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(54) SYSTEMS FOR PATIENT TRANSFER, DEVICES FOR MOVEMENT OF A PATIENT, AND METHODS FOR TRANSFERRING A PATIENT

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A47C 21/06 (2006.01)
A61G 1/003 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC *A61G 7/1028* (2013.01); *A61G 7/103* (2013.01); *A61G 7/1034* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61G 7/1028; A61G 7/103; A61G 7/1034; A61G 7/1098; A61G 13/10; A61G 13/12;
(Continued)

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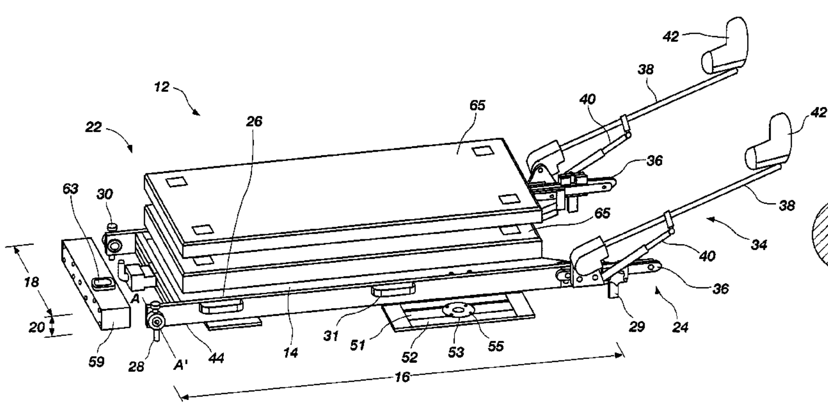
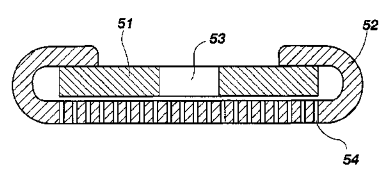
(57) **ABSTRACT**

A patient transfer sled has a support structure including at least one air cushion adjacent a major surface thereof. The air cushion includes a flexible material at least partially surrounding a rigid material, and a portion of the flexible material has a plurality of holes extending therethrough. Systems for patient transfer may include a support surface, such as a table, a patient transfer sled having at least one air cushion, and a source of pressurized air. Methods for moving a patient relative to a support surface include positioning a patient on a patient transfer sled having at least one air cushion, and inflating the air cushion with air to form a sheet of flowing air between the patient transfer sled and the support surface. The methods may be used, for example, to move a patient on an air film over a surface within a system.

20 Claims, 8 Drawing Sheets





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division of application No. 12/563,015, filed on Sep. 18, 2009, now Pat. No. 8,490,226.

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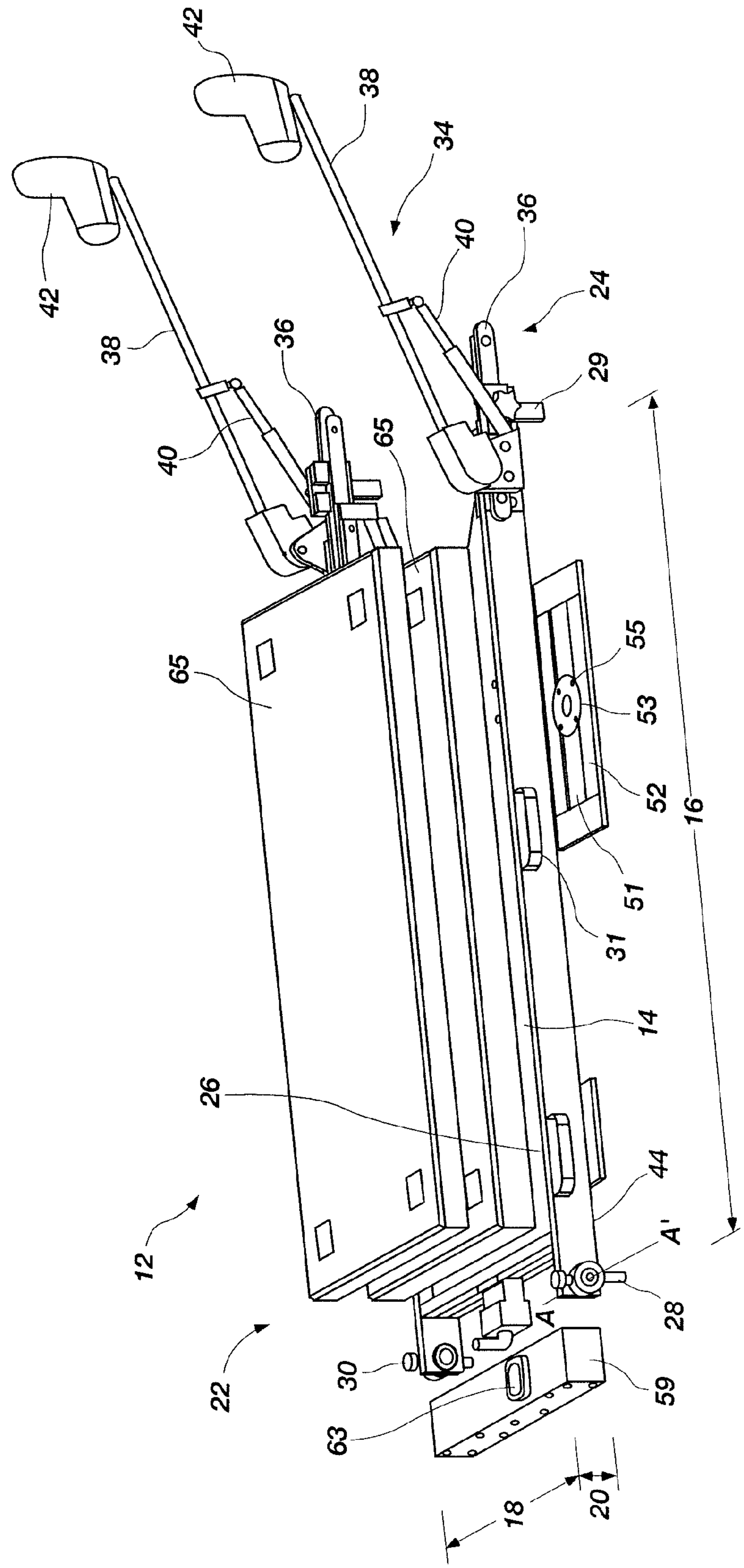
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FIG. 1

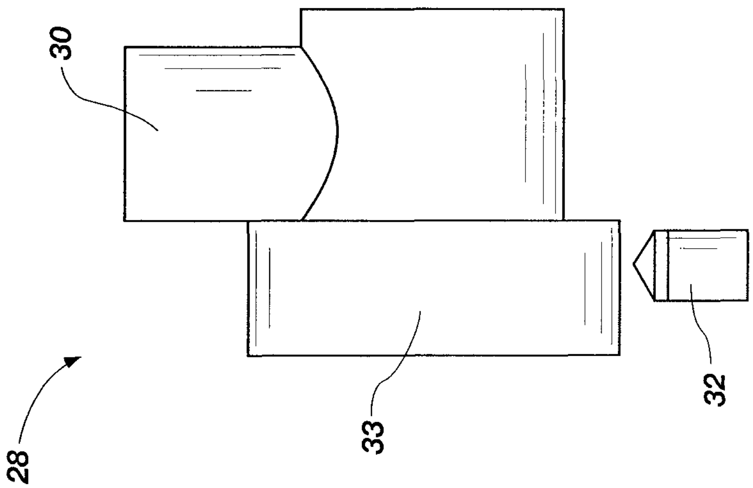

FIG. 2B

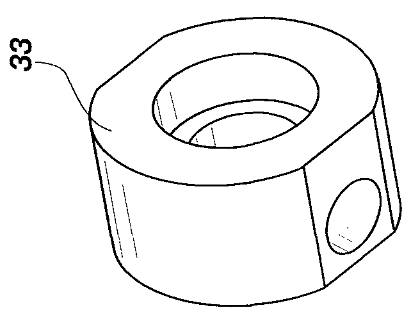

FIG. 2A

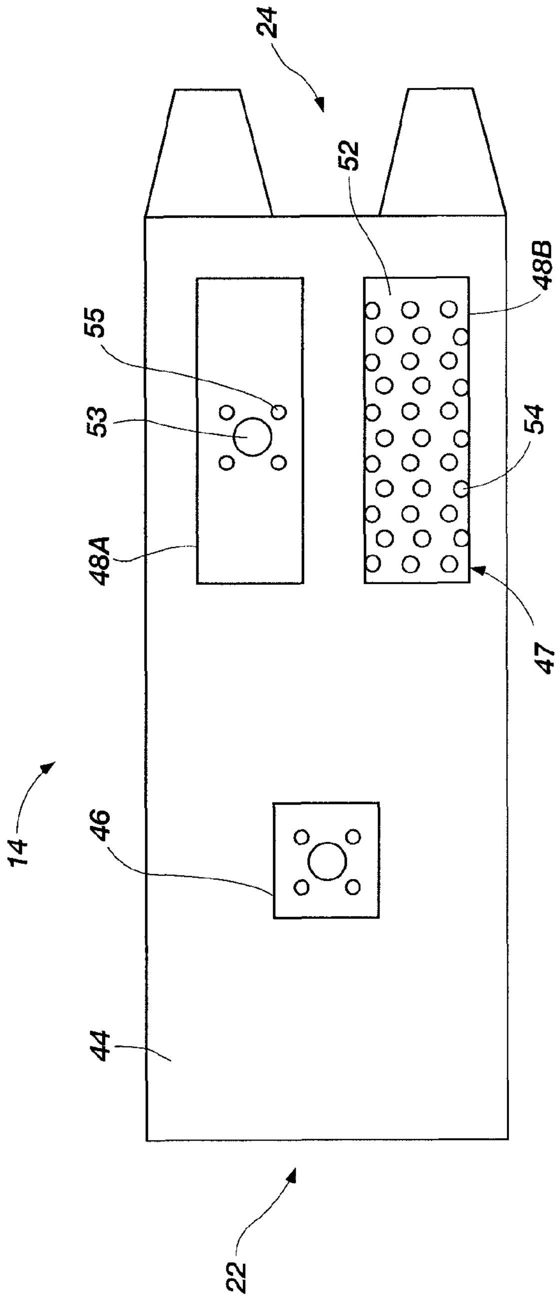

FIG. 3

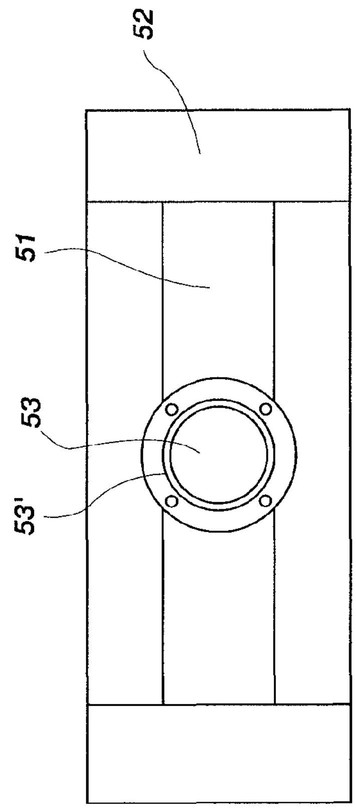

FIG. 4B

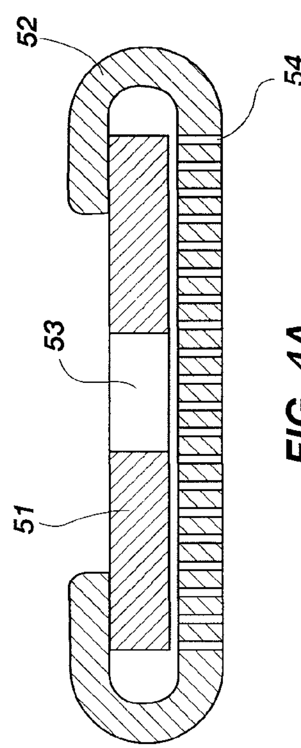

FIG. 4A

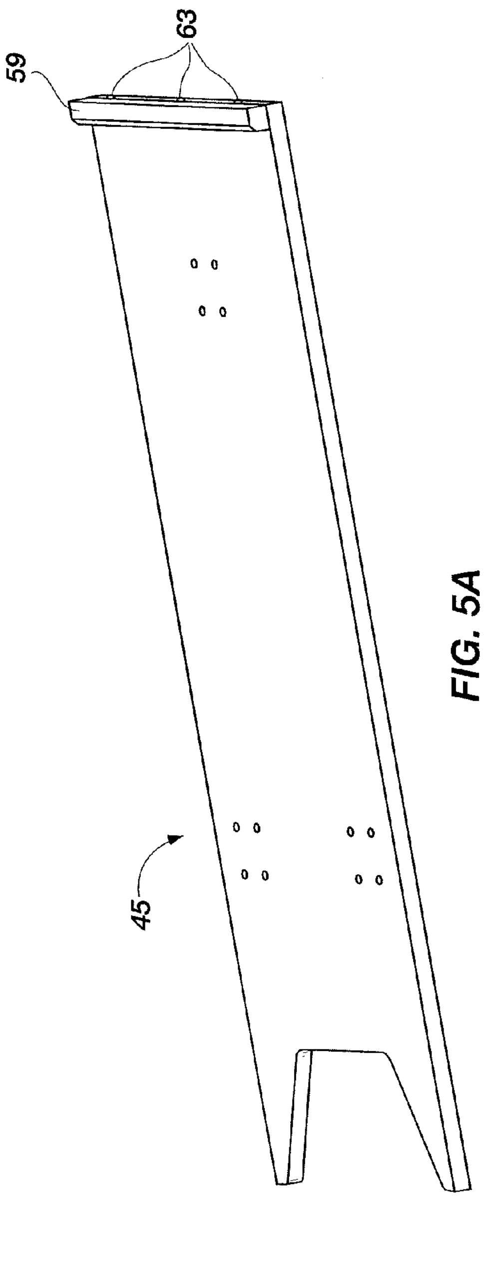

FIG. 5A

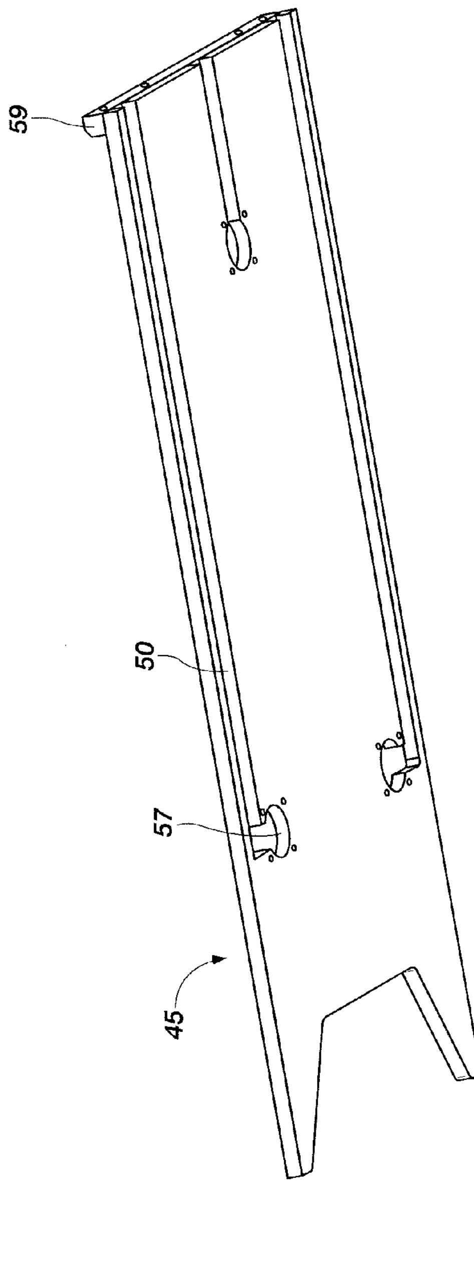

FIG. 5B

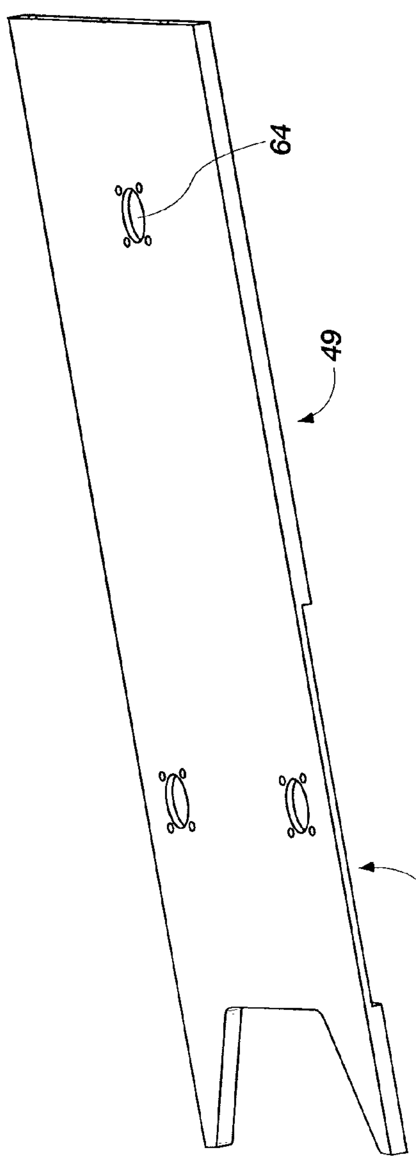

FIG. 6A

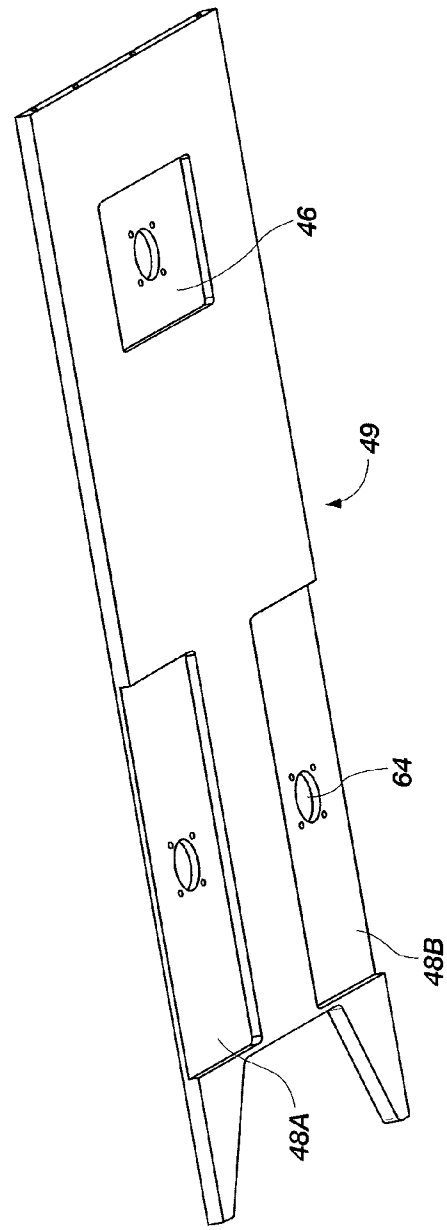

FIG. 6B

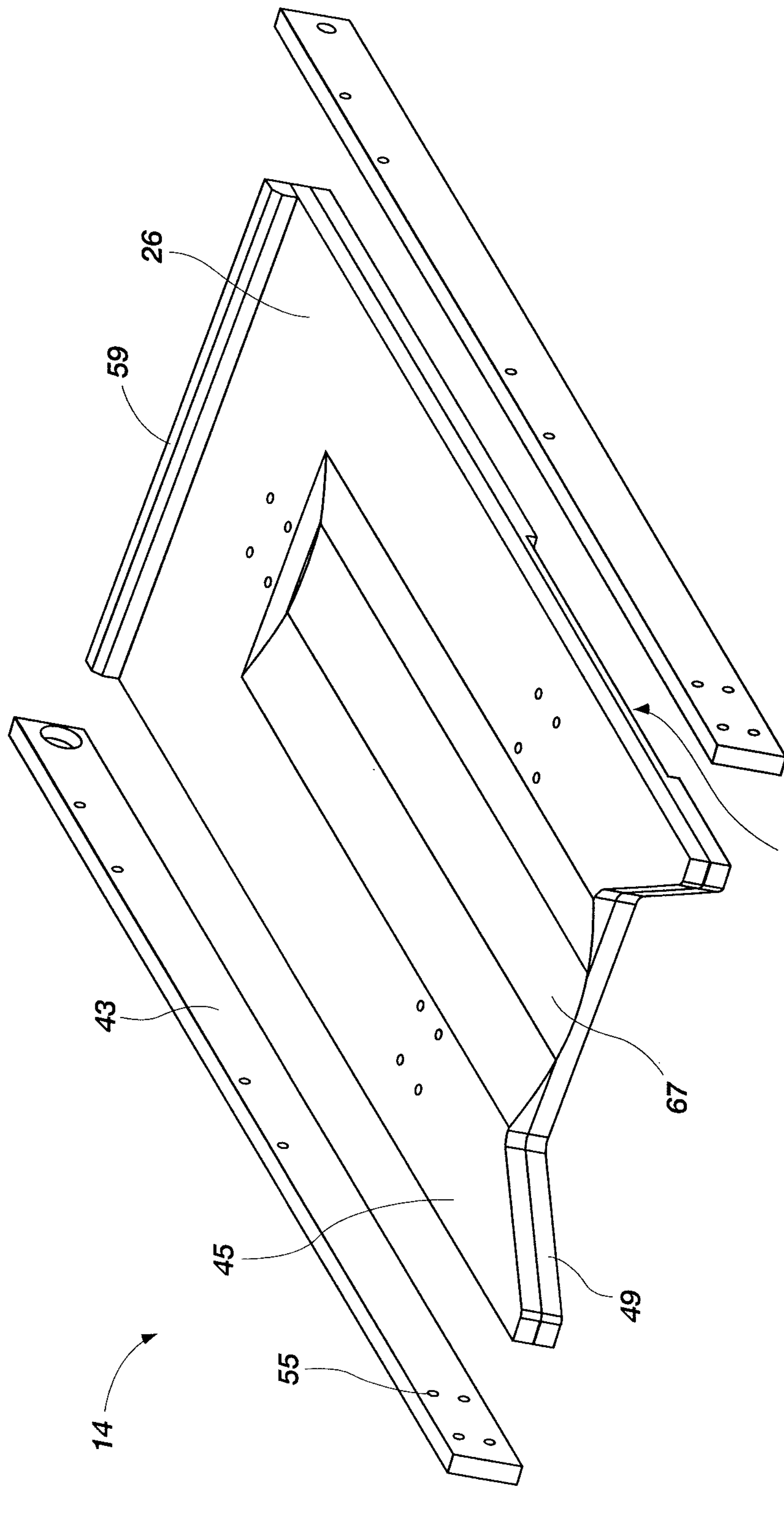

FIG. 7

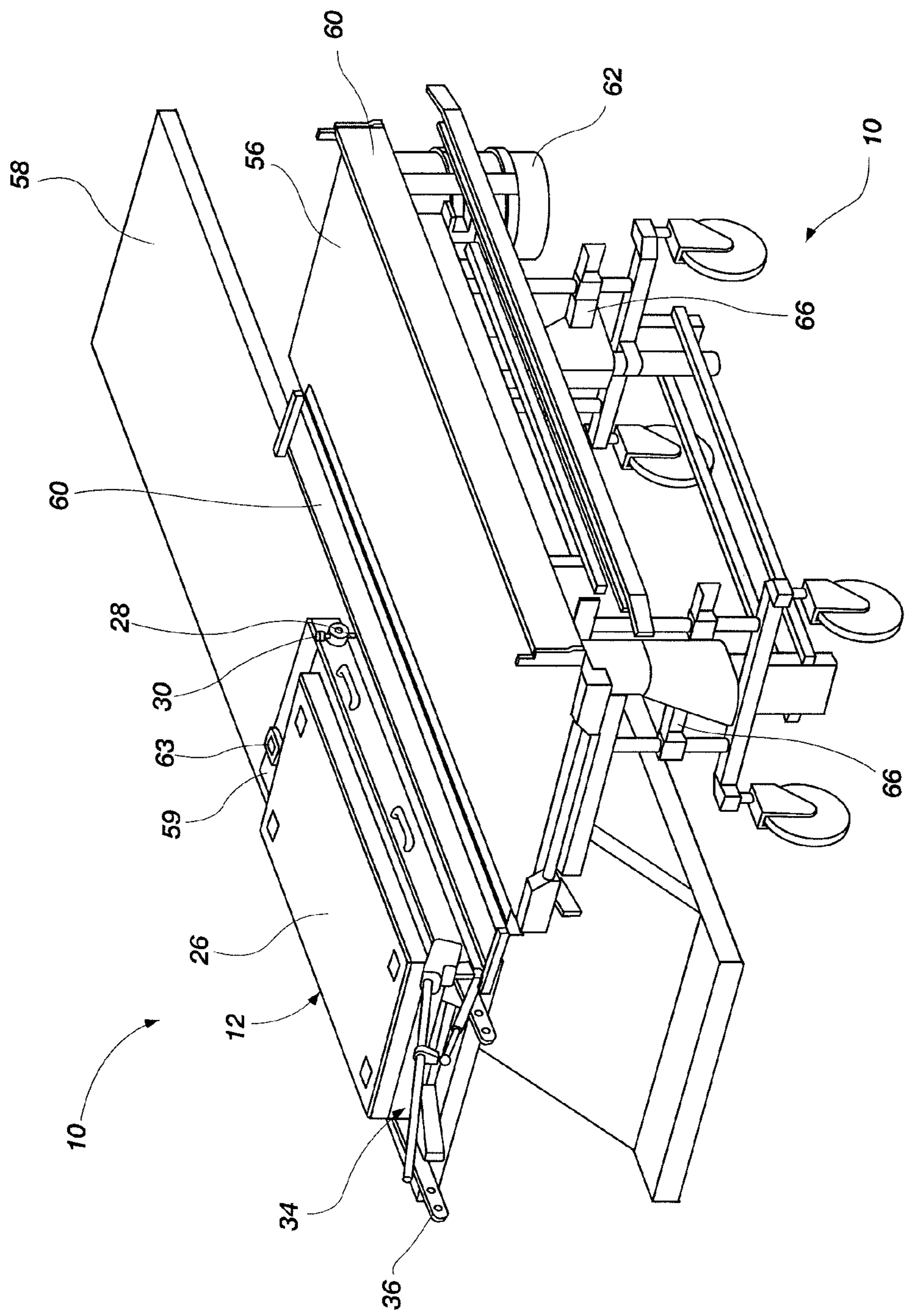

FIG. 8

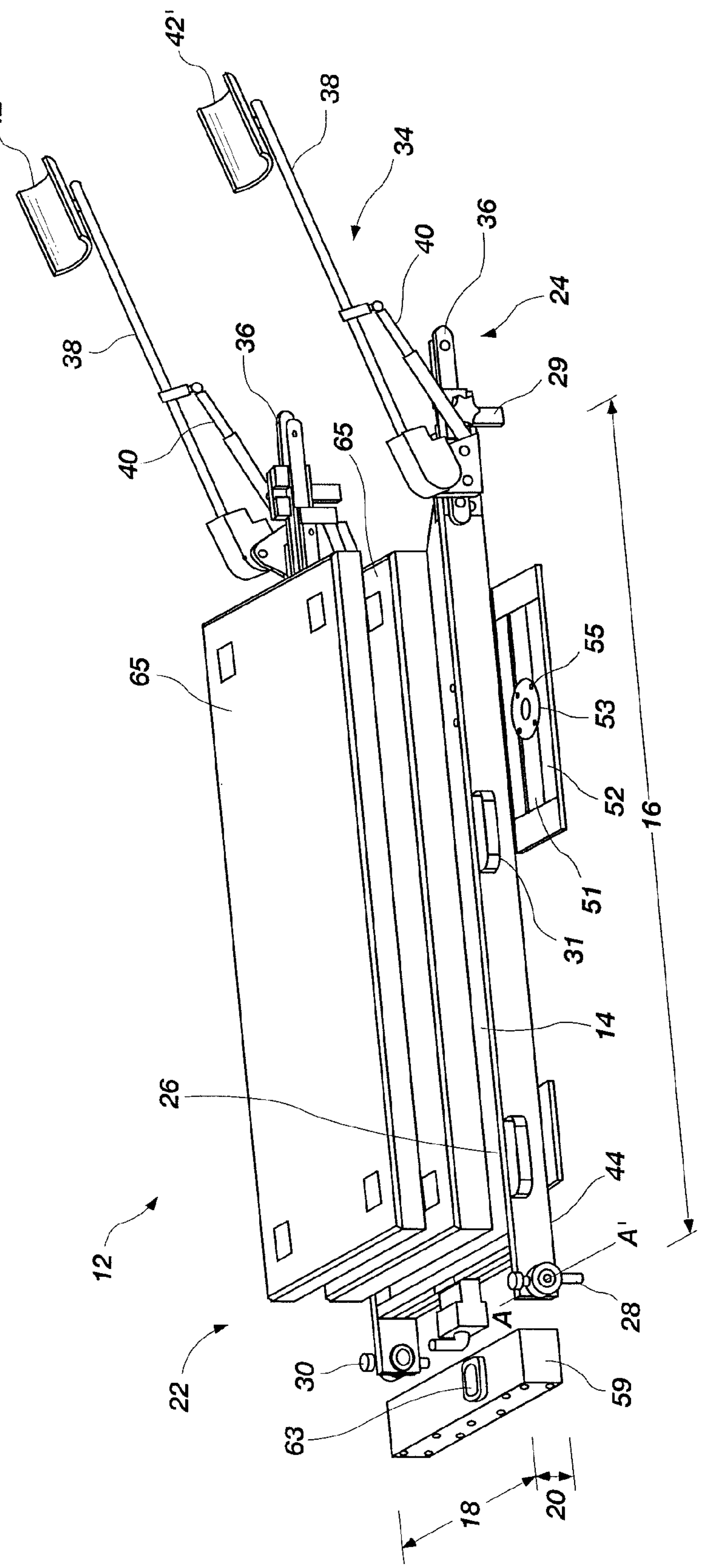
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FIG. 9

SYSTEMS FOR PATIENT TRANSFER, DEVICES FOR MOVEMENT OF A PATIENT, AND METHODS FOR TRANSFERRING A PATIENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/927,646, filed Jun. 26, 2013, now U.S. Pat. No. 8,640,279, issued Feb. 4, 2014, which is a divisional of U.S. patent application Ser. No. 12/563,015, filed Sep. 18, 2009, now U.S. Pat. No. 8,490,226, issued Jul. 23, 2013, which claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 61/098,663, filed on Sep. 19, 2008. The entire disclosures of each of these applications are incorporated herein by this reference.

FIELD

The present invention relates generally to systems, apparatuses, and methods for transferring patients from one location to another.

BACKGROUND

Apparatuses for positioning patients in a precise and immobilized manner are often used in treating patients using radiation application therapies, such as, for example, brachytherapy. In order to control the concentration of energy to specific localized areas of a patient; it is necessary to precisely position treatment applicators and ensure that patient movement does not occur during the application of the therapy. To facilitate application of energy to specific localized areas, the placement of treatment applicators may be verified prior to treatment. This verification may require movement of the patient between a hospital bed, gurney, and/or an imaging platform such as those used when operating a computed tomography (CT) scanning system or a magnetic resonance imaging (MRI) system. However, movement of the patient may undesirably alter the position of the treatment applicators.

It has been proposed to utilize air bearings in the transport of patients. Typical devices of this type employ a flexible perforated bottom sheet for defining a plenum chamber. When the chamber is filled with air, it initially lifts the load upwardly, then as air escapes through the perforations it creates an air bearing between the underlying support surface and the bottom of the perforated flexible sheet. A load may thus be supported by the thin film of pressurized air. An air bearing operates with essentially zero static and running friction which allows for the effortless, smooth movement of a load over a surface. Some devices for patient transfer employing an air bearing are currently known. Generally, these devices create the air bearing using an inflatable bladder. The bladder acts as a mattress upon which a patient lies. Pressurized air passes into and through the bladder creating an air film in the gap between the mattress and the surface underlying it.

In certain instances, the air bearing device may additionally have a semi-rigid backing member, for instance of cardboard. The semi-rigid backing member may be inserted into the plenum chamber to act as an air dispersion means. In another device, the air-chamber is formed of multiple sheets, both flexible and semi-rigid, which are bonded together.

Accordingly, there is a need in the art for improved systems, apparatuses, and methods for moving patients while at least substantially maintaining the positions and orientations of the patients.

BRIEF SUMMARY

In some embodiments, the present invention includes methods for moving a patient relative to a surface using a patient transfer sled having at least one air cushion. Air may be flowed into and through the air cushion causing it to inflate and form an air film between the patient transfer sled and the support surface. The patient transfer sled may be supported on the air film while being moved over the surface.

In additional embodiments, the present invention includes a patient transfer sled having a support structure with at least one pocket or recess formed therein. The patient transfer sled includes at least one air cushion partially disposed within the at least one pocket, and an air passageway extending through the support structure into the air cushion. The patient transfer sled may also have at least one leg support affixed to a base end of the support structure.

In further embodiments, the present invention includes systems for patient transfer that may include a support surface, such as a table, a patient transfer sled having at least one air cushion, and a source of pressurized air. The system may also have a bridge, comprising a substantially planar surface, which may close any surface gaps between adjacent support structures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded view of partially assembled components of an embodiment of a patient transfer sled for use in a patient transfer system in accordance with the present invention;

FIG. **2**A is a perspective view of a component of a locking device of the patient transfer sled shown in FIG. **1**;

FIG. **2**B is a side view of a guide member of the patient transfer sled shown in FIG. **1**;

FIG. **3** is a bottom view of an air cushion support structure of the patient transfer sled shown in FIG. **1**;

FIG. **4**A is a cross-sectional view of an air cushion of the patient transfer sled of FIG. **1**;

FIG. **4**B is a top view of the air cushion shown in FIG. **4**A;

FIG. **5**A is a plan view from a top surface of a fluid passageway layer of the patient transfer sled shown in FIG. **1**;

FIG. **5**B is a plan view from a bottom surface of a fluid passageway layer of the patient transfer sled shown in FIG. **1**;

FIG. **6**A is a plan view from a top surface of an air bearing frame of the patient transfer sled shown in FIG. **1**;

FIG. **6**B is a plan view from a bottom surface of an air bearing frame of the patient transfer sled shown in FIG. **1**;

FIG. **7** is an exploded view of partially assembled components of an embodiment of a support structure of the patient transfer sled shown in FIG. **1**;

FIG. **8** is a perspective view of an embodiment of a patient transfer system that includes the patient transfer sled of FIG. **1**; and

FIG. **9** is an exploded view of partially assembled components of an embodiment of another patient transfer sled for use in a patient transfer system in accordance with the present invention.

DETAILED DESCRIPTION

The present invention provides a method of patient transfer, components for use in a patient transfer system, as well as patient transfer systems that have advantages over currently known systems. It will be appreciated by those skilled in the art that the embodiments herein described, while illustrating certain specific and exemplary embodiments, are not intended to limit the invention or the scope of the appended claims. Those of ordinary skill in the art will also understand that various combinations or modifications of the disclosed embodiments may be made without departing from the scope of the invention.

As used herein, the term “upper end” means and includes the longitudinal end portion of a patient transfer sled that is proximal to the head of a patient when the patient is supported on the sled. As used herein, the term “base end” means and includes the longitudinal end portion of a patient transfer sled that is proximal to the feet of a patient when the patient is supported on the sled.

As used herein, the terms “top side” and “top surface” mean and include the side and surface, respectively, of a patient transfer sled adjacent the body of a patient when the patient is supported on the sled. As used herein, the terms “bottom side” and “bottom surface” mean and include the side and surface, respectively, of a patient transfer sled that are opposite the body of a patient when the patient is supported on the sled.

FIG. **1** is a partially exploded view of an embodiment of a patient transfer sled **12** in accordance with the present invention, which may be used in conjunction with a patient transfer system as described in further detail hereinbelow. As shown in FIG. **1**, the patient transfer sled **12** comprises a generally planar support structure **14**, upon which at least a portion of the body of a patient may be supported. The support structure **14** has an upper end **22** and a base end **24**. When a patient is positioned upon the patient transfer sled **12**, the head of the patient may rest upon a top surface **26**, near the upper end **22**. In some embodiments, the head of the patient may rest upon a cushion **65** (described further below) overlying the support structure **14**.

The support structure **14** may include a number of components, as described in further detail below, which may be comprised of a generally rigid material. By way of non-limiting example, the components of the support structure **14** may be formed from and comprise a metal material (e.g., a commercially pure metal or a metal alloy), a plastic material, or a composite material. For example, components of the support structure **14** may comprise a composite material having carbon fibers embedded within a matrix material, such as epoxy. In such embodiments, the components of the support may include a foam material surrounded by, or sandwiched between, relatively thin layers or “skins” of carbon fiber material. It is noted that carbon fiber materials may be nearly transparent to x-rays, and may minimize x-ray image artifacts when using the patient transfer sled **12** in accordance with embodiments of methods of the present invention, as described hereinbelow. In other embodiments, the components of the support structure **14** may comprise polyvinyl chloride (PVC), polycarbonate, an aromatic polyamide (e.g., KEVLAR®), polyethylene, or polytetrafluoroethylene (PTFE). It may be desirable to form the support structure **14** from a relatively light material to increase a load bearing capacity of the support structure **14**, as will be apparent from the description below.

The support structure **14** may have any suitable shape or geometry, such as, for example, a rectangular shape or an elliptical shape. The support structure **14** may comprise a substantially rectangular three-dimensional structure having a length **16**, a width **18**, and a height **20**. The length **16** may be substantially greater than the width **18**, and both the length **16** and width **18** may be greater than the height **20**. The length **16** of the support structure **14** may be, for example, from about one-hundred and twenty-five (125) centimeters to about two-hundred (200) centimeters, the width **18** of the planar support structure **14** may be, for example, from about sixty-one (61) centimeters to about ninety-one (91) centimeters, and the height **20** of the planar support structure **14** may be, for example, from about ten (10) centimeters to about fifty (50) centimeters. The overall height of the patient transfer sled **12** may, optionally, be increased by increasing the number of cushions **65** overlying the planar support structure **14**.

With continued reference to FIG. **1**, the patient transfer sled **12** may include a plurality of guides **28**, **29**, which may be disposed longitudinally along opposing lateral sides of the support structure **14**, and may be used to guide movement of the patient transfer sled **12** and/or to secure the patient transfer sled **12** in place on an underlying surface or structure. The guides **28**, **29** may be formed of and comprise a metal or metal alloy, such as, for example, aluminum or stainless steel. The plurality of guides **28**, **29** may comprise guides **28** proximal the upper end **22** of the patient transfer sled **12** and guides **29** proximal the base end **24** of the patient transfer sled **12**. The guides **28**, **29** may be substantially the same or, alternatively, may be substantially different.

In an embodiment illustrated in FIG. **1**, the guides **28** may be pivotally attached to the opposing lateral sides of the support structure **14**. The guides **28** may include a handle **30** that may be used to rotate the guides **28** relative to the support structure **14**. If such a configuration is employed, when the handle **30** is rotated approximately 90° relative to the plane of the support structure **14**, the corresponding guide **28** may be caused to pivot between a horizontal orientation and a vertical orientation. Each handle **30** and guide **28** may be rotated around a horizontal rotational axis, as shown in FIG. **1** by the line A-A'. For example, the guides **28** may be rotatable between a first position, in which each guide **28** extends downward beyond a bottom surface **44** of the support structure **14** and beside a lateral side of an underlying table (not shown in FIG. **1**), and a second position, in which each guide **28** is disposed laterally adjacent the support structure **14** above the bottom surface **44** thereof, such that the guides **28** do not interfere with any table or surface on which the support structure **14** may be resting. With the guides **28** in a first, vertical position, the sled **12** may be constrained to longitudinal movement along an underlying table disposed between the guides **28**, and the guides **28** may prevent the sled **12** from moving in a lateral or sideways direction relative to the underlying table.

As shown in FIGS. **2**A and **2**B, the guides **28** may include a wheel or collar **33** that rotates about the rotational axis that extends along line A-A' in FIG. **1**. The guides **28** may include a locking means for holding the guides **28** in one or both of the horizontal position and the vertical position and preventing undesirable rotation of the guides **28**. For example, each guide **28** may include a spring-loaded detent, such as a spring-loaded pin **32**, that is configured to be received in one or more openings or recesses in the collar **33** attached to each respective guide **28**. When the spring-loaded pin **32** is disposed within such an opening or recess in the collar **33**, the spring-loaded pin **32** may hold each guide **28** in a fixed rotational position. FIGS. **2**A and **2**B illustrate one example embodiment of a guide **28** that includes a handle **30** and a locking means for holding the guide **28** in a fixed position, but other configurations of guides may be used in embodiments of the present invention.

For example, another embodiment of the plurality of guides **28**, **29** is also depicted in FIG. **1**. The guides **29** may be adjustably mounted to the opposing lateral sides of the support structure **14**. Each guide **29** may comprise a flat blade portion and a portion that projects from the flat blade. The lateral sides of the support structure **14** may include an opening or slot (not shown) for receiving the projecting portion of the guides **29**. In other embodiments, the opening or slot for receiving the projecting portion of the guides **29** may be provided in brackets **36** (described further below). The projecting portion of the guides **29** may be configured to slide within the slot in a vertical direction relative to the plane of the support structure **14**. If such a configuration is employed, the projecting portion of each guide **29** may be movable from a first position, proximal a second major surface (e.g., the bottom surface **44**), to a second position proximal a first major surface (e.g., the top surface **26**) of the support structure **14**.

The guides **29** may include a locking means for holding the guide **29** in any vertical position within the slot. For example, the guides **29** may include a clamp to hold each guide **29** in a fixed vertical position. With the guides **29** secured in the first position the flat blade portion of each guide **29** extends downward beyond the bottom surface **44** of the support structure **14** and beside a lateral side of an underlying table (not shown in FIG. **1**). With the guides **29** secured in the second position the flat blade portion of each guide **29** is disposed adjacent the support structure **14** above the bottom surface **44** thereof, such that the guides **29** do not interfere with any table or surface on which the support structure **14** may be resting. With the guides **29** in the first vertical position, the sled **12** may be constrained to longitudinal movement along an underlying table disposed between the guides **29**, and the guides **29** may prevent the sled **12** from moving in a lateral or sideways direction relative to the underlying table. Other configurations of guides may also be used in embodiments of the present invention.

With continued reference to FIG. **1**, additional handles **31** may be provided on one or more lateral sides of the support structure **14**. Such additional handles **31** may be used to move the sled **12** during patient transfer.

As shown in an embodiment in FIG. **1**, the patient transfer sled **12**, optionally, may include one or two leg supports **34**. The leg supports **34** may extend from the support structure **14**. The support structure **14** may have one or more brackets **36** configured to connect the leg supports **34** to the support structure **14**. The brackets **36** may be attached to the base end **24** of the patient transfer sled **12**. The leg supports **34** may comprise a pair of similar, separate, supports **34** attached to brackets **36** on opposing lateral sides of the base end **24** of the support structure **14**.

The leg supports **34** may include a weight bearing rod **38** and a separate damper **40** that is connected to the weight bearing rod **38** such that the damper **40** may slide relative to the rod **38** to accommodate the varying leg lengths of patients to be supported by the sled **12**. A foot rest **42** or other body support structure may be connected to each of the weight bearing rods **38**. The foot rests **42** may be boots for receiving the feet of a patient therein while the patient is resting in a supine position on the sled **12**. Alternatively, the foot rests **42** may be stirrups **42'**, shown in FIG. **9**, or any other device suitable for supporting the feet or legs of a patient. One embodiment of the leg support **34**, weight bearing rod **38**, and damper **40** for fastening to bracket **36** mounted on the support structure **14** is shown in detail in FIG. **1**, although other structures and configurations also may be employed in embodiments of patient transfer sleds of the present invention.

In additional embodiments, a single support structure (not shown) may be used to support both legs of a patient in an elevated position as the patient is resting on the patient transfer sled **12**. The single support may have a flat surface upon which a patient's feet or legs may be supported. In still other embodiments, the legs of a patient may be entirely supported by the patient transfer sled **12** (i.e., without the use of optional leg supports **34**). The patient transfer sled **12** may be longer in such embodiments, so as to support the entire length of the body of a patient.

FIG. **1** depicts a top perspective view of the support structure **14** of the patient transfer sled **12**. As shown in FIG. **1**, the support structure **14** has a major top surface **26** and a second, opposed, generally parallel and planar major bottom surface **44** that is opposite the top surface **26**. The top surface **26** may be at least substantially planar. In other embodiments, the top surface **26** may conform to a patient's body. In still further embodiments, as described in further detail below, the top surface **26** of the support structure **14** may have a recess or depression **67** (FIG. **7**). Optionally, one or more cushions **65** may be provided over the top surface **26** of the support structure **14** to provide patient comfort. The one or more cushions **65** may deform when the body of a patient is supported thereon, such that the one or more cushions **65** conform to the recess **67** in the support structure **14**. The top surface **26** and the one or more cushions **65** may optionally be configured to have rounded corners and edges for patient comfort. The top surface **26** and the one or more cushions **65** also may be covered or printed with a distinguishing pattern.

The guides **28**, **29** as shown in FIG. **1**, are in a locked, vertical position (the first position described hereinabove), which may prevent the patient transfer sled **12** from moving in a lateral direction. The top surface **26** may also have straps or restraints (not shown) for holding a patient in a desired location over the top surface **26**.

FIG. **3** is a bottom plan view of the support structure **14** of the patient transfer sled **12**. As shown in FIG. **3**, the bottom surface **44** thereof may have at least one pocket or recess **46** formed or otherwise provided therein. In some embodiments, the support structure **14** may include a plurality of pockets formed or otherwise defined therein. As an example, the support structure **14** may have a first pocket **46**, a second pocket **48**A, and a third pocket **48**B, as shown in FIG. **3**. Further, the first pocket **46** may be located near the upper end **22** of the support structure **14**, and each of the second pocket **48**A and the third pocket **48**B may be located near the base end **24**. As shown in FIG. **3**, in some embodiments, one pocket (e.g., the first pocket **46**) may have a smaller area than another pocket (e.g., the second pocket **48**A and the third pocket **48**B). The pockets **46**, **48**A, **48**B may have any geometry such as, for example, a rectangular shape, a circular shape, or a diamond shape. In addition, the pockets **46**, **48**A, **48**B may have the same geometry, or they may have different geometries. As shown in FIG. **3**, an air cushion **47** may be disposed within each of the pockets **46**, **48**A, **48**B, although only one air cushion **47** is shown in FIG. **3** and is disposed in the third pocket **48**B.

The cushions **47** may be used to form one or more air bearings under the sled **12**, as discussed in further detail below. A simplified schematic illustration of an example embodiment of a cushion **47** is shown in FIGS. **4**A and **4**B. As shown therein, a flexible material **52** may be affixed to a generally thin, rigid sheet **51**. The flexible material **52** may be a vinyl fabric material. In other embodiments, the flexible material **52** may be a rubberized fabric material. Further, the flexible material **52** may have a plurality of holes **54** extending therethrough to allow pressurized air within the air cushion **47** (in an interior space defined between the flexible material **52** and the sheet **51**) to flow out from the cushion **47** through the holes, thereby forming a sheet or film of flowing air between the flexible material **52** and an underlying surface.

The thin rigid sheet **51** may be placed onto a portion of the flexible layer **52**, and the flexible layer may be partially folded over the edges of the rigid sheet **51** and adhered to a back side of the rigid sheet **51**, as shown in FIGS. **4**A and **4**B. Furthermore, the rigid sheet **51** may comprise an air inlet **53** which allows air to flow from a fluid or air passageway **50** (FIG. **5**B) within the support structure **14** into the air cushion **47**. In some embodiments, the air inlet **53** may include a one-way valve **53'** (FIG. **4**B) that allows air to enter the air cushions **47**, but does not allow air to escape back into the air passageway **50**. The one-way valve **53'** facilitates gradual, rather than sudden, deflation upon loss of air flow into the air cushion **47**. The flexible material **52** may be attached to the rigid sheet **51** such that an interior space is provided between the rigid sheet **51** and the flexible material **52** when filled with air. In other words, the flexible material **52** may not conform tightly to the lateral side and/or bottom surfaces of the rigid sheet **51**.

Referring again to FIG. **3**, the air cushions **47** provide a plurality of air bearings under the patient transfer sled **12**. The number of air bearings formed is equal to the number of air cushions **47** included in the sled **12**. Two air bearings may be formed in which one is designed to hold a larger volume of air than the other. Alternatively, a plurality of air bearings may be designed to hold the same or varying volumes of air. As an example, the first pocket **46** may have the dimensions of 15.5 inches by 15.5 inches, and each of the second pocket **48**A and the third pocket **48**B may have dimensions of 15.5 inches by 9.5 inches. As another example, the first pocket **46** may have the dimensions of 6 inches by 8 inches, and each of the second pocket **48**A and the third pocket **48**B may have dimensions of 16 inches by 6 inches. The dimensions of the air cushions **47** will at least partially determine the amount of weight that may be supported by the patient transfer sled **12**. Each of the air cushions **47** may be configured to have the same lift value or capacity. In additional embodiments, one or more of the air cushions **47** may be configured to have a different lift value or capacity relative to one or more of the other air cushions **47**.

It is understood that the air cushions **47** may be formed in a variety of configurations to satisfy particular applications. By way of example and not limitation, a single cushion **46** may be provided near the upper end **22** of the planar support structure **14** (i.e., adjacent the neck/head region of a patient lying thereon), and at least two cushions **48**A, **48**B may be positioned longitudinally near the base end **24** of the support structure **14** (i.e., adjacent the lower back region of a patient lying thereon). If the support structure **14** is configured to support the legs of a patient without using the optional leg supports **34**, additional air cushions may be provided and configured to lift the region of the support structure **14** supporting the legs of the patient.

The support structure **14** may comprise a plurality of separate layers that may be stacked over one another and secured together to form the support structure **14**. Such layers are described in further detail below with reference to FIGS. **5**A through **6**B.

Referring to FIGS. **5**A and **5**B, the support structure **14** may comprise at least one fluid passageway layer **45**. FIG. **5**A is a top view of an embodiment of the at least one fluid passageway layer **45** and FIG. **5**B is a bottom view of an embodiment of the at least one fluid passageway layer **45**. As shown in an embodiment in FIGS. **5**A and **5**B, the at least one fluid passageway layer **45** may comprise a layer of material having a plurality of recesses or channels formed therein to define fluid passageways **50** that lead to and converge at regions **57** at which air flowing through the fluid passageways **50** may enter the air cushions **47**. A manifold **59** may be provided at one end of the fluid passageway layer **45** (e.g., upper end **22**). A plurality of air portals **63** may lead from the exterior of the sled **12** to the manifold **59**, and the manifold **59** may provide fluid communication between the air portal **63** and each of the fluid passageways **50**. In this configuration, a supply of pressurized gas (e.g., air) may be connected to each air portal **63** such that gas will flow into the air inlet **53**, through the manifold **59** to the fluid passageways **50**, and to the converging regions **57**. The support structure **14** may include multiple fluid passageway layers **45** of varied configurations. The at least one fluid passageway layer **45** may comprise the top surface **26** of the support structure **14**.

The manifold **59** may include an adjustable valve or damper (not shown) that allows the amount of air flow being supplied to each of the converging regions **57** to be adjusted. In other words, the manifold **59** may include a valve or damper that may be adjusted to provide more air flow to the first pocket **46** and less air flow to each of the second pocket **48**A and the third pocket **48**B, or vice versa. The valve or damper may be adjusted to provide the same or varying flows to each of the plurality of air pockets **46**, **48**A, **48**B, regardless of the number or configuration of the air pockets **46**, **48**A, **48**B. Such a valve or damper may be desirable to allow the sled **12** to be properly balanced and supported when a patient is resting thereon.

Referring to FIGS. **6**A and **6**B, the support structure **14** also may comprise at least one air bearing frame **49**, which may be mounted under and secured to at least one of the fluid passageway layers **45** (FIGS. **5**A and **5**B). FIG. **6**A illustrates a top view of an embodiment of an air bearing frame **49**, and FIG. **6**B illustrates a bottom view of an embodiment of an air bearing frame **49**. The air bearing frame **49** may have one or more openings extending partially therethrough that correspond to and form the pockets **46**, **48**A, and **48**B of the support structure **14**. The air bearing frame **49** may comprise the bottom surface **44** of the support structure **14**. The air bearing frames **49** define the depths of the pockets **46**, **48**A, and **48**B into which the air cushions **47** are disposed.

The air bearing frame may have at least one aperture **64** extending therethrough positioned adjacent the converging regions **57** of the fluid passageway layers **45** (FIGS. **5**A and **5**B). When the air bearing frame **49** is secured to the at least one fluid passageway layer **45**, the air bearing frame **49** may be used to seal the fluid passageways **50** in the fluid passageway layer **45** such that air flowing through the fluid passageways **50** cannot escape therefrom in any significant volume at any location other than at the converging regions **57** and through apertures **64**, into the air cushions **47**. The rigid sheets **51** of the air cushions **47** may be attached to the air bearing frame **49** such that the apertures **64** are aligned with the air inlets **53** in the rigid sheets **51**, which lead into the interior regions of the air cushions **47**.

FIG. **7** depicts an embodiment of the support structure **14** following mounting of the fluid passageway layer **45** to the air bearing frame **49**. Optionally, side rails **43** may be mounted or secured to the support structure **14**. In some embodiments, the top surface **26** of the support structure **14** may be substantially planar. In other embodiments the top surface **26** of the support structure **14** may be irregular. As shown in an embodiment in FIG. **7**, a portion of the fluid passageway layer **45** and a portion of the air bearing frame **49** may be removed to provide an opening or recess **67**. In other embodiments, a portion of either the fluid passageway layer **45** or a portion of the air bearing frame **49** may be removed to provide the recess **67**. The recess **67** may have any suitable shape or geometry, such as, for example, a rectangular shape or an elliptical shape. The recess **67** may have a curved bottom surface and sidewalls or, alternatively, may have flattened surfaces.

As shown in an embodiment in FIG. **3**, the air cushion **47** may be attached within a pocket **48**B in the support structure **14**. In an embodiment, the air cushion **47** is fastened within the pockets **46**, **48**A, and **48**B around a periphery of the air inlet **53**. Fasteners **55** may be any fastener conventional in the art which is capable of holding the air cushion **47** against the support structure **14** when the air cushion **47** is exposed to pressurized air. As air passes through the fluid passageway **50**, and out of air inlet **53**, the flexible material **52** may inflate with air. As previously mentioned, the air cushions **47** may include a flexible layer **52** having a plurality of holes **54** formed therethrough, which allow air to pass from an interior cavity, encompassed by the flexible layer **52** and the rigid sheet **51**, to the exterior of the cushions **47**, thereby creating a film or sheet of flowing air underneath the patient transfer sled **12**. This film or sheet of flowing air provides an air bearing between the patient transfer sled **12** and any surface upon which it rests, and may provide for at least substantially frictionless movement of the sled **12** across the underlying surface.

A pressurized air source **62**, such as a blower (shown in FIG. **8**), may be used to supply pressurized air to one or more of the air portals **63** and the fluid passageways **50** of the patient transfer sled **12**. The air source **62** may comprise any conventional blower that is capable of supplying pressurized air to the patient transfer sled **12**, such as ones manufactured and sold by Nilfisk, Model GM 80, which provides an air flow of approximately 87 cubic feet per minute at 4 psi. An air supply hose may be used to connect the pressurized air source to one or more air portals **63**.

In some embodiments, a pressure regulator valve (not shown) may be provided between the pressurized air source **62** and one or more air portals **63** to allow an operator to control the pressure of the air within the air cushions **47** and, hence, the rate at which air flows out from the air cushions **47**. As an example, the pressure regulator valve may include a bypass valve that allows an adjustable amount of air to escape out from the bypass valve, instead of flowing into the fluid passageways **50** and the air cushions **47**. In other words, as more air is allowed to escape from the bypass valve, less air will flow into the air cushions **47** of the patient transfer sled **12**. Such bypass valves are commercially available. Alternatively, the pressure of air within the air cushions **47** may be controlled by other means. For example, the air source **62** may include a variable speed control that allows for adjustment of, for instance, blower speed, air pressure, and lift rate, when inflating and deflating the air cushions **47**. The variable speed control may be incorporated into the air source **62** or may comprise a separate device in communication with the air source **62**.

FIG. **8** depicts an embodiment of a patient transfer system **10** in accordance with the principles of the present invention. The patient transfer system **10** provides for the transfer of a patient between adjacent supporting structures. System **10** may include a patient transfer sled **12**, which may be configured to couple to a patient transport gurney or diagnostic imaging table or any other solid surface used to support a patient. The patient transport gurney, or other solid surface used to support a patient, may include lockable wheels. Further, a series of guides **28**, **29** located laterally along opposing lengths of the patient transfer sled **12** may be used to couple the components of the system and prevent the accidental displacement of the patient transfer sled **12** from an underlying support surface, for example patient worktable **56** or diagnostic table **58**. The patient transfer sled **12** of system **10** may include a bracket **36** at the base end **24** to receive a cantilevered leg support **34** (FIG. **1**). In addition, the patient transfer sled **12** may have at least one air bearing formed therein. The air bearing is defined by at least one pocket **46**, **48**A, **48**B formed in the support structure **14**, with air cushions **47** attached to the interior of the one or more pockets **46**, **48**A, and **48**B and having a plurality of holes **54** extending through the flexible material **52**. As a result of the air bearing, the patient transfer sled **12** is capable of reduced friction or substantially frictionless movement over the other components in the system.

The patient transfer system **10** also includes a patient worktable **56** that may be a patient transport gurney, or similar apparatus. The patient worktable **56** may be adapted to have a bridge **60** connected thereto. The bridge **60** operates to close any surface gaps between the adjacent support structures since gaps might defeat the air bearing. The bridge **60** may be affixed to the patient worktable **56**, by way of example and not limitation, using a hinge, so that the bridge **60** may be oriented either perpendicular or parallel to the patient worktable **56**. Alternatively, in some embodiments, the bridge **60** may be affixed to a diagnostic table **58**, for example. In still other embodiments, the bridge **60** may be a free-standing apparatus that may be positioned between the worktable **56** and the diagnostic table **58** to provide a continuous surface therebetween. The patient worktable **56** may, optionally, be adapted to have at least one stabilization mechanism **66** connected thereto. The stabilization mechanism **66** may prevent vertical movement of the surface of the worktable **56** during patient transfer. The stabilization mechanism **66** may facilitate providing adjacent support structures at the same elevation throughout patient transfer.

The patient transfer system **10** also may include a diagnostic table component **58**. The patient may be transferred between the patient worktable **56** and the diagnostic table **58** on patient transfer sled **12**. The diagnostic table **58** may be the support structure associated with an imaging machine like a CT or MRI. It may also include any other patient support apparatus. By way of non-limiting example, the patient transfer sled **12** may be used to move a patient between two tables or support structures rather than between a table or support structure and a diagnostic machine.

In addition, the patient transfer system **10** includes an air source **62** as described above. In an embodiment the patient worktable **56** may, by way of example and not limitation, be in combination with an air source **62** for supplying a high volume, low pressure amount of air to patient transfer sled **12**. In other embodiments, the air source **62** may be in combination with the diagnostic table **58**. In yet another embodiment, the air source **62** may be incorporated into the walls of the medical facility with a connection valve available in each room, which simply requires attachment of the air supply line. During operation of the patient transfer system **10**, the air source **62** is continuously connected to the patient transfer sled **12**; consequently, the air supply line may be produced so as to accommodate a distance between the air source **62** and the sled **12** following movement of the sled.

Also disclosed are methods of using the patient transfer sled **12**, and, optionally, a patient transfer system **10**, as described above, for transferring a patient for the purpose of medical treatment. A patient worktable **56**, which may comprise a portable patient transport cart, is provided. With the handles **30** of the sled **12** rotated such that the guides **28** do not project downwards beyond the bottom surface **44** of the sled **12**, and guides **29** clamped above the bottom surface **44** of the sled **12**, the patient transfer sled **12** may be placed on the patient worktable **56**, having stabilizer mechanisms **66** engaged (when present). Prior to treatment, a patient is placed in the lithotomy position (a position with the patient lying on his back, knees bent, thighs apart) on the support structure **14**, the legs of the patient optionally being supported by the leg supports **34**. Alternatively, the patient may be placed on the support structure **14**, which may include one or more cushions **65**, in any position for facilitating medical treatment.

Once the patient is securely positioned atop the patient transfer sled **12**, various medical treatments may be undertaken. By way of non-limiting example, the treatment may be implantation of brachytherapy perineal implants for the treatment of prostate or cervical cancer. In some embodiments, such medical treatment will necessitate the transfer of a patient to a different support structure so that additional therapies or monitoring may occur. By way of non-limiting example, the patient may be transferred to a CT or MRI machine. Typically these diagnostic machines will include a table for a patient to rest upon. Accordingly, a patient may be moved from a patient worktable **56** to a diagnostic table **58** using the patient transfer sled **12** without disturbing implant placement.

To facilitate moving the patient, an air source **62** is connected to the fluid passageway **50** of the patient transfer sled **12**. In an embodiment, the air source **62** may be a portable blower connected to a patient transport cart. In other embodiments, the air source **62** may comprise a fixed air blower or air compressor that is mounted in a room, an air supply line that is integral to the wall structure, or any other air source capable of supplying air to the one or more fluid passageways **50**.

When the air supply is connected to at least one fluid passageway **50** the air cushions **47** disposed within the pockets are inflated and air passes through holes **54** to form an air film between the patient transfer sled **12** and the patient worktable **56**. The patient is then moved from the patient worktable **56** to, for example, a diagnostic table **58**, by positioning the patient worktable **56** adjacent the diagnostic table **58**, and positioning the bridge **60** so as to bridge any gap between the worktable **56** and the diagnostic table **58**, thereby providing an at least substantially continuous surface therebetween, as shown in FIG. **8**. The patient transfer sled **12** then may be slid upon the air film or films generated by the air cushions **47** off from the worktable **56**, over the bridge **60**, and onto the diagnostic table **58**. The patient transfer sled **12** and, consequently, the patient thereon may be positioned over the diagnostic table **58** by, for example, one or more technicians grasping handles **31** and applying a slight force in the desired direction of movement.

Following movement of the patient to the desired location, each handle **30** may be rotated so as to cause the guides **28** to project downward beyond the bottom surface **44** of the sled **12**. Similarly, guides **29** may be lowered into a second position so as to project downward beyond the bottom surface **44** of the sled **12**. In this configuration, the guides **28**, **29** may project downward such that they are laterally disposed adjacent to side surfaces of the diagnostic table **58**, thereby confining the diagnostic table **58** between the guides **28**, **29** on opposing sides of the patient transfer sled **12** to prevent the sled **12** from unintentionally sliding sideways off from the diagnostic table **58**.

Once the sled **12** and the patient are disposed on the diagnostic table **58**, the sled **12** and patient may be slid on the air bearings of the sled **12** longitudinally along the diagnostic table **58** into a location at which diagnostic methods may be performed, such as, for example, into the imaging field of a CT or MRI machine.

The process described above may be reversed to transfer the patient from the diagnostic table **58** back to the patient worktable **56**.

In additional embodiments, laterally extending pockets could be provided in the surfaces of the worktable **56**, bridge **60**, and diagnostic table **58**, such that the guides **28**, **29** could be positioned to project downward into the pockets as the patient transfer sled **12** is slid off from the worktable **56**, over the bridge **60**, and onto the diagnostic table **58**. In other words, the guides **28**, **29** could also be used to guide lateral movement of the patient transfer sled **12**, in addition to longitudinal movement of the patient transfer sled **12**.

While the present invention has been described herein with respect to certain preferred embodiments, those of ordinary skill in the art will recognize and appreciate that it is not so limited. Rather, many additions, deletions and modifications to the preferred embodiments may be made without departing from the scope of the invention as hereinafter claimed. In addition, features from one embodiment may be combined with features of another embodiment while still being encompassed within the scope of the invention as contemplated by the inventors.

What is claimed is:

1. A patient transfer sled, comprising:

a generally planar support structure having a first major surface for supporting a patient thereon and an opposing second major surface;

at least one air cushion adjacent the second major surface of the generally planar support structure, wherein the at least one air cushion comprises a flexible material at least partially surrounding a rigid material, and wherein a portion of the flexible material has a plurality of holes extending therethrough.

2. The patient transfer sled of claim **1**, wherein the at least one air cushion comprises at least one air inlet.

3. The patient transfer sled of claim **2**, further comprising a source of pressurized air coupled to the at least one air inlet and configured to supply air to the at least one air cushion.

4. The patient transfer sled of claim **3**, wherein the source of pressurized air comprises an air blower.

5. The patient transfer sled of claim **4**, wherein the air blower is in communication with a variable speed control.

6. The patient transfer sled of claim **2**, wherein the at least one air inlet is configured to allow air to enter the at least one air cushion without air escaping from the at least one air cushion through the at least one air inlet.

7. The patient transfer sled of claim **1**, further comprising at least one patient support cushion over the generally planar support structure.

8. The patient transfer sled of claim **1**, wherein the flexible material of the at least one air cushion comprises a rubberized fabric.

9. The patient transfer sled of claim **1**, wherein the flexible material of the at least one air cushion comprises vinyl.

10. The patient transfer sled of claim **1**, further comprising a pressure valve for regulating a pressure of air within the at least one air cushion.

11. The patient transfer sled of claim **1**, wherein the at least one air cushion defines a plurality of discontinuous volumes of air.

12. The patient transfer sled of claim **11**, wherein the plurality of discontinuous volumes of air comprises a first volume of air having a length, a width, and a thickness and a second volume of air having a length, a width, and a thickness; wherein the second volume of air has at least one dimension different from the first volume of air, the at least one dimension different from the first volume of air selected from the group consisting of the length, the width, and the thickness.

13. The patient transfer sled of claim **1**, wherein the flexible material at least partially surrounding a rigid material secures the flexible material to the rigid material.

14. A patient transport system comprising:

a table having an at least substantially planar upper surface;

a bridge attached to the table, the bridge comprising an at least substantially planar surface that may be oriented laterally adjacent to and at least substantially coplanar with the at least substantially planar upper surface of the table;

the patient transport sled of claim **1**, the at least one air cushion disposed over the at least substantially planar upper surface of the table; and

a source of pressurized air coupled to the patient transfer sled and configured to supply air to the at least one air cushion.

15. The patient transport system of claim **14**, wherein the source of pressurized air comprises an air supply line incorporated into a wall of a building.

16. The patient transport system of claim **14**, wherein the at least one air cushion defines a plurality of discontinuous volumes of air.

17. The patient transport system of claim **16**, wherein the flexible material at least partially surrounding a rigid material secures the flexible material to the rigid material.

18. A method of moving a patient relative to a support surface, comprising:

positioning a patient on an upper surface of a generally planar support structure of a patient transfer sled;

at least partially inflating with a gas at least one cushion adjacent a lower surface of the generally planar support structure of the patient transfer sled to cause the patient and the generally planar support structure to be at least substantially supported over a surface underlying the patient transfer sled by the at least one cushion, wherein the at least one cushion comprises a flexible material at least partially surrounding a rigid material, a portion of the flexible material having a plurality of holes extending therethrough;

flowing pressurized gas from a gas source into the at least one cushion and out from the at least one cushion through the plurality of holes extending through the flexible material adjacent the surface underlying the patient transfer sled to form a volume of flowing gas between the flexible material of the at least one cushion and the surface underlying the patient transfer sled; and

sliding the patient transfer sled with the patient thereon relative to the surface underlying the patient transfer sled over the volume of flowing gas.

19. The method of claim **18**, wherein flowing pressurized gas from a gas source into the at least one cushion and out from the at least one cushion through the plurality of holes extending through the flexible material adjacent the surface underlying the patient transfer sled comprises maintaining a volume of gas within the at least one cushion.

20. The method of claim **18**, further comprising:

orienting a bridge comprising an at least substantially planar surface laterally adjacent to and at least substantially coplanar with an at least substantially planar upper surface of a table, and

sliding the patient transfer sled with the patient thereon over the bridge on the volume of flowing gas.

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