **30** on the patient with at least one of the air bladders within the vest inflated to provide therapy to the patient;

FIG. **32** is an end view illustrating the vest of FIG. **30** on the patient with the right rear air bladder inflated to provide continuous lateral rotational therapy to the patient;

FIG. **33** is an end view illustrating the vest of FIG. **30** on the patient with the left rear air bladder inflated to provide continuous lateral rotational therapy to the patient;

FIG. **34** is a perspective view illustrating a plurality of control modules configured to be coupled to a bed to control the various therapies of the present invention;

FIG. **35** is a perspective view illustrating one of the control modules of FIG. **34**;

FIG. **36** is a perspective view of a longitudinal rotation platform according to another embodiment of the present invention which is movable between a chair position and a bed position;

FIG. **37** is a perspective view of the longitudinal rotation platform of FIG. **36**, illustrating movement of a head support section and a leg support section;

FIG. **38** is a diagrammatical view illustrating the body of a patient positioned in a weightless, neutral body position;

FIG. **39** is a side elevational view of the longitudinal rotation platform of FIG. **36**;

FIG. **40** is a side elevational view similar to FIG. **39**, illustrating movement of the head section and leg section to move the patient to a reclined position;

FIG. **41** is a side elevational view similar to FIG. **39**, illustrating movement of the patient support surface to a Trendelenburg position;

FIG. **42** is a side elevational view similar to FIG. **39**, illustrating additional details of a patient support surface including bladders for the locating and retaining the patient on the support surface;

FIG. **43** is a side elevational view similar to FIG. **39**, illustrating the patient support surface in a reclined position;

FIG. **44** is a side elevational view similar to FIG. **39**, illustrating the patient retention bladders when the patient support surface is in the Trendelenburg position;

FIG. **45** is a perspective view, in partial schematic, of a drive mechanism for pivoting the patient support surface of FIG. **39**;

FIG. **46** is a side elevational view, in partial schematic, of the drive mechanism of FIG. **45**;

FIG. **47** is a perspective view of components positioned adjacent the patient support surface of FIG. **39**;

FIG. **48** is a perspective view of a bed configured to incorporate an embodiment of the proning apparatus of the present invention;

FIG. **49** is a perspective view of a proning apparatus according to a further embodiment of the present invention, including a rotatably mounted support member in substantial coaxial alignment with a longitudinal axis of a patient support surface;

FIG. **50** is an end view, in partial schematic, illustrating operation of the proning apparatus of FIG. **49**;

FIG. **51** is an end view, in partial schematic illustrating further operation of the proning apparatus of FIG. **49**;

FIG. **52** is a perspective view of an alternative embodiment of the proning apparatus of FIG. **49**;

FIG. **53** is a perspective view of a proning apparatus according to another embodiment of the present invention;

FIG. **54** is a perspective view of a proning apparatus according to a further embodiment of the present invention, the proning apparatus including a transversely moving support member;

FIG. **55** is an end view, in partial schematic, of the proning apparatus of FIG. **54**;

FIG. **56** is an end view similar to FIG. **55**, illustrating operation of the proning apparatus;

FIG. **57** is an end view similar to FIG. **55**, illustrating further operation of the proning apparatus;

FIG. **58** is a perspective view of an alternative embodiment of the proning apparatus of FIG. **54**, illustrating the support member in an operative position;

FIG. **59** is a perspective view similar to FIG. **58**, illustrating the support member in a stored position;

FIG. **60** is a perspective view of a proning apparatus according to a further embodiment of the present invention, including a rotational support member positioned substantially off-center from a longitudinal axis of a patient support surface;

FIG. **61** is an end view similar to FIG. **60**, illustrating the proning apparatus;

FIG. **62** is an end view similar to FIG. **60**, illustrating operation of the proning apparatus;

FIG. **63** is an end view similar to FIG. **60**, illustrating further operation of the proning apparatus;

FIG. **64** is an end view, with a partial cut away, illustrating an alternative embodiment of the proning apparatus of FIG. **60**;

FIG. **65** is a side elevational view of the proning apparatus of FIG. **64**;

FIG. **66** is a perspective view of a proning apparatus according to a further embodiment of the present invention, including a wrap supported substantially off-center from a longitudinal axis of a patient support surface;

FIG. **67** is an end view, in partial schematic, illustrating the proning apparatus of FIG. **66**;

FIG. **68** is an end view similar to FIG. **67**, illustrating operation of the proning apparatus;

FIG. **69** is an end view similar to FIG. **67**, illustrating further operation of the proning apparatus;

FIG. **70** is a perspective view of a proning apparatus according to a further embodiment of the present invention, including a sleeve supported for transverse movement relative to a patient support surface;

FIG. **71** is an end view, in partial schematic, illustrating the proning apparatus of FIG. **70**;

FIG. **72** is an end view similar to FIG. **71**, illustrating operation of the proning apparatus; and

FIG. **73** is an end view similar to FIG. **71**, illustrating further operation of the proning apparatus.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, FIGS. **1–7** illustrate a proning apparatus **10** according to one exemplary embodiment of the present invention. The apparatus **10** includes a unitary base **12** defining a longitudinal axis **13** and having head portion **14**, a body portion **16**, and a leg portion **18**. The body portion **16** includes a shoulder section **19** and is positioned intermediate the head portion **14** and the leg portion **18**. Head portion **14** includes a face-receiving aperture **20** substantially centered along the longitudinal axis **13** and adapted to receive the face of a patient therein. Body portion **16** includes an abdomen-receiving aperture **22** in spaced relation to the face-receiving aperture **20** and substantially centered along the longitudinal axis **13**. The leg portion **18** includes a groin receiving aperture **24** in spaced relation to the abdomen-receiving aperture **22** and substantially centered along the longitudinal axis **13**. The abdomen-receiving aperture **22** is adapted to expose the abdomen of a patient **23** and the groin-receiving aperture **24** is adapted to expose the groin of the patient **23** when the face of the patient supported on the base **12** is received within the face-receiving aperture **20**.

Adjustable supports, preferably head support cushions **26**, are releasably secured to head portion in lateral spaced relation on opposite sides of the face-receiving aperture **20**. Shoulder supports, preferably cushions **28**, are releasably secured to the shoulder section **19** of the body portion **16** intermediate the abdomen-receiving aperture **22** and the face-receiving aperture **20**. Hip supports, preferably cushions **30**, are also releasably secured to body portion **16**, intermediate the groin-receiving aperture **24** and the abdomen-receiving aperture **22**. Leg supports, preferably cushions **32**, are releasably secured to leg section **18** and are longitudinally spaced from the hip support cushions **30** on an opposite side of the groin-receiving aperture **24**. All of the cushions **26, 28, 30** and **32** may be secured to the base **12** by suitable fasteners such as hook and loop fasteners, snaps, straps, or the like.

FIGS. **1** and **2** illustrate the adjustability of cushions **26, 28, 30** and **32**. Illustratively, hook and loop fasteners are utilized with the hook portion **27** coupled to the base **12** and mating loop portions **29** coupled to the support cushions **26, 28, 30** and **32**. By using adjustable fasteners, the cushions **26, 28, 30** and **32** may be positioned at desired locations to engage and support the patient. Cushions **26, 28, 30** and **32** are illustratively formed from a pressure reducing material such as gel packs, foam, air bladders, beads or other pressure reducing filler material in order to reduce concentrated pressure from being applied to distinct portions of the body of the patient **23**.

A head strap **34** is coupled to head portion **14** at a first side **35** of the base **12**. A shoulder strap **36**, a hip strap **38**, and a leg strap **40** are also coupled to the first side **35** of the base **12**. Head strap **34** includes a circular padded section **42** including a contoured recess **43** for engaging the back of a patient's head. Straps **36, 38**, and **40** include padded sections **44, 46**, and **48**, respectively, for engaging portions of the patient's body. The padded sections **42, 44, 46**, and **48** are positioned intermediate opposing first and second ends **49** and **50** of the respective straps **34, 36, 38**, and **40**. Free second ends **50** of straps **34, 36, 38**, and **40** are configured to be coupled to free ends **52** of straps **54** coupled to an opposite second side **55** of the base **12** as shown in FIG. **1**. Caregiver gripping handles **56** are formed on opposite sides **35** and **55** of the base **12** to facilitate proning of the patient **23** as discussed below.

In operation, straps **34, 36, 38**, and **40** are placed underneath a patient lying on a bed **58** as shown in FIG. **5**. A caregiver **60** can grip the base **12** by way of the handles **56**, as shown in FIG. **6**, and then rotate the patient as illustrated by arrow **62** from the supine position (i.e. face up) shown in FIG. **6** to the prone position (i.e. face down) shown in FIG. **7**. As detailed above, proning is believed to be an effective intervention to increase oxygenation in a patient **23** suffering from acute respiratory distress syndrome (ARDS). When in the prone position, the support cushions **26, 28, 30**, and **32** help reduce the likelihood of formation of pressure ulcers on the skin of the patient **23** by reducing concentrated pressure applications.

As best shown in FIGS. **2** and **4**, the base **12** is formed to include a plurality of line management devices, preferably hose and line clips **66**, for holding various hoses **68** and lines **70** in position adjacent to the base **12**. These clips **66** are supported adjacent the side edges **35** and **55** of the base **12** and include top and bottom spring arms **72** and **74**. The arms **72** and **74** are biased toward each other to permit insertion and retention of the tubes and lines **68** and **70** into the clips **66**. Therefore, ventilator tubes such as tube **68**, as well as other lines such as feeding lines, drainage lines and intravenous (IV) lines can be routed through the clips **66** to manage the tubes and lines during proning of the patient **64**. The head aperture **20** and cushions **26** permit the ventilator tube **68** to be routed to the patient **23** during proning as best shown in FIGS. **6** and **7**.

Another embodiment of the present invention is illustrated in FIGS. **8–12** as comprising a proning therapy sleeve **80** having a bottom surface or support portion **82** located underneath a patient **23**. Bottom support portion **82** includes opposing head and foot ends **83** and **84** and is configured to be located on a conventional support surface or mattress **86** of a bed **87**. Proning therapy sleeve **80** includes opposing

side portions **88** and **90** which are connected to and extend outwardly from opposing side edges **89** and **91** of the support portion **82**. More particularly, the side portions **88** and **90** are configured to be located on opposite sides of the patient **23**. The patient's arms **92** and **94** extend through

In one illustrated embodiment of the present invention illustrated in FIG. **12**, the bottom support portion **82** includes an air zone or chamber **140** coupled to the air supply **123**. When air is supplied to the chamber **140**, air is forced outwardly through a plurality of holes or apertures **141** formed in an outer lower surface **142**, as illustrated by

bladder **215** is inflated to support the patient **23** in the prone position. Once in the prone position, the fasteners of the flaps **164**, **166**, **168**, **170**, **172** and **174** are disconnected and bladder **162** can be rotated away from the patient **23** to expose the patient's posterior side. The support cushions **176**, **178**, **184**, **188**, **196**, **198**, **200**, **206**, and **208** remain under the patient to provide support in the prone position.

FIG. **19** illustrates another embodiment of the proning apparatus **160'** present invention similar to FIGS. **14–18** in which the inflatable air bladder **162** is replaced with a thinner sheet or air bladder **220** located below the patient **23**. The sheet **220** rests on a conventional mattress. Flaps **164**, **166**, **170**, **172**, and **174** are operated in a manner as described above when it is desired to prone the patient.

FIGS. **20–25** illustrate another embodiment of the present invention. In this embodiment, a multi-directional rotation platform **230** includes a base **232** having a plurality of castors **234**. Base **232** supports an inner frame **236** having a plurality of rollers **238**. An outer movable frame **240** [illegible]

and **296** are located within the left and right front portion **282**, respectively, and bladders **298** and **300** are located within the left and right rear portion **284**, respectively.

Each of the bladders **294**, **296**, **298**, and **300** illustratively includes one or more separately inflatable zones. With reference to FIG. **28**, each bladder **294**, **296**, **298**, and **300** includes separate upper and lower zones identified as **294***a*, **294***b*, **296***a*, **296***b*, **298***a*, **298***b*, and **300***a*, **300***b*, respectively. Air is selectively supplied to bladders **294**, **296**, **298**, and **300** to perform chest binding when a ventilator **302** is coupled to the patient **23** by a ventilator tube **304** as shown in FIGS. **26** and **30**. In addition, bladders **294**, **296**, **298**, and **300** perform percussion/vibration therapy. The air supply and control module **305** is illustratively mounted to a bed frame **306** to selectively supply air to the various zones within bladders **294**, **296**, **298**, and **300** to perform the therapy on the patient **23**.

The air supply and control module **305** is further illustrated schematically in FIG. **26**. The air supply and control

When the pressure transducer **308** determines that air is not being supplied to the patient **23**, then the pressure signal **310** indicates such to the controller **307**. The controller **307**, in turn, instructs the switching valve **312** to operate in a second mode wherein air is evacuated from the bladders **294**, **296**, **298** and **300** by operation of the pump **313**. The air then passes through the exhaust line **317** and muffler **318** to atmosphere **319**.

Throughout operation of the system **270**, the pressure sensor **309** will provide an indication of whether effective pressure is being applied by the vest **280** to the lungs of the patient **23**. Moreover, the signal **311** provided to the controller **307** may result in instructions provided on display **320**. For example, if the vest requires tightening on the patient **23**, this may be indicated by the display **320**.

Referring now to FIGS. **32** and **33**, the chest binding apparel apparatus **280** may be utilized to perform continuous lateral rotational therapy (CLRT) on the patient **23**. More particularly, with reference to FIG. **32**, deflation of the left rear bladder **294** and inflation of the right rear bladder **296**, supported outside of the rigid shell **301**, results in rotational movement of the patient **23** in the direction of arrow **61**. Deflation of the right rear bladder **296** and inflation of the left rear bladder **294**, again supported outside of the rigid shell **301**, results in rotation of the patient **23** in the direction of arrow **62** which is opposite the direction of arrow **61** of FIG. **32**. Alternating inflation and correspondence deflation of the bladders **294** and **296** results in oscillating rotational movement of the chest of the patient **23**. This continuous lateral rotational therapy provides the benefit of moving liquids contained within the lungs of the patient **23**.

It is understood that the various embodiments of the present invention may be controlled with control modules **321** as shown in FIGS. **34** and **35**. Modules **321** are designed to be coupled to a bed **322**. Illustratively, bed **322** includes an electrical communication network and an air supply. When the modules **321** are coupled to the bed **322**, a processor within the modules **321** is coupled to the electrical communication network of the bed to receive therapy instructions from a user input. The modules **321** then control flow of air from the air supply to the various air zones to provide the therapy. Such modules are disclosed in U.S. Pat. Nos. 5,630,238 and 6,047,424, which are expressly incorporated herein by reference.

Yet another embodiment of the of the present invention is illustrated in FIGS. **36–44**. In this embodiment, a longitudinal rotation platform apparatus **323** includes the base **324** having a plurality of castors **325**. Base **324** includes opposing side members **326** and **328**. Push handles **330** are also coupled to the base **324**. An articulating patient support surface **332** is also coupled to the base **324**. Suitable drive mechanisms (not shown) are provided to articulate the patient support surface from a chair position shown in FIGS. **36** and **37** to a substantially flat bed position shown in FIGS. **40** and **43**.

Natural upright lung positioning facilitates improved ventilation and lung drainage. The present invention provides proper patient location through range of therapy, a flexible range of therapy (Trendelenburg to chair egress), potential release of intrinsic Nitric Oxide, reduced floor space usage, and psychological benefit of less "bed-like" appearance.

Illustratively, the patient support surface **332** includes a leg section **334**, a seat section **336**, and a back section **338**. Leg section **334** and back section **338** are pivotable upwardly and downwardly relative to seat section **336** to move the support surface **332** intermediate the chair position to the bed position.

Referring now to FIG. **38**, the body of a patient **23** in a weightless, neutral body or zero-gravity position is illustrated. Such weightless neutral body position is well-known in the art and is a position the body of a patient **23** would assume in a weightless environment. As illustrated in FIG. **38**, in the weightless neutral body position, the head **339** of the patient **23** is positioned at approximately 24.5° from the back **341**, while the back **341** is positioned at approximately 128° relative to the thighs **343**. Finally, the thighs **343** are positioned at approximately 133° relative to the legs **345**. It is believed that not only does the weightless neutral body position provide added comfort for the patient **23**, but also improves oxygenation to the patient **23**.

FIG. **40** illustrates the support surface in an intermediate reclined position. FIG. **41** illustrates the support surface **332** in a flat bed position and pivoted about transverse axis **340** to a Trendelenburg position.

Illustratively, support surface **332** includes body locating and retention bladders **335** and **337** located adjacent to patient's lower back **341** and seat or thighs **343**. Bladders **335** and **337** help locate the patient **23** on the chair as illustrated in FIG. **42**. Bladder **335** helps prevent movement of the patient **23** toward a head end of the support surface **332** in the direction of arrow **342** when the support surface **332** is in the Trendelenburg position as shown and best illustrated in FIG. **44**. Bladder **337** helps prevent movement of the patient toward the foot-end of the patient support surface **332** in the direction of arrow **344** when the support surface **334** is in the chair position or the reverse Trendelenburg position.

FIGS. **45** and **46** illustrate a drive mechanism **350** for pivoting the support surface **332** about a transverse pivot axis. The drive mechanism **350** may be similar to the mover disclosed in U.S. patent application Ser. No. 09/810,376, which is assigned to the assignee of the present invention and is incorporated herein by reference. FIG. **47** illustrates siderails **352** and a foot prop **354** located adjacent the support surface **332**.

Referring now to FIG. **48**, a further illustrative embodiment of the proning apparatus **400** of the present invention is illustrated as including a frame **402** supported by a plurality of casters **404**. The frame **402** supports a patient platform or support **406** including an upwardly facing patient support surface **408**. The patient support surface **408** includes a head end **410** and a foot end **412** and extends between first and second opposing side edges **414** and **416**. A longitudinal axis **418** extends intermediate the first and second side edges **414** and **416**.

An accessory frame **420** is supported by the bed frame **402** and includes a first pair of uprights **420***a*, **420***b* positioned proximate the head end **410** of the patient support surface **408** and a second pair of uprights **422***a*, **422***b* positioned proximate the head end **410** of the patient support surface **408**. A first cross member **424** extends in a transverse direction and connects upper ends of the first uprights **420***a* and **420***b*. Likewise, a second cross member extends transversely relative to the patient support surface **408** and connects the upper ends of the second uprights **422***a* and **422***b*.

A plurality of accessory hooks **428** are pivotally supported by an inner surface **430** of each upright **420** and **422**. As illustrated in FIG. **48**, the hooks **428** may include first and second arms **432** and **434** defining a substantially "J" shape. When in a non-operative mode, the hooks **428** are received within a recess **436** formed within the inner surface **430** of

to receive a plurality of accessories, including, but not limited to, intravenous (IV) bags, and monitoring equipment. It should be appreciated that the hooks **428** may be provided with a locking mechanism (not shown) to lock the hooks **428** in an operative position extending substantially perpendicular to the inner surface **430** of the respective upright **420**, **422**.

Referring further to FIG. **1**, the first uprights **420***a* and **420***b* may each support a power assist handle **438** proximate a rear edge **440**. The power assist handles **438** are operably connected to a drive motor **442** for propelling the apparatus **400**. The power assist handles **438** may comprise those of the type disclosed in co-pending U.S. patent application Ser. No. 09/853,221, which is assigned to the assignee of the present invention and which is expressly incorporated herein by reference.

The first and second cross members **424** and **426** support a longitudinally extending accessory support **444**. The accessory support **444** may be utilized to support a number

base members **508** and **510** may be supported on casters (not shown) to facilitate movement of the proning apparatus **500** relative to a conventional bed **501**.

A strengthening member **512** extends intermediate the first and second uprights **504** and **506** and may be utilized in the manner described above with respect to the accessory support **444** for supporting accessories such as lights and cameras. The sleeve support member **454** is rotatably supported by the first and second uprights **504** and **506** in vertical spaced relation to the strengthening member **512**. The sleeve support member **454** is substantially aligned in a transverse or horizontal direction with the longitudinal axis **418** of the patient support surface **408**. The sleeve **456** includes first and second longitudinally extending side edges **514** and **516** defining an access opening therebetween and configured to receive the patient **23** in a set-up mode of operation, and to close the access opening in a turning mode of operation. The sleeve **456** of FIGS. **49–51** comprise a mattress **518** including a plurality of longitudinally extending fluid filled bladders **520**. The bladders **520** combine to

sheet **540**. The sheet **540** extends around an outer surface **528** of the sleeve support member **454** much in the same manner of the straps **524** of the mattress **518**. The first and second side edges **514** and **516** of the sheet **540** overlap wherein the first side **514** of the sheet **540** is secured to a center portion **515** thereof through fasteners **542**. In the embodiment of FIG. **52**, the fasteners **542** include a strap **544** received within a conventional buckle **546**.

Operation of the proning apparatus **500'** of FIG. **52** is substantially similar to that of the mattress **518**. It should be noted that conventional support cushions, such as a head cushion **548**, a chest cushion **550** and a leg cushion **552** may be positioned intermediate the front of the patient **23** and the patient support surface **408** before the patient support surface **408** is raised into contact with the sleeve **456'** following the turning of the patient **23**.

FIG. **53** illustrates a further variation of the proning apparatus **400"** wherein the sleeve **456"** is formed as a substantially rigid shell **558** including a first portion **560** for supporting the patient **23** and a second portion **562** pivotally supported by the first portion **560**. A plurality of cushions **563**, **564**, **565** and **566** are supported by an inside surface **567** of the second portion **562** of the shell **558** and are used to support the patient **23** in a prone position. These cushions **564** include a head cushion **563**, a chest cushion **564**, thigh cushions **565**, and calf cushions **566**. A plurality of rollers **568** provide a bearing surface to provide for rotation of the

includes a driver, such as the manual crank **530** illustrated in FIG. **55–57**. As may be readily appreciated, the manual crank **530** may be replaced by a conventional electric motor. The crank **530** is operably connected to the first and second chains **614** and **616** through a conventional mechanical linkage, such as a pair of sprockets **622** supported on opposing ends of a longitudinally extending drive shaft (not shown) extending beneath the patient support surface **408**. As can be readily appreciated, operation of the hand crank **530** results in corresponding movement of the first and second chains **614** and **616** through the track **620** about the periphery of the first and second drive support members **602** and **604**. A sleeve **626** is supported for movement with the sleeve support member **612**. The sleeve **626** is substantially similar to the sleeve **456** described above with respect to FIG. **52**.

Referring to FIGS. **55–57**, the operation of the proning apparatus **600** is described in greater detail. Initially, as illustrated in FIG. **55**, the patient **23** is wrapped in the sleeve **626** with the sleeve support member **612** positioned essentially horizontally level with the patient **23** adjacent the first side edge **414** of the patient support surface **408**. As illustrated in FIG. **55**, at this point the patient **23** is in a supine position. The drive mechanism **530** is then activated for driving the first and second chains **614** and **616** in a substantially counterclockwise direction around the first and

[redacted]

shell **558** about its longitudinal axis **570**. The shell **558** may

arrows **628**. Motion of the hand crank **530** is illustrated by

supported proximate the upper ends of the first and second uprights **420** and **422** and laterally offset from the longitudinal axis **418**. A drive mechanism, which may comprise a hand crank **530**, as illustrated in FIG. **60**, is provided adjacent one end of the support member **454** for providing rotational movement thereto. A sheet **710** including opposing first and second ends **712** and **714** is supported by the support member **454**. Moreover, the first end **712** of the sheet **710** is fixed to the support member **454** while a second end **714** is positioned proximate the first side edge **416** of the patient support surface **408**.

An upper surface **716** of the sheet **710** may be provided with a material having a higher coefficient of friction than the lower surface **718** in order to facilitate adhesion of the patient **23** to the sheet **710** while enhancing sliding between the sheet **710** and the patient support surface **408**.

Referring now to FIGS. **61–63**, operation of the proning apparatus **700** is described in greater detail. Initially, the proning apparatus **700** is positioned adjacent the bed **401** such that the sheet support **454** is positioned above the patient support surface **408** and is horizontally or laterally offset from the longitudinal axis **418**. More particularly, the sheet support **454** is preferably positioned immediately above the second side edge **416** of the patient support surface **408**. The second end **712** of the sheet **710** is then passed under the back of the patient **23** supported on the patient support surface **408**. The drive mechanism is activated, typically by rotating the hand crank **530** in the direction of arrow **719**. Such movement causes the sheet **710** to wrap upon the support member **454**, resulting in the sheet moving transversely across the patient support surface **408** and upwardly toward the support member **454**. As such, the patient **23** is caused to turn and rotate about a pivot point **720** defined by the sheet **710**. As illustrated in FIG. **63**, the patient **23** is then located in a prone position on the patient support surface **400**. The sheet **710** may then be removed from underneath the front of the patient **23**.

FIGS. **64** and **65** illustrate an alternative embodiment of the proning apparatus **700'**. In the proning apparatus **700'**, the support member or sheet roll **454** may be fixed from rotation between the first and second uprights. The first and second uprights **420'** and **422'** include a first portion or housing **730** telescopingly receiving a second portion or arm **732**. As such, a pulling device is defined by the arm **732** wherein vertical movement of the arm **732** results in the sheet **710** being pulled transversely across the patient support surface **408** and upwardly. As such, the patient **23** is caused to turn from a supine to a prone position in the manner described above with respect to FIGS. **61–63**. The first and second uprights **420'** and **422'** may be supported on casters **404** to facilitate movement of the proning apparatus **700'** relative to the bed **401**.

Turning now to FIGS. **66–69**, a further embodiment of the proning apparatus **800** of the present invention is illustrated for use with a bed **401** including a patient support surface **408** supported by a bed frame **402**. The patient support **408** may be driven in vertical motion by a conventional drive mechanism.

First and second uprights **420** and **422** are connected to first and second base members **508** and **510** and extend generally vertically thereto. A support member **802** is fixed intermediate the first and second uprights **420** and **422** proximate the upper ends thereof. As such, the support member **802** is positioned vertically above the patient support surface **408** and is positioned horizontally off-center from the longitudinal axis **418** of the patient support surface **408**. In a preferred embodiment, the support member **802** is positioned horizontally proximate one of the first and second sides **414** and **416** of the patient support surface **408**. A sleeve **804** defined by a sheet **806** including first and second ends **808** and **810** and a center portion **812** intermediate the first and second ends **808** and **810**. More particularly, the sleeve **804** is defined by a plurality of fasteners **542** securing the second end **810** of the sheet **806** to the center portion **812** thereof. The first end **808** of the sheet **806** is fixed to the support member **802**.

In operation, as illustrated in FIGS. **67–69**, a patient **23** is placed in a supine position with the sheet **806** positioned intermediate the back of the patient **23** and the patient support surface **408**. The second end **810** of the sheet **806** then is wrapped around the front of the patient **23** and secured to a center portion **812** thereof through the fasteners **542**. The fasteners **542** preferably include a strap **544** secured to the second end **810** of the sheet **806** and a buckle **546** secured to the center portion **812** thereof.

Next, as illustrated in FIG. **68**, the patient support surface **408** is lowered in the direction of arrow **814**. The patient support surface **408** is lowered until the sheet **806** no longer contacts the patient support surface **408**. As such, the sleeve **804** and patient **23** are caused to rotate in the direction of arrow **816**. Next, the patient support surface **408** is raised in the direction of arrow **818**. Contact between the sleeve **804** and the patient support surface **408** again occurs proximate the shoulder of the patient **23** thereby defining a pivot point therebetween. The caregiver may then assist in causing pivoting movement of the patient **23** about the pivot axis by applying a force in the direction of arrow **820**. The patient **23** is then placed in a prone position within the sleeve **804** as illustrated in FIG. **69**. At that point, the fasteners **542** may be released and the sheet removed from underneath the chest of the patient **23**.

Referring now to FIGS. **70–73**, another exemplary embodiment of a proning apparatus **900** of the present invention is illustrated as including a sheet **902** extending between sides **414** and **416** of a patient support surface **408**. Moreover, the sheet **902** is guided in motion by a pair of drive rollers **904** and **906** and a pair of idler rollers **908** and **910**. The first drive roller **904** is supported adjacent the first side edge **414** of the patient support surface **408** while the second drive roller **906** is supported adjacent the second side edge **416** of the patient support surface **408**. The first and second idler rollers **908** and **910** are positioned above the patient support surface **408** horizontally adjacent to the first and second drive rollers **904** and **906**. The sheet **902** includes a first sleeve portion **912** configured to be placed adjacent the chest of the patient **23**, a second sleeve portion **914** configured to be placed adjacent the back of the patient **23** and a connecting portion **916** extending between the first sleeve portion **912** and the first drive roller **904**. The first and second sleeve portions **912** and **914** are releasably secured together by a plurality of fasteners **542** thereby defining a sleeve **920** for receiving the patient **23**.

The first idler roller **908** is rotatably supported by a pair of uprights **922** and the second idler roller **910** is rotatably supported by a second pair of uprights **924**. Both the first and second pair of uprights **922** and **924** are coupled to the bed-frame **402** and extend upwardly from the first and second drive rollers **904** and **906**.

The operation of the proning apparatus **900** is illustrated in FIGS. **71–73**. In FIG. **71**, the sheet **902** is placed intermediate the back of the patient **23** and the patient support surface **408**. The first sleeve portion **912** is then secured to the second sleeve portion **914** by way of the fasteners **542**. Next, the drive mechanism is operated to cause the sheet to move in the direction indicated by arrows **925**. The first drive roller **904** pulls on the connecting portion **916** of the sheet **902** which, in turn, pulls the sleeve **920** upwardly and to the right in FIG. **24** and causing a rotation of the sleeve **920** and the patient **23** about a pivot point **926** in the

direction of arrow **928**. Continued movement of the sheet **902** causes the patient **23** to continue to rotate into a prone position as illustrated by FIG. **73**.

As detailed above, proning has shown to be an effective intervention to increase oxygenation in the ARDS patient. Ease in attaining the prone position facilitates its utilization. The present invention reduces manpower required, increases caregiver efficiency, and improves line management. The present invention further provides a system solution through frame articulation.

Additionally, as described above chest binding may prove to be an effective method of alveolar recruitment. The present invention provides for ventilation of distant lung areas, portability, dynamic patient positioning, and alternative percussion and vibration.

Although the invention has been described in detail with reference to preferred embodiments, variations and modifications exist within the scope and spirit of the invention as described and defined in the following claims.

We claim:

1. A longitudinal rotation therapy method comprising the steps of: supporting a patient on a patient support surface including a back section, a seat section, and a leg section, said patient support surface further including a longitudinal axis and a transverse axis;

positioning said back section upwardly relative to said seat section wherein the chest of a patient is located above the thighs of the patient;

positioning said leg section downwardly relative to said seat section wherein the feet of the patient are located below the thighs of the patient;

rotating said patient support surface about said transverse axis in a first direction;

stopping rotation of said patient support surface upon reaching a first limit;

rotating said patient support surface about said transverse axis in a second direction opposite said first direction;

stopping rotation of said patient support surface upon reaching a second limit; and

repeating said rotating and stopping steps thereby providing oscillating rotational movement to said patient support surface.

2. The method of claim **1**, wherein said positioning steps comprise the steps of placing the patient in a weightless neutral body position.

3. The method of claim **2**, further comprising the step of providing a head section coupled to said back section, wherein said weightless neutral body position is defined when said head section is angled relative to said back section by an angle substantially equal to 25 degrees, said back section is angled relative to said seat section by an angle substantially equal to 128 degrees, and said seat section is angled relative to said leg section by an angle substantially equal to 133 degrees.

4. The method of claim **2**, wherein said first limit is defined when said patient support surface is in a Trendelenburg position.

5. The method of claim **4**, wherein said second limit is defined when said patient support surface is in a chair egress position.

6. The method of claim **2**, further comprising the step of providing first and second body retention and locating bladders, said first bladder supported by said back section and said second bladder supported by said seat section.

7. The method of claim **6**, wherein said first bladder is configured to prevent movement of the patient toward a head end of said patient support surface when said patient support surface is in a Trendelenburg position.

8. The method of claim **6**, wherein said second bladder is configured to prevent movement of the patient toward a foot end of said patient support surface when said patient support surface is in at least one of a chair position and a reverse Trendelenburg position.

9. The method of claim **1**, wherein said back section is positioned lower when said patient support surface reaches said first limit than when said patent support surface reaches said second limit.

10. The method of claim **1**, wherein said leg section is positioned lower when said patient support surface reaches said second limit than when said patent support surface reaches said first limit.

11. The method of claim **1**, wherein said back section is angled relative to said seat section by an angle substantially equal to 128 degrees, and said seat section is angled relative to said leg section by an angle substantially equal to 133 degrees.

12. The method of claim **11**, further comprising the steps of providing a head section coupled to said back section, and positioning said head section relative to said back section by an angle substantially equal to 25 degrees.

13. The method of claim **1**, further comprising the steps of providing a chest binding apparel apparatus adjacent the chest of the patient, and controlling said chest binding apparel apparatus to provide pressure against the chest of the patient.

14. The method of claim **13**, wherein said chest binding apparatus includes a plurality of air bladders.

15. The method of claim **14**, wherein said controlling step includes the step of supplying air to said plurality of air bladders.

16. The method of claim **15**, wherein said controlling step further includes the step of supplying air to said plurality of air bladders in response to the operation of a ventilator supplying air to the lungs of the patient.

17. A rotational therapy method comprising the steps of:

supporting a patient on a patient support surface including a longitudinal axis and a transverse axis, said patient including a head, a back, thighs, legs, an anterior side and a posterior side, said posterior side facing said patient support surface, said back angularly positioned in an anterior direction relative to said thighs by approximately 128 degrees, and said thighs angularly positioned in a posterior direction relative to said legs by approximately 133 degrees;

rotating said patient support surface about at least one of said longitudinal axis and said transverse axis in a first direction;

stopping rotation of said patient support surface upon reaching a first limit;

rotating said patient support surface about at least one of said longitudinal axis and said transverse axis in a second direction opposite said first direction;

stopping rotation of said patient support surface upon reaching a second limit; and

repeating said rotating and stopping steps thereby providing oscillating rotational movement to said patient support surface.

18. The method of claim **17**, wherein said rotating steps comprise rotating said patient support surface about said transverse axis.

19. The method of claim **17**, wherein said rotating steps comprise rotating said patient support surface about said longitudinal axis.

20. The method of claim **17**, wherein said head is angularly positioned in an anterior direction relative to said back by approximately 25 degrees.

21. The method of claim **17**, wherein said back section is positioned below a center position when said patient support surface reaches said first limit.

22. The method of claim 21, wherein said first limit is defined when said patient support surface is in a Trendelenburg position.

23. The method of claim 17, wherein said leg section is positioned below a center position when said patient support surface reaches said second limit.

24. The method of claim 23, wherein said second limit is defined when said patient support surface is in a chair egress position.

25. The method of claim 17, further comprising the step of providing first and second body retention and locating bladders, said first bladder supported by said back section and said second bladder supported by said seat section.

26. The method of claim 25, wherein said first bladder is configured to prevent movement of the patient toward a head end of said patient support surface when said patient support surface is in a Trendelenburg position.

27. The method of claim 25, wherein said second bladder is configured to prevent movement of the patient toward a foot end of said patient support surface when said patient support surface is in at least one of a chair position and a reverse Trendelenburg position.

28. The method of claim 17, further comprising the steps of providing a chest binding apparel apparatus adjacent the chest of the patient, and controlling said chest binding apparel apparatus to provide pressure against the chest of the patient.

29. The method of claim 28, wherein said chest binding apparatus includes a plurality of air bladders.

30. The method of claim 29, wherein said controlling step includes the step of supplying air to said plurality of air bladders.

31. The method of claim 30, wherein said controlling step further includes the step of supplying air to said plurality of air bladders in response to the operation of a ventilator supplying air to the lungs of the patient.

32. A longitudinal rotation platform apparatus comprising:

a base;

a patient support surface supported by said base and including a longitudinal axis and a transverse axis, said patient support surface further including a back section, a seat section configured to be angularly positioned upwardly relative to said back section by approximately 128 degrees, and a leg section configured to be angularly positioned downwardly relative to said seat section by approximately 133 degrees; and

a drive mechanism coupled to said patient support surface and configured to rotate said patient support surface about said transverse axis in oscillating movement.

33. The apparatus of claim 32, further comprising a control device coupled to said drive mechanism and configured to cause said drive mechanism to rotate said patient support surface in oscillating movement.

34. The apparatus of claim 32, further comprising castors coupled to said base.

35. The apparatus of claim 32, wherein said back section is pivotably coupled to said seat section, and said seat section is pivotably coupled to said leg section.

36. The apparatus of claim 32, further comprising a head section configured to be angularly positioned upward relative to back section by approximately 25 degrees.

37. The apparatus of claim 32, further comprising first and second body retention and locating bladders, said first bladder supported by said back section and said second bladder supported by said seat section.

38. The apparatus of claim 37, wherein said first bladder is configured to prevent movement of the patient toward a head end of said patient support surface, and said second bladder is configured to prevent movement of the patient toward a foot end of said patient support surface.

39. The apparatus of claim 32, further comprising a chest binding apparatus configured to provide pressure against the chest of the patient supported on said patient support surface.

40. The apparatus of claim 39, wherein said chest binding apparatus includes a plurality of air bladders coupled to an air supply.

41. The apparatus of claim 40, further comprising a ventilator configured to supply air to the lungs of the patient, said air supply configured to supply air to said air bladders of said chest binding apparatus in response to operation of said ventilator.

42. A longitudinal rotation platform apparatus comprising:

a base;

a patient support surface supported by said base and including a head end, a foot end, a longitudinal axis and a transverse axis, said patient support surface further including a back section, a seat section coupled to said back section, and a leg section coupled to said seat section;

a drive mechanism coupled to said patient support surface and configured to rotate said patient support surface about said transverse axis in oscillating movement;

a first body retention and locating bladder supported by said back section and configured to prevent movement of the patient toward said head end; and

a second body retention and locating bladder supported by said seat section and configured to prevent movement of the patient toward said foot end.

43. The apparatus of claim 42, wherein said back section, said seat section, and said leg section are positioned to support the patient in a weightless neutral body position.

44. The apparatus of claim 43, wherein said seat section is angularly positioned upwardly relative to said back section by approximately 128 degrees, and said leg section is angularly positioned downwardly relative to said seat section by approximately 133 degrees.

45. The apparatus of claim 42, further comprising a control device coupled to said drive mechanism and configured to cause said drive mechanism to rotate said patient support surface in oscillating movement.

46. The apparatus of claim 42, further comprising castors coupled to said base.

47. The apparatus of claim 42, wherein said back section is pivotably coupled to said seat section, and said seat section is pivotably coupled to said leg section.

48. The apparatus of claim 42, further comprising a head section configured to be angularly positioned upwardly relative to back section by approximately 25 degrees.

49. The apparatus of claim 42, further comprising a chest binding apparatus configured to provide pressure against the chest of the patient supported on said patient support surface.

50. The apparatus of claim 48, wherein said chest binding apparatus includes a plurality of air bladders coupled to an air supply.

51. The apparatus of claim 50, further comprising a ventilator configured to supply air to the lungs of the patient, said air supply configured to supply air to said air bladders of said chest binding apparatus in response to operation of said ventilator.

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