(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 233 822 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.08.2023 Bulletin 2023/35

(21) Application number: **23180970.8**

(22) Date of filing: **05.09.2018**

(51) International Patent Classification (IPC):
A61G 7/018 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A61G 7/005; A61G 7/008; A61G 7/012; A61G 7/015; A61G 7/018

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **15.09.2017 DK PA201770696**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
18769278.5 / 3 681 456

(71) Applicant: **Bergmann, Jean-Paul**
8361 Hasselager (DK)

(72) Inventor: **Bergmann, Jean-Paul**
8361 Hasselager (DK)

(74) Representative: **Patrade A/S**
Ceresbyen 75
8000 Aarhus C (DK)

Remarks:
This application was filed on 22.06.2023 as a divisional application to the application mentioned under INID code 62.

(54) **HOSPITAL BED AND PATIENT SUPPORT EASY TO CLEAN AND MAINTAIN**

(57) Elongated patient support (90) configured for a hospital bed (10) and extending in a longitudinal direction (20) and a transverse direction (30) perpendicular to the longitudinal direction (20), the patient support (90) comprising:

- an exterior patient support face (95) formed by a single patient side sheet (160) extending in the longitudinal direction (20) and the transverse direction (30) and oppositely;
- a bed face (96) formed by multiple bed side sheets (165) coupled to the patient side sheet (160) and each bed side sheet (165) separated by a gap (97) extending in the transverse direction (30), the bed side sheets (165) being welded to the patient side sheet (160), wherein each bed side sheets (165) being welded to the patient side sheet (160) is configured as a patient support section (91) pivotally coupled to an adjacent patient support section (91).

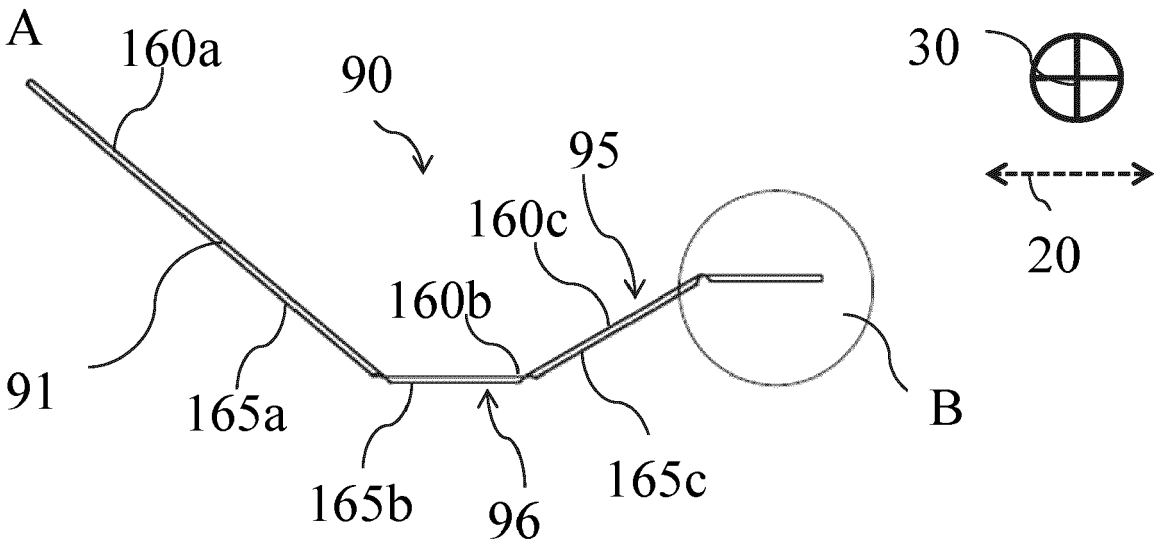


Fig. 16

EP 4 233 822 A2

Description

Field of the Invention

[0001] The present invention relates to a hospital bed with an enclosed housing that is easy to clean, transport and maintain. The enclosed housing protects the structural elements during cleaning procedures. Furthermore it is easy to rotate the hospital bed about a longitudinal axis and a transverse axis. The invention further relates to a patient support which is easy to clean, transport and maintain.

Background of the Invention

[0002] Across the world, hospitals meet the major challenges of fewer staff, higher efficiency demands and greater microbial threats. Hospital-acquired infection is a huge problem and affects up to 10% of hospitalised patients. Hospital beds and patient supports are one of the main sources of infection.

[0003] To overcome these problems, new methods and procedures of cleaning hospital beds and patient supports have been investigated. It has proven to be a challenge to clean the hospital beds and patient supports gently, carefully and effectively at the same time. Effective cleaning procedures have shown to increase wear and tear - particularly on electrical and mechanical elements causing reduced lifespan of the hospital beds and patient supports.

[0004] The construction of conventional hospital beds generally include a plurality of mechanical and electrical elements and free structures that permit motion such as tilting, rotation, pivoting, angulating and bending for positioning the patient. To prevent collision of individual elements during motion and to secure a plurality of precise motions, hospital beds often have a complex construction. Complex structural construction complicates the cleaning procedures and trigger easy accessibility of germs.

[0005] US 2011/0010858 A1 discloses a positioning mechanism of a bed appropriate for use in hospital settings. The disclosed position mechanism aims at a less structural complex design than previous hospital beds, which mechanism provides for adjustments of a bedframe including a combination of both transverse and longitudinal tilt. The disclosed positioning mechanism consists of at least three height-adjustable lifters mounted on an undercarriage frame and which lifters are connected to a patient surface frame at the other side via additional fittings providing for the free movement leading to the transversal and longitudinal tilts. Furthermore, the disclosed position mechanism is limited on the degree of tilt about the longitudinal axis due to the use of two parallel lifters in the transvers direction precisely for providing that tilt.

[0006] US 2014/0208512 A1 discloses a patient support system. It consists of independently adjustable end columns supporting a centrally connected patient support structure.

[0007] In general, these hospital beds and other conventional beds are rotatable about one or more axes. They comprise a plurality of mechanical, electrical and structural elements often placed on the exterior of the frame. The elements are thereby exposed to wear and tear during cleaning and are easily accessible for germs.

[0008] CN1065800586A discloses a multifunctional electric bed which also provides for adjustments of a bedframe including a combination of both transverse and longitudinal tilt. Contrary to US2011/0010858 A1 the disclosed positioning mechanism only comprises two lifting pillars, which facilitates a wider degree of tilt about the longitudinal axis due to the use of only two parallel lifters in the longitudinal direction. However, similar to US2011/0010858 A1 the pillars are connected to a bedframe via a first mounting element mounted on a raising pillar and a second mounting element to be mounted hereto and to the bedframe with only rotational freedom between these two elements. The second element to be further mounted to the bedframe incorporates the longitudinal slack or slip by rails in the bedframe. The bedframe is then mounted onto an elongated housing of the bed, for the purpose of partly framing the adjustment mechanism and mountings.

[0009] These tendencies call for the invention of a new hospital bed and a patient support with simple, but strong constructions. They should be fast and easy to clean and maintain and thereby safe for the user and caretakers. Furthermore is should be easy to produce and assemble.

Object of the Invention

[0010] The object of the invention is to provide a new and improved hospital bed and a patient support which overcomes one or more of the shortcomings mentioned above.

Description of the Invention

[0011] The aforementioned aspects may be achieved by a hospital bed comprising an elongated housing. The hospital bed may comprise two pillar connections. The pillar connections may be arranged on a pillar. The housing may have an exterior face extending in a longitudinal direction and a transverse direction. The transverse direction is perpendicular to the longitudinal direction. The housing may further comprise a skirt. The skirt may extend perpendicularly to the exterior face and may thereby form an interior and an exterior. The housing may further comprise at least two housing connections. The housing connections may be in the interior and may be arranged coaxially along a longitudinal axis. The longitudinal axis may be substantially parallel to the longitudinal direction. The housing connection may each be adapted for communication with a pillar connection.

[0012] *Hospital bed* may be used as a general term for

beds used during recovery, transport, examination, prevention, treatment and several medical procedures including surgery and imaging. It may be used in a hospital, nursing home, patient home, hospice, palliative home or the like. It may be used by a user and/or a caretaker.

[0013] *User* may be used as a general term for the user of the hospital bed such as a patient or the like.

[0014] *Caretaker* may be used as a general term for a doctor, nurse, therapist, physician and technician or the like.

[0015] In one embodiment, the communication between the housing connection and the pillar connection may enable rotation of the housing and thereby, when used as intended, reposition of the user. Rotation may be used as a general term for tilting, pivoting, angulating and bending or the like.

[0016] A further advantage of this embodiment is that reposition of the user may enable enhanced physical activity and comfort for the user which may lead to early recovery.

[0017] It may encourage self-help, e.g. when a user enters the bed. Thereby it spares the caretaker and reduces the risk of work-related injury.

[0018] Another advantage of this embodiment is that the user may be repositioned which may reduce the risk of decubitus ulcers (bed sores), phlebo-thrombosis, hypostatic pneumonia and other conditions associated to bed rest in the same position.

[0019] Another advantage of this embodiment is that the hospital bed may be personalized to the user to meet the demands of a relevant condition.

[0020] In another embodiment, the communication between the housing connection and the pillar connection may be a contact or operative association or the like in the form of a connection, link, joint or the like. Thereby it may be possible to rotate the hospital bed about the longitudinal axis.

[0021] In another embodiment, the housing connection may be a hollow cylinder. An effect of this embodiment is that the housing connection is configured for a cylindrical pillar connection. Thereby it may be possible to pivot the elongated housing from a horizontal position of the exterior face to an almost vertical position to either side about the longitudinal axis.

[0022] Furthermore, a single hollow cylinder may provide for two housing connections -one housing connection in each end, in the case where the hollow cylinder extends in the longitudinal direction between the positions of each housing connection

[0023] Furthermore, a simple construction is obtained. The hollow cylinder may be a through-going construction. Thereby the construction may be stronger.

[0024] In another embodiment, the housing connection may be made of aluminium or aluminium alloy. Thereby a person skilled in the art may enhance material properties to a desired effect such as a strong and light-weight construction material.

[0025] In another embodiment, the housing connection may be made of steel, plastics or any other material or combination of materials that would be found appropriate by a person skilled in the art. Thereby the housing connection may be adapted for different purposes.

[0026] In another embodiment, the housing connection may be made of a material compatible with imaging procedures. Thereby it may not be necessary to move the user if a medical imaging procedure such as MRI is needed.

[0027] In another embodiment, the power element responsible for longitudinal translocation of the housing may be applied by an actuator, a caretaker, a user or the like. Thereby it is possible to reposition the housing in several ways and personalize the use of the bed.

[0028] An effect of this embodiment is the formation of an interior. The interior may enclose elements such as mechanical and electrical elements and the like, or a combination of these. Thereby elements are more protected and this may elongate the life-span of the elements.

[0029] A further effect of this embodiment is a more simple construction. Thereby the elements are not as easily accessible by germs.

[0030] Elements may be protected during a cleaning procedure. A mechanical bed wash may be up to 80°C or higher and may be followed be a drying procedure. A mechanical bed wash exposes mechanical and electrical elements to stress and reduces the life-span of these elements. An enclosed housing reduces the negative effects of both mechanical and by-hand washing procedure on the elements arranged in the interior of the housing.

[0031] A further advantage of this embodiment is that the need for lubrication of elements is reduced. This may be desirable in an environment such as a hospital where a high level of hygiene is important. Furthermore, maintenance is kept to a minimum.

[0032] The hospital bed may comprise only two pillars. Thereby the construction is simple and easier to clean and maintain. Furthermore it may reduce the risk of collision of parts. In another embodiment, the pillar connection may be made of aluminium or an aluminium alloy. Thereby a person skilled in the art may enhance material properties to the effect desired. This may be a strong and light-weight construction material.

[0033] A person skilled in the art would know different appropriate materials to different purposes such as e.g. an MRI compatible material.

[0034] In another embodiment, the connection between the pillar connection and the pillar may be any kind of a mechanical bearing or element that constrains relative motion between the pillar connection and the pillar to only the desired motion. Thereby the hospital bed may rotate about a transverse axis for e.g. Trendelenburg position.

[0035] The connection between the pillar and the pillar connection may be a joint or a hinge, such as a barrel hinge. A person skilled in the art would know different types of suitable connections.

[0036] A further advantage is that a mechanical bearing or element may minimize friction between the pillar and the pillar connection.

[0037] In an aspect of the invention, one housing connection may be configured for communication with one pillar connection, which communication comprises a longitudinal translocation.

[0038] An effect of this embodiment is that rotation about the transverse axis is possible without collision of structural elements in the bed.

[0039] A further effect of the longitudinal translocation in the communication is that the construction may comprise slack or slip which may reduce any strain inflicted on the remaining construction of the hospital bed during rising of and lowering of the bed be use of the pillars.

[0040] Furthermore, the longitudinal translocation may achieve for a position of the bed where one end is raised above the other end without any need for additional telescopic elements, as the housing connection in communication with a respective complementary pillar connection may have the effect of a telescopic element in itself.

[0041] A further effect of this embodiment is a simple construction. Thereby the bed may be fast and easy to produce and assemble. It may be assembled at the hospital or any other suitable place.

[0042] A further effect may be that a simple construction is easy to clean and maintain.

[0043] In another aspect of the invention, the hospital bed may further comprise a stop-element, wherein one housing connection and the stop-element are configured for communication with one pillar connection, which communication comprises a non-longitudinal translocation.

[0044] An effect of this embodiment is that during rotation about the transverse axis element, such as an actuator, mechanical and electrical elements will not be dislocated by pull, twist or push. Thereby the elements will be more protected and lifespan may be elongated.

[0045] A further advantage of this embodiment is that the hospital may keep a fixed distance from other objects, e.g. a wall. Thereby the hospital bed may be safer in use.

[0046] In another embodiment, the stop-element may be placed at the end intended as the head section or in the end intended as the foot section or it may be placed in both ends. Thereby it is possible to construct a hospital bed intended for different purposes.

[0047] In another embodiment, the stop-element may be a cover, a plate or the like arranged on one side of the pillar connection.

[0048] In another embodiment, the stop-element may be a protrusion on the exterior face of the pillar connection. The housing connection may comprise a milled groove that may be configured to communicate with the protrusion. Thereby the rotation about the longitudinal axis is limited to an angle determined by the size of the milled groove.

[0049] In another aspect, the housing connection may be a hollow cylinder ending in a cylinder part having a solid centre acting as a stop-element.

[0050] A person skilled in the art will know different types of appropriate stop-element.

[0051] In another aspect of the invention, the hospital bed may have at least one pillar connection that may be configured with a transverse pillar connection for pivoting about a transverse axis perpendicular to the longitudinal axis.

[0052] An effect of this embodiment is that the hospital bed may be rotated to a desired position. Hereby a position is obtained that may be used for treating, preventing or under surgeries.

[0053] A further effect is that it is possible to obtain Trendelenburg position and anti-Trendelenburg. Thereby, when used as intended, pivoting the hospital bed about the transverse axis may prevent a plurality of conditions such as embolism in a user. Furthermore repositioning a user may also be used for surgeries such as abdominal or gynaecological and the like. It may also be used to treat shock, low blood pressure or the like.

[0054] A further effect of this embodiment is that the height of the whole bed can be adjusted. Thereby the movement in and out of bed will become easier for the user and reduce work-load for the caretaker.

[0055] In another embodiment, the power element responsible for pivoting about the transverse axis may be applied by an actuator, a caretaker, a user or the like. Thereby it is possible to rotate the housing in several ways and personalize the use of the bed.

[0056] In another aspect of the invention, the hospital bed may have at least one pillar connection that may be a cylinder. The pillar connection may comprise at least a first and a second section. The first section may be adapted for communication with the housing connection. The second section may have a diameter larger than the first section and may be configured as a stop-element for stopping longitudinal translocation.

[0057] An effect of this embodiment is that the construction of the stop-element is simple and comprises few elements. Thereby cleaning is easier. Furthermore it may be easier to maintain, assemble and produce.

[0058] In another aspect of the invention, the hospital bed may comprise an actuator. The actuator may be arranged and connected to the interior of the housing and at least one of the pillar connections for pivoting about the longitudinal axis.

[0059] An effect of this embodiment is that the actuator may be arranged and connected to the interior of the housing. Thereby it is more hygienic and easier to clean the housing.

[0060] A further effect of this embodiment is that the life-span of the actuator arranged in the interior may be elongated compared to actuator arranged on the exterior as the cleaning and washing procedures may be less harsh.

[0061] A further advantage of this embodiment is that a powered actuator may reduce the work-load of the caretaker and thereby reduce risk of work-related injury.

[0062] In another embodiment, the actuator may be a

linear actuator. The actuator may be controlled by a control signal which may be applied by the user or a caretaker. The actuator may respond to the control signal by converting an energy source into a mechanical motion used to control the position of the housing and thereby the patient support. The energy source may be selected from the group consisting of electrical energy, thermal energy, magnetic energy, hydraulic pressure, and pneumatic pressure, or a combination of these. Thereby it may be customised to a hospital bed.

[0063] A further effect of this embodiment is that the actuator may enable smooth, quiet and precise movement or a combination of these; thereby it may be more comfortable and safe for the user.

[0064] A further effect of this embodiment is that the actuator may be of any shape and/or size. Thereby it may fit into the interior of a custom-made hospital bed.

[0065] In another aspect of the invention, the hospital bed may further comprise a patient support. The patient support may be adapted to be supported by the exterior face of the housing. The patient support may comprise at least two patient support sections that may be pivotally coupled. At least one patient support section may be operably connected to a bending actuator by an arm. The bending actuator may be arranged and connected to the interior of the housing. The bending actuator may be configured to move the operably connected patient support section(s) relatively to another patient support section.

[0066] Here the term bending actuator is used in relation to an actuator used for being or pivoting the patient support sections.

[0067] An effect of this embodiment is that powered help by the actuator to reposition the user may reduce the workload to the caretakers and thereby reduce the risk of work-related injury.

[0068] A further effect of this embodiment is that the support section may help the patient to reposition. Thus the physical comfort will increase which may lead to early recovery. It also reduces the risk of decubitus ulcers (bed sores), phlebo-thrombosis, hypostatic pneumonia and other conditions associated to bed rest in the same position.

[0069] One advantage of this embodiment is that the hospital bed can be personalized to the patient and best meet the demands of the relevant condition.

[0070] A further advantage of this embodiment is that the head section may be raised to obtain Fowler position. The Fowler position may benefit the staff and the patient as it may be used for sitting (e.g. while feeding) and may ease the user's breathing.

[0071] A further advantage of this embodiment is that the foot section may be raised which may benefit the staff and the user. It may e.g. help to move the patient further toward the head section.

[0072] In another embodiment, the bending actuator may be a linear actuator. The bending actuator may be controlled by a control signal which may be applied by the user or a caretaker. The bending actuator may respond to the control signal by converting an energy source into a mechanical motion used to control the position of the housing and thereby the patient support. The energy source may be selected from the group consisting of electrical energy, thermal energy, magnetic energy, hydraulic pressure, and pneumatic pressure, or a combination of these.

[0073] A further advantage of this embodiment is that the bending actuator may enable smooth, quiet and precise movement or a combination of these; thereby it may be more comfortable and safe for the user.

[0074] In another embodiment, the bending actuator may be of any shape and/or size; thereby it may fit into the interior of a custom-made hospital bed.

[0075] In another embodiment, the bending actuator may be arranged in the interior of the housing. Thereby it is more hygienic and easier to clean the housing.

[0076] A further effect of this embodiment is that the life-span of the bending actuator arranged in the interior may be elongated compared to actuators arranged on the exterior as the cleaning and washing procedures may be less harsh.

[0077] In another embodiment, the patient support may easily be taken off/onto the housing. Thereby cleaning of the housing is possible without the patient support.

[0078] In another embodiment, the support frame may be length-adjustable. Thereby it may be used for different purposes and for paediatric patients.

[0079] In another embodiment, the arm is connected to the patient support by a roller bearing. Thereby the rolling resistance is low and there is little sliding.

[0080] In another aspect of the invention, the exterior of the housing of the hospital bed may be substantially smooth.

[0081] An effect of this embodiment is that a smooth surface may be without obstructions. Thereby impurities and germs may be easier to wash off.

[0082] A further advantage of this embodiment may be that the exterior of the housing may not comprise protrusions, sharp edges or the like. Thereby it may be more safe for the user and the caretaker.

[0083] In another embodiment, the smooth exterior may be made of a material compatible with imaging procedures. Thereby it may not be necessary to move the user if a medical imaging such as MRI is needed.

[0084] In another embodiment, the housing may be made of a metal alloy. The alloy may be an aluminium alloy. Thereby the housing may be made of a strong and light-weight construction material. Thereby it is easy to transport and may withstand stress.

[0085] In another embodiment, the housing may be made of steel, plastics or any other material or combination of materials a person skilled in the art would find appropriate. Thereby the housing connection may be adapted for different purposes.

[0086] In another aspect of the invention, the hospital bed wherein the housing may be made of aluminium.

[0087] An effect of this embodiment may be that the

housing is light-weight, strong and resistant to corrosion and cracking. Thereby it may be a suitable construction material for a hospital bed as it will be easy to transport and will have a long lifespan.

[0088] In another aspect of the invention, the hospital bed may have at least one pillar connected to a pillar actuator. The pillar actuator may be adapted for a vertical, linear movement relative to a support frame for pivoting about the transverse axis.

[0089] In an embodiment, the pillar actuator may be a linear actuator. The pillar actuator may be controlled by a control signal which may be applied by the user or a caretaker.

[0090] The pillar actuator may respond to the control signal by converting an energy source into a mechanical motion used to control the position of the housing and thereby the patient support. The energy source may be selected from the group consisting of electrical energy, thermal energy, magnetic energy, hydraulic pressure, and pneumatic pressure, or a combination of these.

[0091] A further advantage of this embodiment is that a powered pillar actuator may reduce the work-load of the caretaker and thereby reduce risk of work-related injury.

[0092] In another embodiment, the pillar actuator may enable smooth, quiet and precise movement or a combination of these; thereby it may be more comfortable and safe for the user.

[0093] In another embodiment, the pillar actuator may be of any shape and/or size. Thereby the pillar actuator may fit into the interior of a custom-made hospital bed.

[0094] In another embodiment, the pillars may be independently height-adjustable by a slider or telescopic mechanism or the like. Thereby it is possible to obtain Trendelenburg and anti-Trendelenburg position or the like.

[0095] Another advantage of this embodiment is that the height of the bed may be adjusted by synchronizing the position of the pillars. Thereby the bed may be lowered (e.g. for the user to have a possibility for easy exit of the bed) or raised (e.g. for the caretaker to have a better working position).

[0096] In another embodiment, the support frame may have wheels. Thereby it is easily portable. The wheels may be lockable. Thereby safety for the user and the caretaker is increased.

[0097] In a further embodiment, the support frame may be of different shapes and/or sizes or it may be the foot of the pillar. Thereby the support frame may be adjusted to better fit the intended use.

[0098] In another aspect of the invention, there is an elongated patient support that may be configured for a hospital bed. The patient support may be extending in a longitudinal direction and a transverse direction. The transverse direction is perpendicular to the longitudinal direction. The patient support may comprise an exterior patient support face formed by a single patient side sheet. The exterior patient support face may extend in the longitudinal direction and the transverse direction. The patient support further comprises a bed face. The bed face is arranged oppositely to the exterior patient support face. The bed face may be formed by multiple bed side sheets. The bed side sheets may be coupled to the patient side sheet and each bed side sheet may be separated by a gap. The gaps are extending in the transverse direction. The bed side sheets may be welded to the patient side sheet. Each bed side sheets being welded to the patient side sheet may be configured as a patient support section pivotally coupled to an adjacent patient support section,

[0099] An advantage is that the patient support may be an enclosed construction. An enclosed construction may be easy to clean, maintain, assemble and produce.

[0100] The gap(s) between the bed sheet, and thus a transverse part of the patient side sheet being unsupported by the patient support sheets may form a compression path and thereby function as hinges.

[0101] Compression path is used to describe the transverse section of the patient support, which may be bendable due to the gap in the transverse direction created on the bed face between the bed side sheets. This section may be bendable as it only comprises the patient side sheet, which may be compressible and thus a repeatedly bending in this section will not cause fatigue in the patient support.

[0102] Thereby the patient support may pivot into different angles between the different patient support sections. Each patient support section is divided by the compression path formed by the gaps between the bed side sheets.

[0103] A further effect of this embodiment is that the support section may help the patient to reposition. Thus the physical comfort will increase which may lead to early recovery. It also reduces the risk of decubitus ulcers (bed sores), phlebo-thrombosis, hypostatic pneumonia and other conditions associated to bed rest in the same position.

[0104] A further advantage of this embodiment is that the head section may be raised to obtain Fowler position. The Fowler position may benefit the staff and the patient as it may be used for sitting (e.g. while feeding) and may ease the user's breathing.

[0105] A further advantage of this embodiment is that the foot section may be raised which may benefit the staff and the user. It may help to move the patient further toward the head section.

[0106] Furthermore it is possible to position the user in a position suitable for the user's condition or suitable for the caretaker's work position.

[0107] In another embodiment, the patient support may be operably coupled to an actuator by which the workload of the user and the caretaker is reduced. Furthermore it may enable smooth, quiet and precise motion which is more comfortable and safe for the user.

[0108] In one aspect, at least one of the patient support sections may be operably connected to a bending actuator by an arm. The bending actuator may be arranged

and connected to the interior of the elongated housing and configured to move the operably connected patient support section(s) relatively to another patient support section.

[0109] In another embodiment, the support frame may be length-adjustable. Thereby it may be used for different purposes and for paediatric patients.

[0110] In another embodiment, the patient support may be made of thermoplastics such as acrylonitrile butadiene styrene, polypropylene, polycarbonate or other polymers. Thereby the patient support may obtain a smooth exterior which is easy to clean and maintain. A person skilled in the art may choose different materials to obtain different purposes.

[0111] Another advantage is that the sheets may be made of a material compatible with imaging procedures. Thereby it may not be necessary to move the user if a medical imaging such as MRI is needed.

[0112] In another aspect of the invention, the patient side sheet may be made of a flexible plastics material and the bed side sheets may be made of a strong plastics material.

[0113] An effect of this embodiment is that the sheet is made of a flexible and bendable material whereas the other sheet is made of a strong material. Thereby the patient support may be both flexible and may pivot in the desired angles and may be strong with a high durability.

[0114] Furthermore the patient support may comprise a smooth easy-to-clean surface.

[0115] In an embodiment, the sheets may be made of different materials or different thicknesses or both. Thereby it is possible to use different materials with different properties suitable for the use of the bed.

[0116] In another aspect of the invention, the patient support may have a bed face which comprises at least one connection means. The connection means may be one or more nut(s). The connection means may be embedded into at least one bed side sheet for connecting and fixating the patient support to the hospital bed.

[0117] An effect of this embodiment is that the patient support may be attached to the hospital bed by a connection means extending from the hospital bed to the patient support. Thereby the patient support may still have a smooth exterior patient support face which is easy to clean and maintain.

[0118] A further advantage is that there are no gaps, cavities or the like on the exterior patient support face, thereby eliminating potential entrapment areas for fingers or small objects.

[0119] Normally gaps used in hospital beds are either smaller than 8 mm or larger than 25 mm. This embodiment allows for the use of different types and sizes of gaps without consideration of entrapment areas.

[0120] In another embodiment, the patient support may easily be taken off/onto the hospital bed. Thereby cleaning of the hospital bed is possible without the patient support.

[0121] In another embodiment, the connection means may be a nut, coupling, bolt, cable or the like, or any combination of those. Thereby a person skilled in the art may choose the most appropriate connection means.

[0122] In another embodiment, the connection means may be located in the interior of the housing. Thereby cleaning is easier.

[0123] In an aspect of the invention, the patient support comprising a compression path may be obtained by a process comprising several acts. The acts may be one or more of:

- Providing at least one patient side sheet for the exterior patient support face to be formed by a first mould.
- Providing at least two bed side sheets for a bed face to be formed by a second mould. The second mould may comprise protrusions along the periphery of each bed side sheet.
- Heating the sheets to their respective thermoforming temperatures.
- Applying vacuum or pressure or a combination of both to the moulds thereby forming the sheets with sheet protrusions according to protrusions of the moulds.
- Bringing the moulds together such that the patient side sheet is brought in contact with the bed side sheets under high pressure. Thereby the sheets may be welded together at least along the protrusions with hollow parts created in between the sheets.

[0124] The patient support may be configured for a hospital bed and extending in a longitudinal direction and a transverse direction perpendicular to the longitudinal direction.

[0125] An effect of this process may be that the patient support will form a seamless construction. Thereby the patient support may have a homogenously exterior which is substantially smooth and easy to clean. Furthermore the patient support will not have any sharp edges and will be safe for users and caretakers.

[0126] A further advantage is that the two sheets may be welded together in several points. Thereby the construction may be stronger and tighter compared to conventional patient supports.

[0127] In an embodiment of the patient support the patient side sheet is made of a flexible plastics material and the at least two bed side sheets are made of a strong plastics material.

[0128] The effects and advantages of this embodiment is in line with those already describe above in relating to achieving a compression path easier cleaning and An effect of this embodiment is that a patient support with a compression path which may function as hinges.

[0129] In an embodiment, the process is twinsheet thermoforming. An effect of this embodiment is that twinsheet thermoforming is simpler than several conventional processes. Thereby twinsheet thermoforming may create higher production rates.

[0130] A further advantage is that when no screws, bolts, hinges or the like are needed, the exterior patient support face is easy to clean and maintain.

[0131] A further advantage is that there is no noise from hinges and the like, thereby creating a peaceful environment for the user and caretaker.

[0132] A further advantage is that twinsheet thermoforming provides a simple construction with low weight. Thereby the patient support may be easy to remove e.g. for cleaning or transport.

[0133] In another embodiment, the patient support may comprise one or more internal reinforcements such as structural elements or rigid foam components. Hereby a simple exterior is obtained that is easy to clean simultaneously with having a strong construction.

[0134] In an alternative embodiment the patient support is obtained by a twin sheet thermoforming process wherein a bed side sheet and a patient sheet is provided to be formed in their respective moulds. At least the mould for the bed side sheet may comprise one or more transverse protrusions. The transvers protrusions may accommodate transverse gaps in the bed side sheet and thus the forming of compression paths in the patient support.

[0135] In another embodiment, the division of individual patient support sections is formed by squeezing, pressing or the like in a transverse direction. Thereby it is possible to bend the patient support between the patient support sections.

[0136] As an example, the patient support may be obtained by providing at least one sheet for the exterior patient support face and at least two sheets for the bed face. The sheets are placed in a female mould and heated to their respective thermoforming temperatures. Then the two mould halves are sealed together. Air pressure may be applied to the moulds through needles, and a vacuum is created so the sheets are formed against the moulds. A hollow part may be formed by the sheets.

Description of the Drawing

[0137]

Fig. 1 illustrates different views of a housing and a housing connection;
Fig. 2 illustrates a housing connection;
Fig. 3 illustrates different views of a pillar connection arranged on a pillar;
Fig. 4 illustrates a front view and a top view of a pillar connection arranged on a pillar;
Fig. 5 illustrates different views of a pillar connection with a stop-element arranged on a pillar;
Fig. 6 illustrates a front view and a top view of a pillar connection with a stop-element arranged on a pillar;
Fig. 7 illustrates a housing with an actuator;
Fig. 8 illustrates a hospital bed;
Fig. 9 illustrates a hospital bed pivoted around a longitudinal axis;
Fig. 10 illustrates a hospital bed with a patient support;
Fig. 11 illustrates a cross section of a hospital bed with a patient support and a bending actuator;
Fig. 12 illustrates a cross section of a hospital bed with an actuator;
Fig. 13 illustrates a cross section of a bottom view of a hospital bed, a patient support and actuators;
Fig. 14 illustrates a hospital bed pivoted around a transverse axis;
Fig. 15 illustrates a cross section of a hospital bed seen from the head end mattress retainer;
Fig. 16 illustrates different views of a patient support;
Fig. 17 illustrates different views of a patient support;
Fig. 18 illustrates a process.

Item list

[0138]

10	Hospital bed
20	Longitudinal direction
25	Longitudinal axis
30	Transverse direction
35	Transverse axis
40	Housing
41	Exterior face
42	Exterior
43	Smooth
45	Interior
48	Skirt
50	Housing connections
60	Pillar
61	Pillar connection
62	Transverse pillar connection
64	Hinge
65	Mountings
71	First section
72	Second section
80	Longitudinal translocation
85	Non-longitudinal translocation
90	Patient support
91	Patient support section
92	Head end mattress retainer
93	Foot end mattress retainer
95	Exterior patient support face

(continued)

96	Bed face
97	Gap
98	Connection means
99	Compression path
100	Bending actuator
105	Arm
106	Roller bearing
120	Actuator
121	Attachment seat for actuator
130	Support frame
131	Wheel
140	Stop-element
150	Vertical, linear movement
160	Patient side sheet
165	Bed side sheet
170	Mould
180	Mould edges
190	Hollow part
200	Protrusion
300	Process
310	Act of providing
320	Second act of providing
330	Act of heating
340	Act of applying
350	Act of bringing

Detailed description of the invention

[0139] Fig. 1 illustrates different views of a hospital bed 10 with an elongated and enclosed housing 40.

[0140] The housing 40 has an exterior face 41 which extends in a longitudinal direction 20 and a transverse direction 30 perpendicular to the longitudinal direction 20.

[0141] The housing further comprises a skirt 48 which extends perpendicularly to the exterior face 41 and forms an interior 45 and an exterior 42.

[0142] The skirt 48 comprises a pair of longitudinal sides arranged oppositely to each other and substantially parallelly to the longitudinal direction 20. The skirt extends perpendicularly to the exterior face 41. The skirt 48 further comprises a pair of transverse sides which extend from the exterior face 41 and which sides are arranged oppositely to each other and substantially parallelly to the transverse direction 30.

[0143] The skirt 48 has a bottom securing an enclosed housing 40.

[0144] The exterior face 41 may be smooth 43.

[0145] Fig. 1B illustrates a cross section of the housing connection 50 arranged in the interior of the housing 45. The housing connection is a hollow cylinder adapted for communication with a cylindrical pillar connection.

[0146] Fig. 1C illustrates two housing connections 50. The housing connections 50 are arranged in the interior 45 and coaxially along a longitudinal axis 25. The longitudinal axis 25 is substantially parallel to the longitudinal direction 20. The housing connections 50 are adapted for communication with respective complementary pillar connections 61 (not shown here). Each pillar connection 61 is arranged on a pillar 60 (Fig. 1A).

[0147] The two pillars 60 are placed on opposed sides of the housing 40.

[0148] Fig, 2 illustrates two housing connections 50 from a different angle.

[0149] Fig. 3-4 illustrates different views of a pillar connection 61 arranged on a pillar 60.

[0150] The pillar 60 is a telescopic lifting pillar.

[0151] The pillar connection 61 is a cylinder and is mounted on a transverse pillar connection 62 on a mounting 65. The pillar connection 61 and the transverse pillar connection 62 are connected through a hinge 64 and are able to move relatively to each other about transverse axis 35. The pillar connection 61 is illustrated in communication with a housing connection 50.

[0152] Fig. 4A illustrates a front view, and Fig. 4B illustrates a top view of the pillar connection 61 arranged on a pillar 60.

[0153] Figs. 5-6 illustrate different views of another embodiment of a pillar connection 61 with a stop-element 140 arranged on a pillar 60. The pillar connection 61 is a cylinder.

[0154] The stop-element 140 is configured to stop longitudinal translocation 80.

[0155] The pillar connection 61 comprises a first section 71 configured for communication with the housing connection 50 (not shown). The pillar connection 61 further comprises a second section 72. The second section 72 has a diameter larger than the first section 71 and is configured as a stop-element 140 for stopping longitudinal translocation 80.

[0156] The pillar 60 is a telescopic lifting pillar.

[0157] The pillar connection 61 is mounted on a transverse pillar connection 62 on a mounting 65. The pillar connection 61 and the transverse pillar connection 62 are connected through a hinge 64 and are able to move relatively to each other about transverse axis 35.

[0158] Fig. 6A illustrates a front view, and Fig. 6B illustrates a top view of a pillar connection 61 with a stop-element arranged on a pillar 60.

[0159] Fig. 7 illustrates a cross section of a hospital bed 10. The hospital bed 10 comprises a housing 40 with a skirt 48. The skirt 48 has a bottom (not shown here) which secures an enclosed housing. The hospital bed 10 further comprises a linear actuator 120 arranged in and

connected to the interior of the housing 45. The actuator 120 is connected to a pillar connection 61 for pivoting about the longitudinal axis 25.

[0160] Fig. 8 illustrates a cross section of the hospital bed 10. The hospital bed 10 comprises a housing 40, a patient support 90 and a support frame 130. The housing 40 communicates with pillar connections 61, arranged on pillars 60 through housing connections 50 (not shown here). The hospital bed 10 further comprises an actuator 120 for pivoting around the longitudinal axis 25, e.g. for rolling, and a bending actuator 100 configured to move the patient support sections 91 (not shown here) relatively to each other.

[0161] Fig. 9 illustrates the same hospital bed 10 as shown in Fig. 8 where the actuator 120 pivots the housing 40 around the longitudinal axis 25.

[0162] The actuator 120 allows the user and caretaker to change the position of the housing 40 and thereby the patient support 90, e.g. for rolling out of the hospital bed 10.

[0163] Figs. 10-12 illustrate a hospital bed 10. The hospital bed comprises a housing 40, a support frame 130 with wheels 131, and a patient support 90.

[0164] The exterior face of the housing 40 is substantially smooth 43.

[0165] The patient support 90 is supported by the exterior face of the housing 41. The patient support 90 comprises at four patient support sections 91a-d.

[0166] The patient support sections 90 are pivotally coupled, and two patient support sections, 91a,d, are operably connected to a bending actuator 100 (not shown here) by an arm 105.

[0167] The patient support 90 comprises a section adapted for head end mattress retainer 92 and a section adapted for foot end mattress retainer 93.

[0168] The arm 105 is connected to a patient support section 91a,d and to the exterior of the housing 42. The arm is connected to the patient support with a roller bearing 106.

[0169] Fig. 11 illustrates a cross section of the hospital bed 10. The hospital bed has a patient support 90 comprising 4 patient support sections 91. One of the patient support sections 91 comprises a foot end mattress retainer 93 and one comprises a head section 92. A bending actuator 100 is arranged and connected to the interior of the housing 45. The bending actuator 100 is configured to move the patient support sections 91 relatively to each other for e.g. a more comfortable position for the patient. The actuator 120 is arranged in the interior 45 near the foot end mattress retainer 93. Thereby the end intended for the feet is configured for a non-longitudinal translocation 85.

[0170] Fig. 12 illustrates a cross section of the hospital bed 10. The hospital bed has a patient support 90 comprising 4 patient support sections 91. One of the patient support sections 91 comprises a foot end mattress retainer 93 and one comprises a head section 92. A bending actuator 100 is arranged and connected to the interior of the housing 45 (not shown here). The actuator 120 is arranged in the interior 45 near the head end mattress retainer 92. Thereby the end intended for the head is configured for a non-longitudinal translocation 85.

[0171] Fig. 13 illustrates a housing 40 comprising two bending actuators 100a,b. The bending actuators 100a,b are arranged and connected to the interior of the housing 45. The bending actuators 100a,b are also connected to an arm 105. Furthermore there is an actuator 120 arranged and connected to the interior of the housing 45. The housing is enclosed (not shown here).

[0172] Fig. 14 illustrates a hospital bed 10. The hospital bed 10 comprises a housing 40, a support frame 130, and a patient support 90.

[0173] The support frame 130 communicates with the pillars 60. The pillar 60 is connected to an actuator 120 adapted for a vertical, linear movement relative to a support frame 130 for pivoting about the transverse axis 35, e.g. for Trendelenburg position.

[0174] Fig. 15 illustrates a cross section of a hospital bed 10 seen from the head end mattress retainer 92.

[0175] Fig. 16 illustrates an elongated and enclosed patient support 90. The patient support 90 has an exterior patient support face 95 extending in a longitudinal direction 20 and a transverse direction 30 perpendicular to the longitudinal direction 20. Furthermore the patient support 90 comprises a bed face 96 arranged oppositely to and coupled to the exterior patient support face 95. The patient support 90 has four patient support sections 91 that are pivotally coupled. The patient support sections 91 are divided by a compression path 99 formed by the gaps 97 between the bed side sheets 165. The patient support 90 is formed by a least three sheets 160,165 by a twinsheet-forming process. The patient side sheet 160 is made of a flexible plastics material. The bed side sheets 165 are made of a hard plastics material.

[0176] Figs. 16A,B illustrate a cross section of the patient support 90. The patient support has a hollow part 190.

[0177] Fig. 16C illustrates a top view of a patient support 90.

[0178] Fig. 17 illustrates different bottom views of a patient support 90. The patient support sections 91 are divided by through-going compression paths 99 extending in the transverse direction 30.

[0179] Fig. 18 illustrates a process 300 of obtaining a patient support 90 by an act of providing 310 at least one patient side sheet 160. The process 300 further comprises a second act of providing 320 at least two bed side sheets. The sheets 160, 165 are placed in moulds 170. The process 300 further comprises an act of heating 330 the sheets 160, 165 to their respective thermoforming temperatures. The process 300 further comprises an act of applying 340 air pressure and vacuum to the moulds 170. Then the sheets 160, 165 are formed against the moulds 170. The process 300 further comprises an act of bringing 350 the moulds 170 together thereby forming a hollow part between the patient side sheet 160 and the

bed side sheets 165 and welding the sheets together.

ITEMS

[0180] ITEM 1. Hospital bed (10) comprising an elongated housing (40) and two pillar connections (61) each arranged on a pillar (60), said housing (40) comprises:

- an exterior face (41) extending in a longitudinal direction (20) and a transverse direction (30) perpendicular to the longitudinal direction (20);
- a skirt (48) extending perpendicularly to the exterior face (41) forming an interior (45) and an exterior (42); and
- at least two housing connections (50) in the interior (45) arranged coaxially along a longitudinal axis (25) substantially parallel to the longitudinal direction (20), each housing connection (50) is adapted for communication with a pillar connection (61).

[0181] ITEM 2. Hospital bed (10) according to item 1, wherein at least one housing connection (50) is configured for communication with one pillar connection (61), said communication comprises a longitudinal translocation (80).

[0182] ITEM 3. Hospital bed (10) according to item 2, further comprising a stop-element (140) wherein one housing connection (50) and the stop-element (140) are configured for communication with one pillar connection (61), said communication comprises a non-longitudinal translocation (85).

[0183] ITEM 4. Hospital bed (10) according to one or more of items 1 to 3, wherein at least one pillar connection (61) further is configured with a transverse pillar connection (62) for pivoting about a transverse axis (35) perpendicular to the longitudinal axis (25).

[0184] ITEM 5. Hospital bed (10) according to one or more of items 1 to 4, wherein at least one of the pillar connections (61) is a cylinder comprising at least a first (71) and a second section (72), wherein the first section (71) is adapted for communication with a housing connection (50), and the second section (72) has a diameter larger than the first section (71) and is configured as a stop-element (140) for stopping longitudinal translocation (80).

[0185] ITEM 6. Hospital bed (10) according to one or more of items 1 to 5, further comprising an actuator (120) arranged and connected to the interior (45) of the elongated housing and at least one of the pillar connections (61) for pivoting about the longitudinal axis (25).

[0186] ITEM 7. Hospital bed (10) according to one or more of items 1 to 6, further comprising a patient support (90) adapted to be supported by the exterior face (41) of the elongated housing, wherein the patient support (90) comprises at least two patient support sections (91) pivotally coupled with at least one of the patient support sections (91) being operably connected to a bending actuator (100) by an arm (105), the bending actuator (100) is arranged and connected to the interior (45) of the elongated housing and configured to pivot the operably connected patient support section(s) (91) relatively to another patient support section (91).

[0187] ITEM 8. Hospital bed (10) according to one or more of items 1 to 7, wherein the exterior (42) of the elongated housing (40) is substantially smooth (43).

[0188] ITEM 9. Hospital bed (10) according to one or more of items 1 to 8, wherein the elongated housing (40) is made of aluminium.

[0189] ITEM 10. Hospital bed (10) according to one or more of items 1 to 9, wherein at least one pillar (60) is connected to a pillar actuator adapted for a vertical, linear movement (150) relative to a support frame (130) for pivoting about the transverse axis (35).

[0190] ITEM 11. Elongated patient support (90) configured for a hospital bed (10) and extending in a longitudinal direction (20) and a transverse direction (30) perpendicular to the longitudinal direction (20), the patient support (90) comprising:

- an exterior patient support face (95) formed by a single patient side sheet (160) extending in the longitudinal direction (20) and the transverse direction (30) and oppositely;
- a bed face (96) formed by multiple bed side sheets (165) coupled to the patient side sheet (160) and each bed side sheet (165) separated by a gap (97) extending in the transverse direction (30), the bed side sheets (165) being welded to the patient side sheet (160), wherein each bed side sheets (165) being welded to the patient side sheet (160) is configured as a patient support section (91) pivotally coupled to an adjacent patient support section (91).

[0191] ITEM 12. Patient support (90) according to item 11, wherein a transverse part of the patient side sheet (160), unsupported by the bed side sheets (165), is a compression path (99).

[0192] ITEM 13. Patient support (90) according to any one of items 11 to 12, wherein the patient side sheet (160) is made of a flexible plastics material, and the bed side sheets (165) are made of a strong plastics material.

[0193] ITEM 14. Patient support (90) according to any one or more of items 11 to 13, wherein the patient support (90) comprises at least two patient support sections (91) pivotally coupled, with at least one of the patient support sections (91) being operably connected to a bending actuator (100) by an arm (105), the bending actuator (100) is arranged and connected to the interior (45) of the elongated housing and configured to pivot the operably connected patient support section(s) (91) relatively to another patient support section (91).

[0194] ITEM 15. Patient support (90) according to any one or more of items 11 to 14, wherein the bed face (96) comprises at least one connection means (98), such as a nut embedded into at least one bed side sheet (165), for connecting and fixating the patient support (90) to the

hospital bed (10).

[0195] ITEM 16. Patient support (90) configured for a hospital bed (10) and extending in a longitudinal direction (20) and a transverse direction (30) perpendicular to the longitudinal direction (20), said patient support (90) comprises a compression path (99) obtained by a process (300) comprising one or more acts of:

- providing (310) at least one patient side sheet (160) for the exterior patient support face (95) to be formed by a first mould (170A);
- providing (320) at least two bed side sheets (165) for a bed face (96) to be formed by a second mould (170B), said second mould (170B) comprises protrusions along the periphery of each bed side sheet (165);
- heating (330) the sheets (160, 165) to their respective thermoforming temperatures;
- applying (340) vacuum or pressure or a combination of both to the moulds (170A, 1 70B), thereby forming the sheets (160, 165) with sheet protrusions according to protrusions of the moulds;
- bringing (350) the moulds (170) together such that the patient side sheet (160) is brought in contact with the bed side sheets (165) under high pressure, thereby welding the sheets (160, 165) together such that the sheets are welded together at least along the protrusions with hollow parts (190) created therein between.

[0196] ITEM 17. A patient support (90) according to item 16, wherein the at least one sheet for the exterior patient support face (95) is made of a flexible plastics material and the at least two bed side sheets (165) are made of a strong plastics material.

Claims

1. Elongated patient support (90) configured for a hospital bed (10) and extending in a longitudinal direction (20) and a transverse direction (30) perpendicular to the longitudinal direction (20), the patient support (90) comprising:

- an exterior patient support face (95) formed by a single patient side sheet (160) extending in the longitudinal direction (20) and the transverse direction (30) and oppositely;
- a bed face (96) formed by multiple bed side sheets (165) coupled to the patient side sheet (160) and each bed side sheet (165) separated by a gap (97) extending in the transverse direction (30), the bed side sheets (165) being welded to the patient side sheet (160), wherein each bed side sheets (165) being welded to the patient side sheet (160) is configured as a patient support section (91) pivotally coupled to an adjacent patient support section (91).

2. Patient support (90) according to claim 1, wherein a transverse part of the patient side sheet (160), unsupported by the bed side sheets (165), is a compression path (99).

3. Patient support (90) according to claims 1 or 2, wherein the patient side sheet (160) is made of a flexible plastics material, and the bed side sheets (165) are made of a strong plastics material.

4. Patient support (90) according to any one or more of claims 1 to 3, wherein the patient support (90) comprises at least two patient support sections (91) pivotally coupled, with at least one of the patient support sections (91) being operably connected to a bending actuator (100) by an arm (105), the bending actuator (100) is arranged and connected to the interior (45) of the elongated housing and configured to pivot the operably connected patient support section(s) (91) relatively to another patient support section (91).

5. Patient support (90) according to any one or more of claims 1 to 4, wherein the bed face (96) comprises at least one connection means (98), such as a nut embedded into at least one bed side sheet (165), for connecting and fixating the patient support (90) to the hospital bed (10).

6. Patient support (90) according to claim 5, wherein the connection means (98) are a nut, coupling, bolt, cable or the like, or any combination of those.

7. Patient support (90) according to claims 5 or 6, wherein the connection means (98) are located in the interior (45) of the housing (40).

8. Patient support (90) configured for a hospital bed (10) and extending in a longitudinal direction (20) and a transverse direction (30) perpendicular to the longitudinal direction (20), said patient support (90) comprises a compression path (99) obtained by a process (300) comprising one or more acts of:

- providing (310) at least one patient side sheet (160) for the exterior patient support face (95) to be formed by a first mould (170A);
- providing (320) at least two bed side sheets (165) for a bed face (96) to be formed by a second mould (170B), said second mould (170B) comprises protrusions along the periphery of each bed side sheet (165);
- heating (330) the sheets (160, 165) to their respective thermoforming temperatures;
- applying (340) vacuum or pressure or a combination of both to the moulds (170A, l 70B),

thereby forming the sheets (160, 165) with sheet protrusions according to protrusions of the moulds;
- bringing (350) the moulds (170) together such that the patient side sheet (160) is brought in contact with the bed side sheets (165) under high pressure, thereby welding the sheets (160, 165) together such that the sheets are welded together at least along the protrusions with hollow parts (190) created therein between.

9. A patient support (90) according to claim 8, wherein the at least one sheet for the exterior patient support face (95) is made of a flexible plastics material and the at least two bed side sheets (165) are made of a strong plastics material.

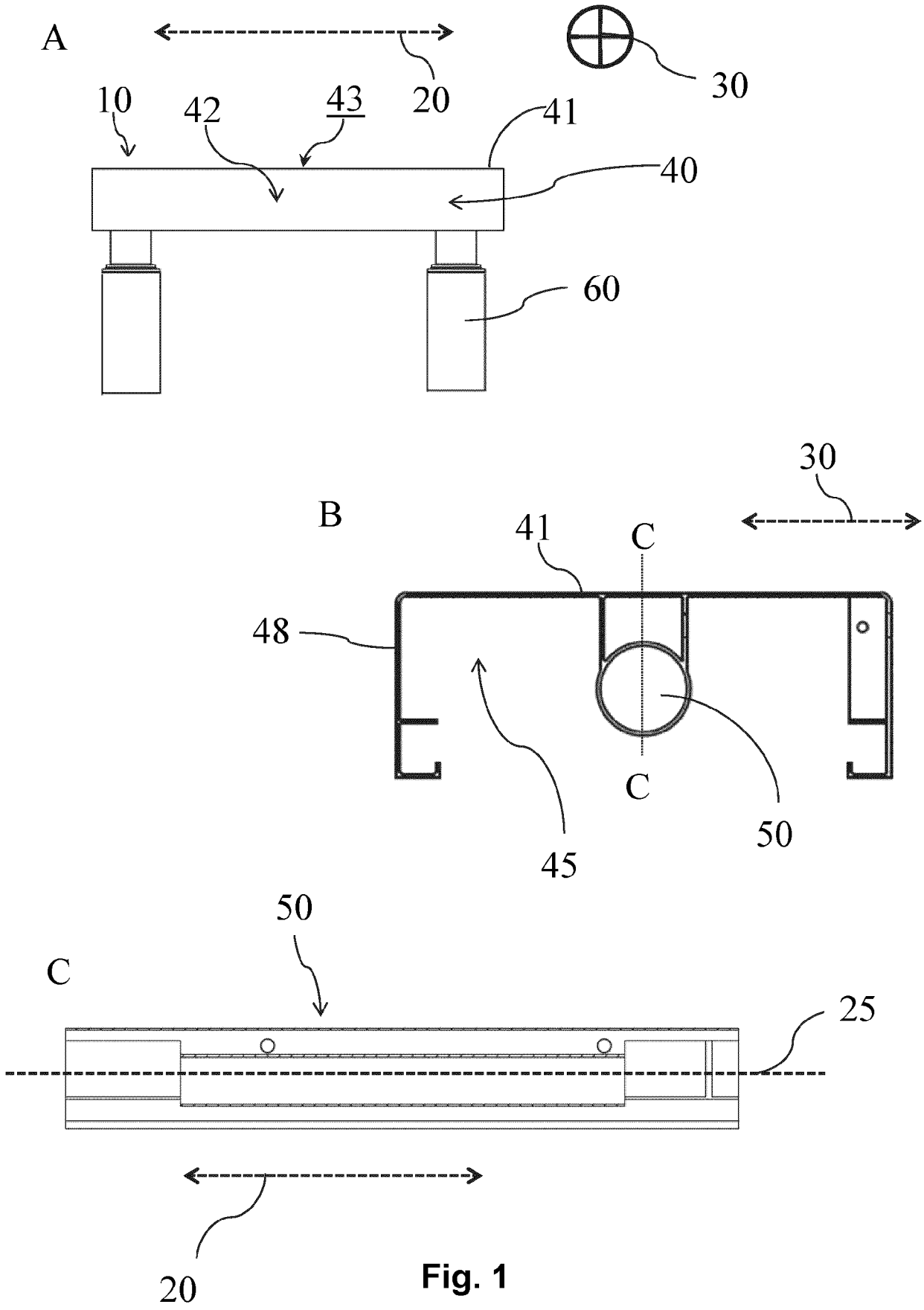


Fig. 1

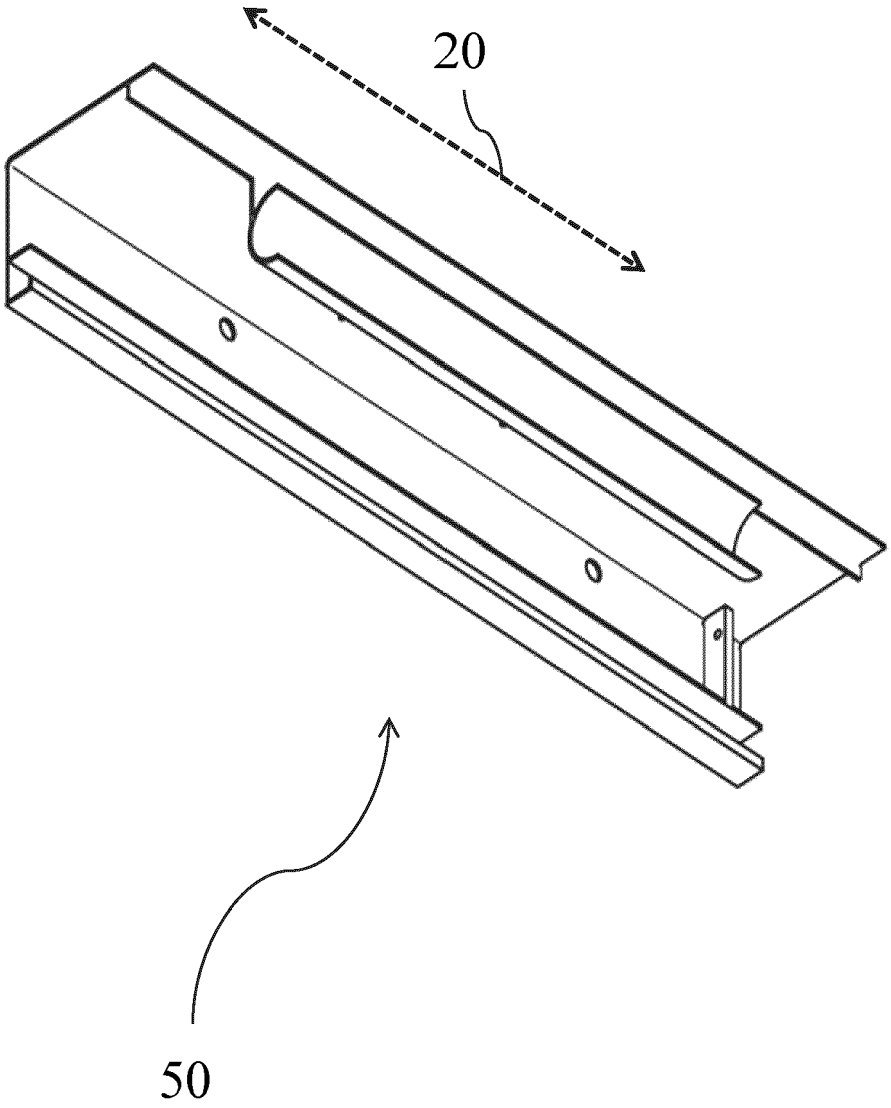


Fig. 2

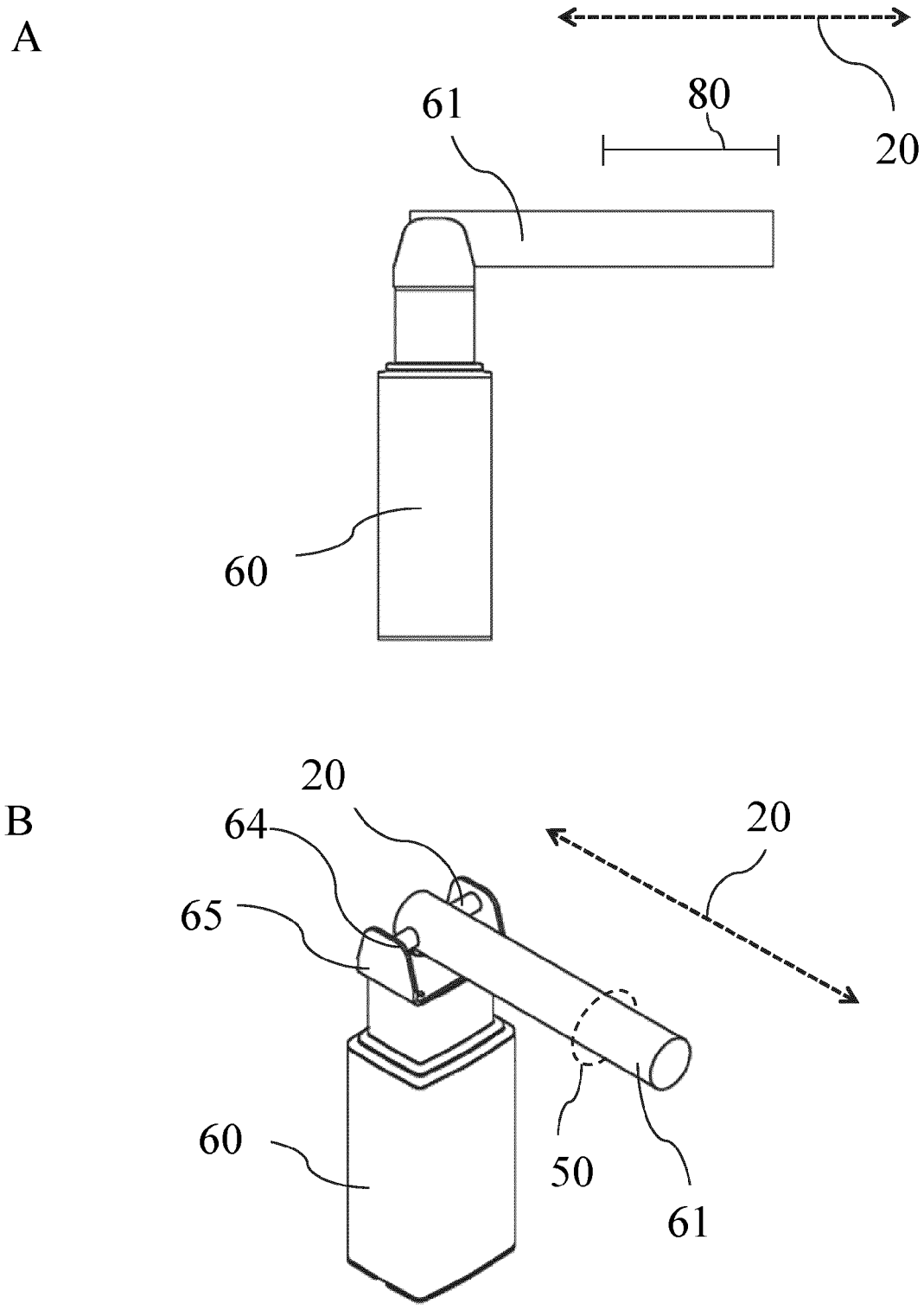


Fig. 3

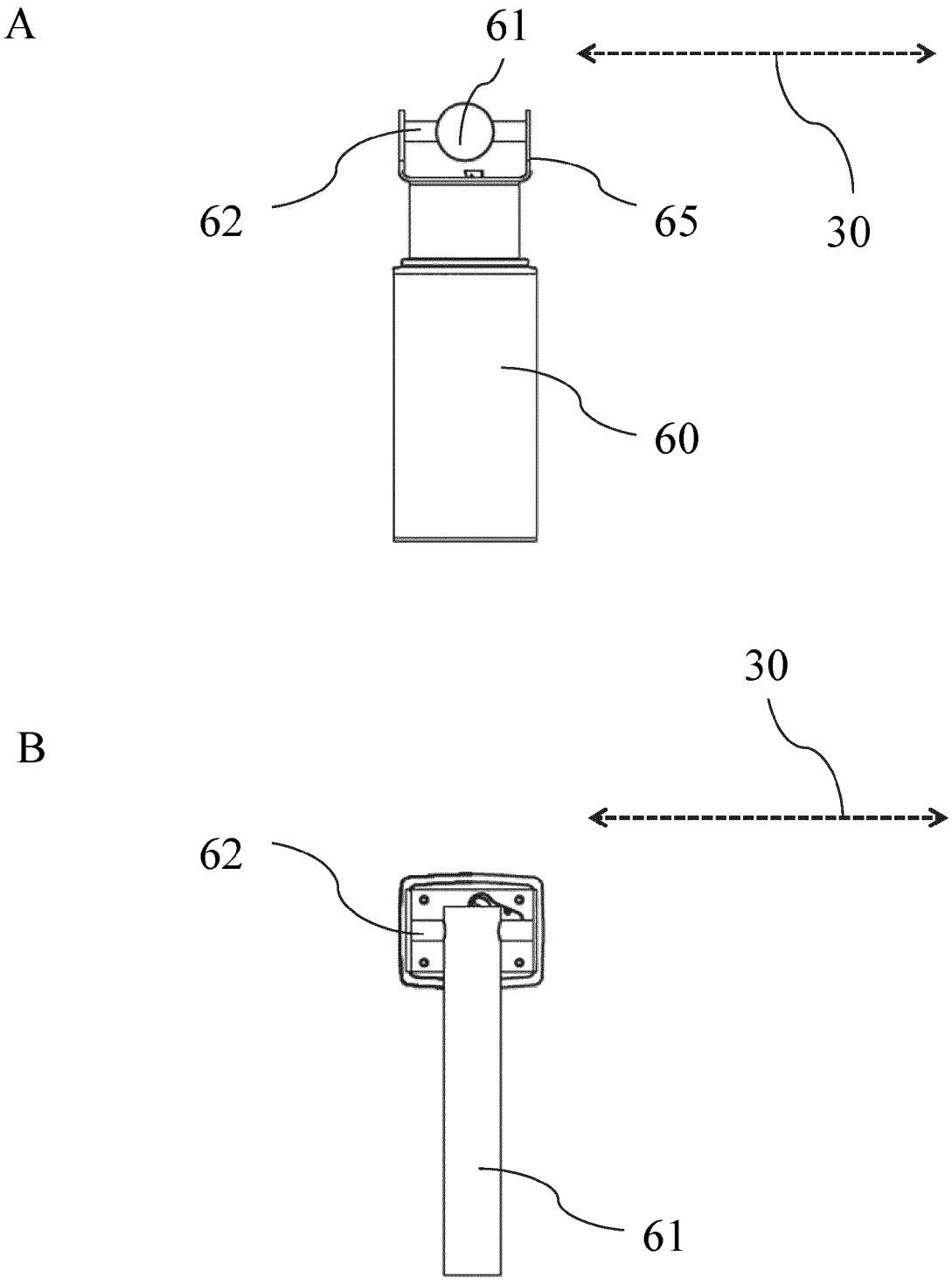
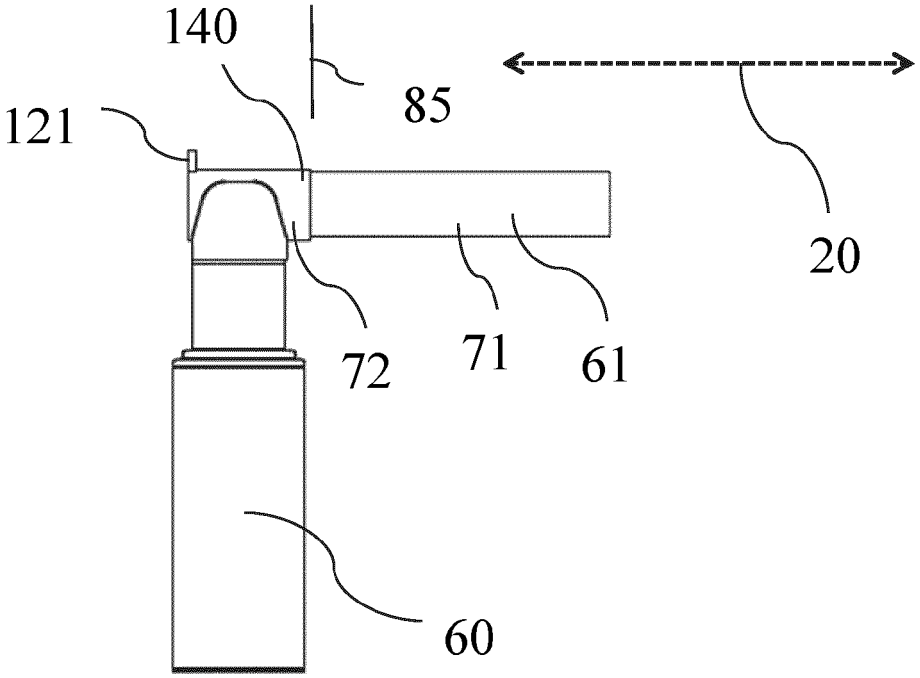


Fig. 4

A



B

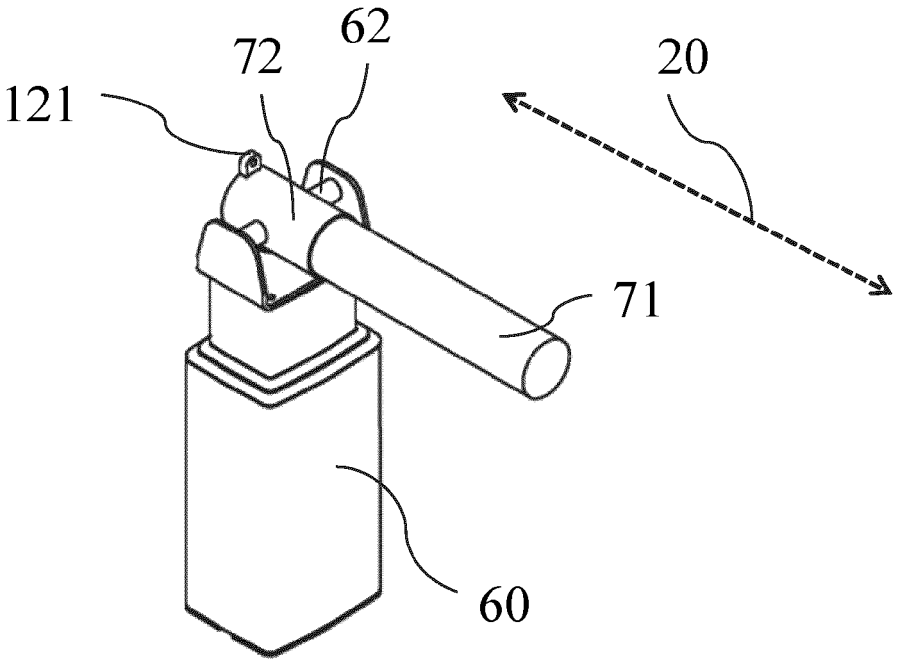


Fig. 5

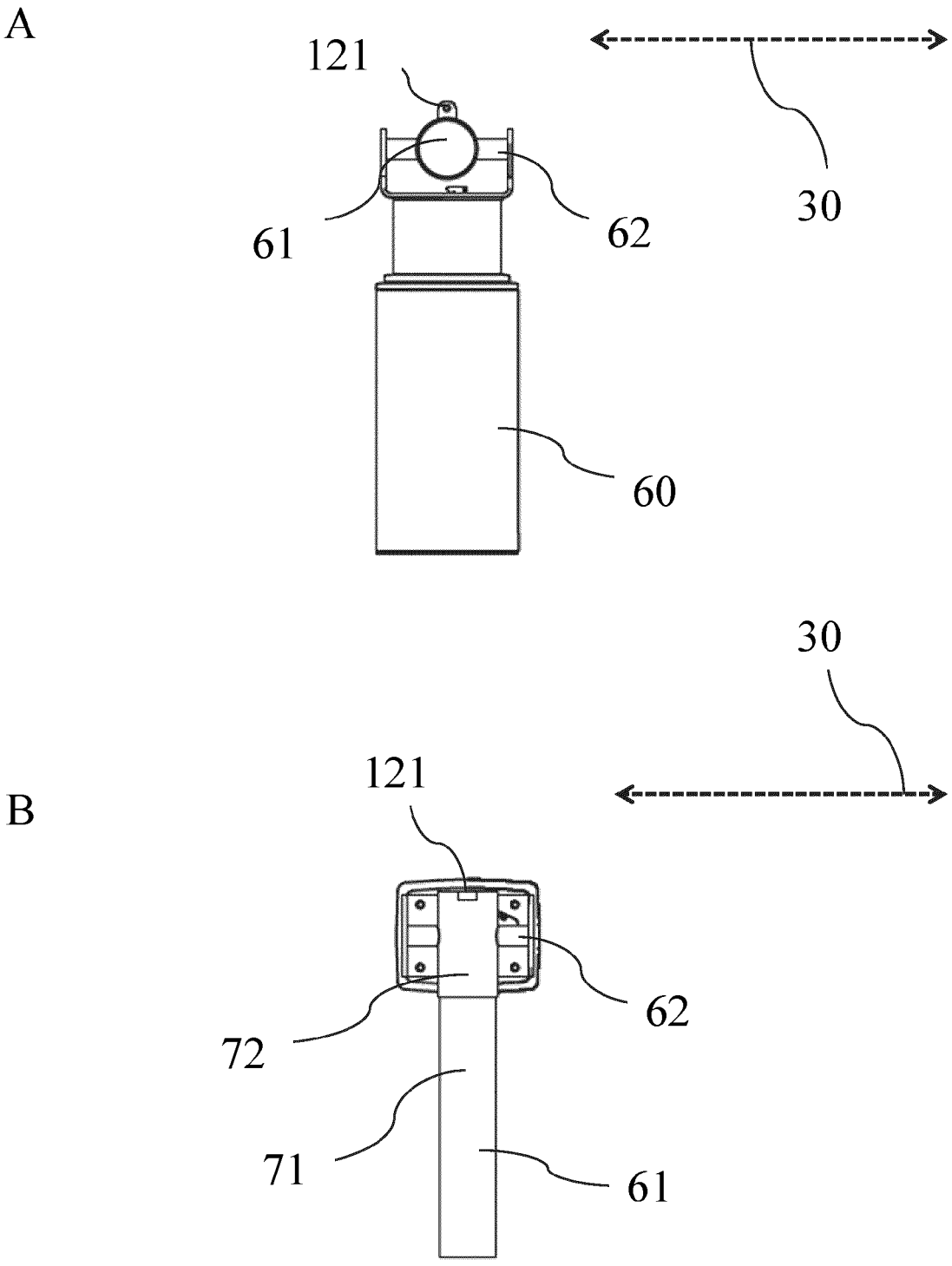


Fig. 6

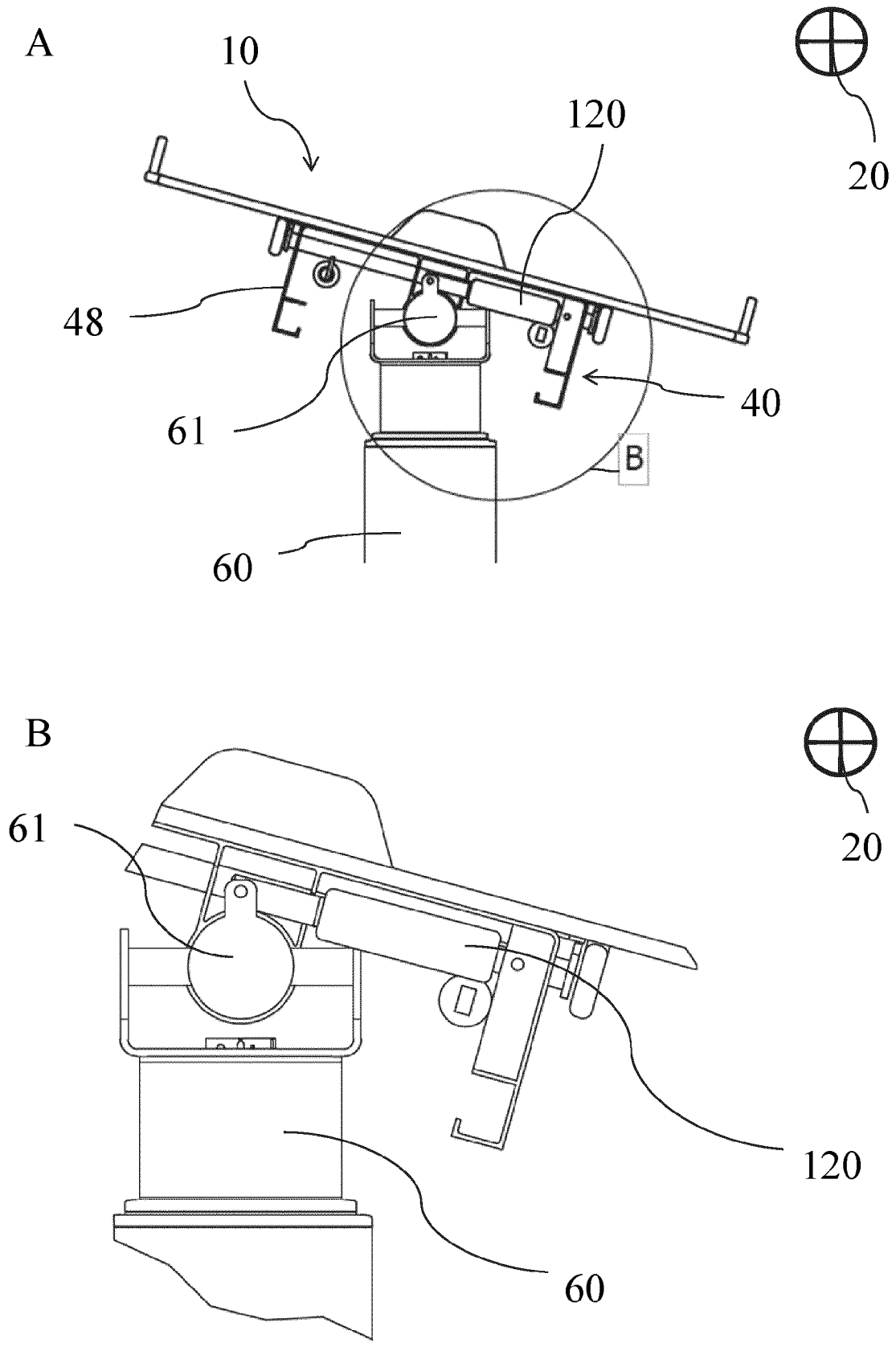


Fig. 7

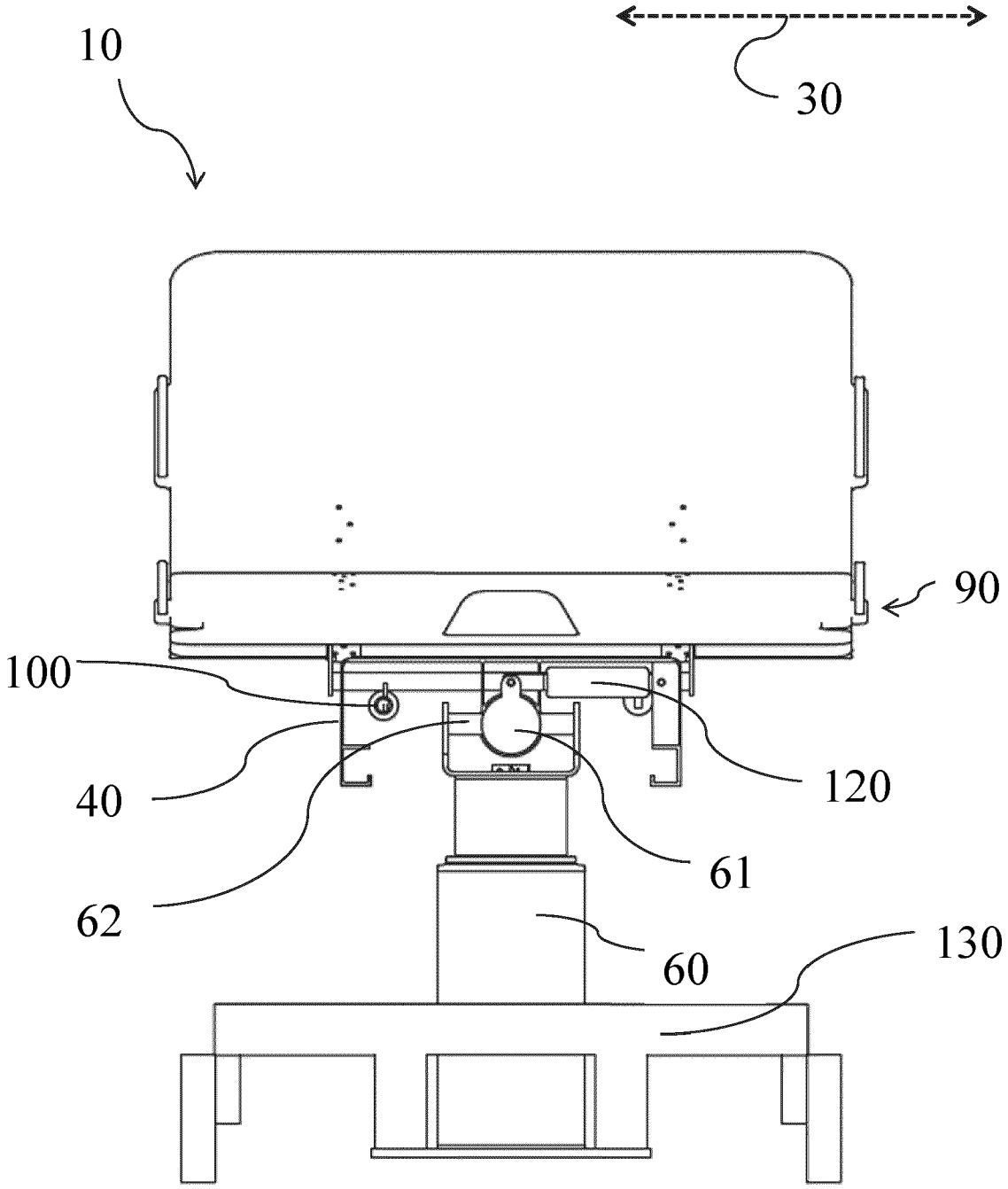


Fig. 8

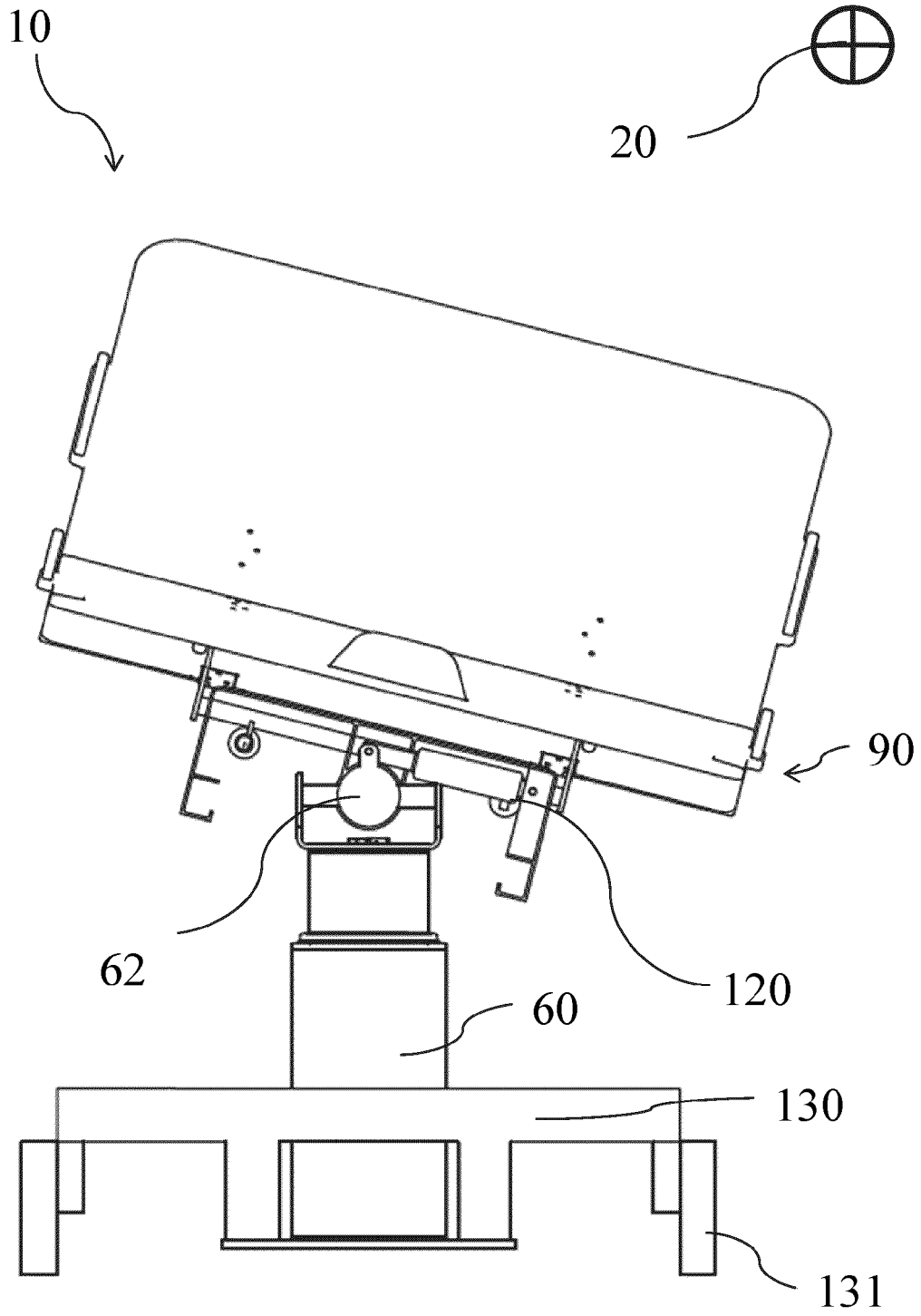


Fig. 9

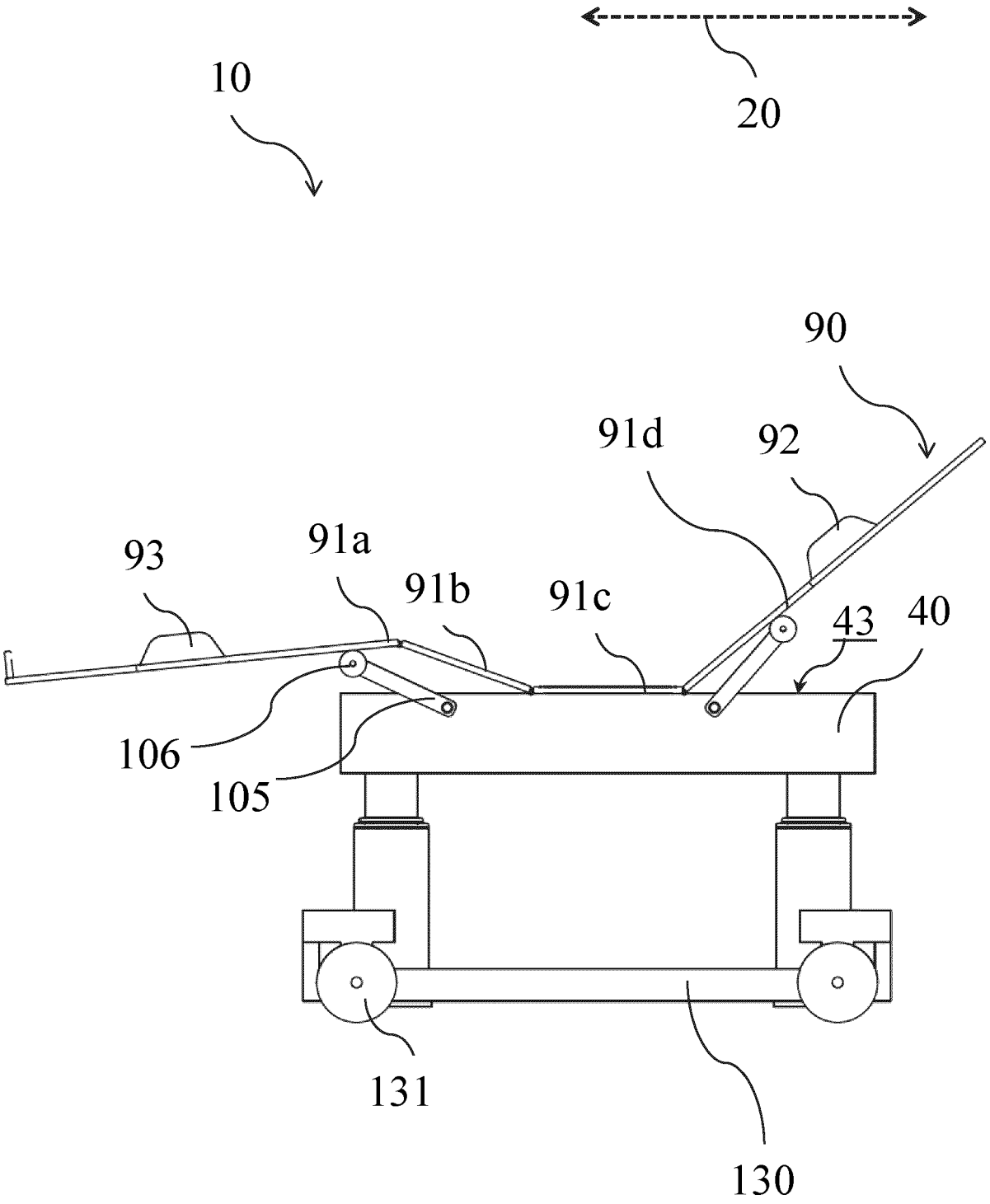


Fig. 10

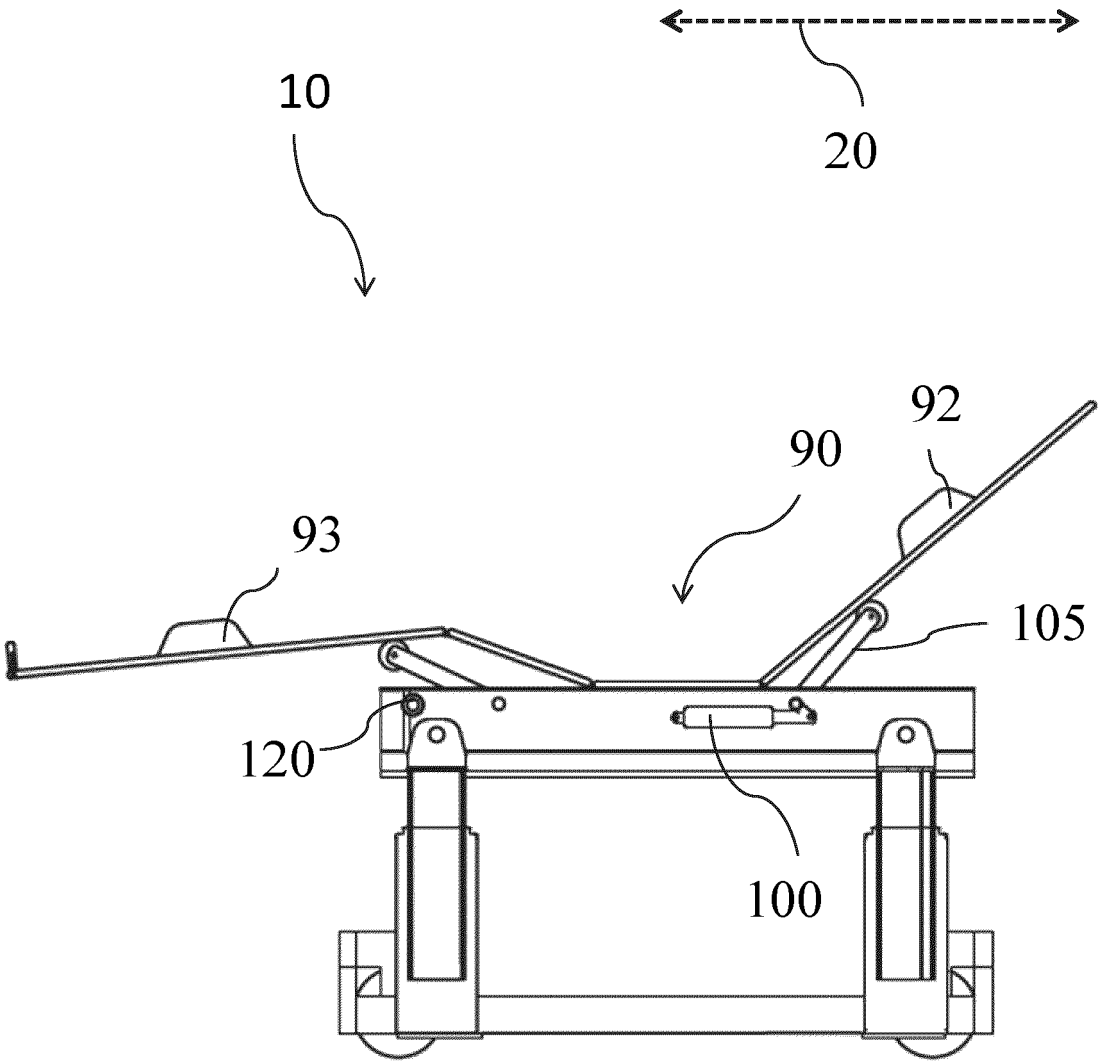


Fig. 11

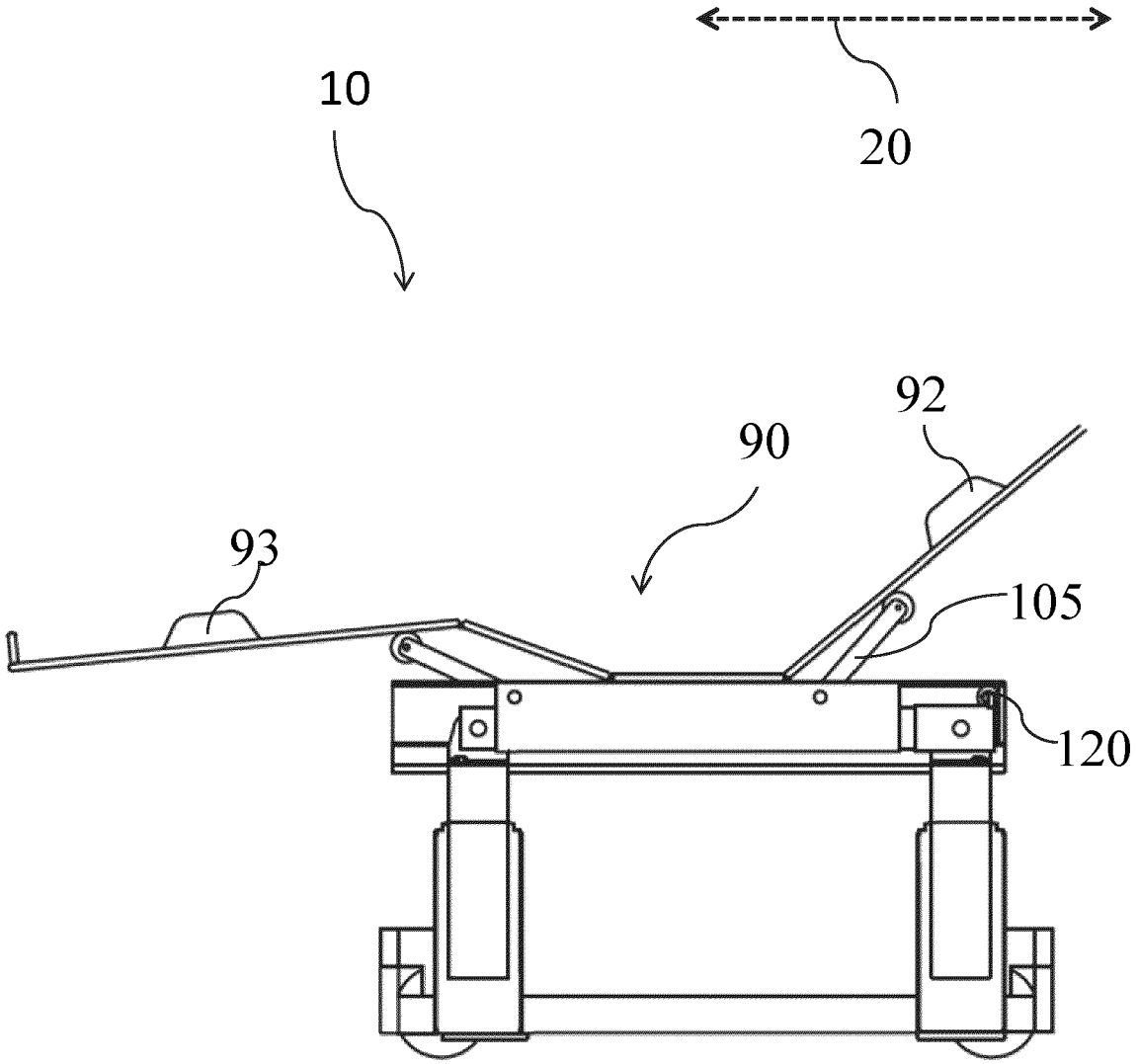


Fig. 12

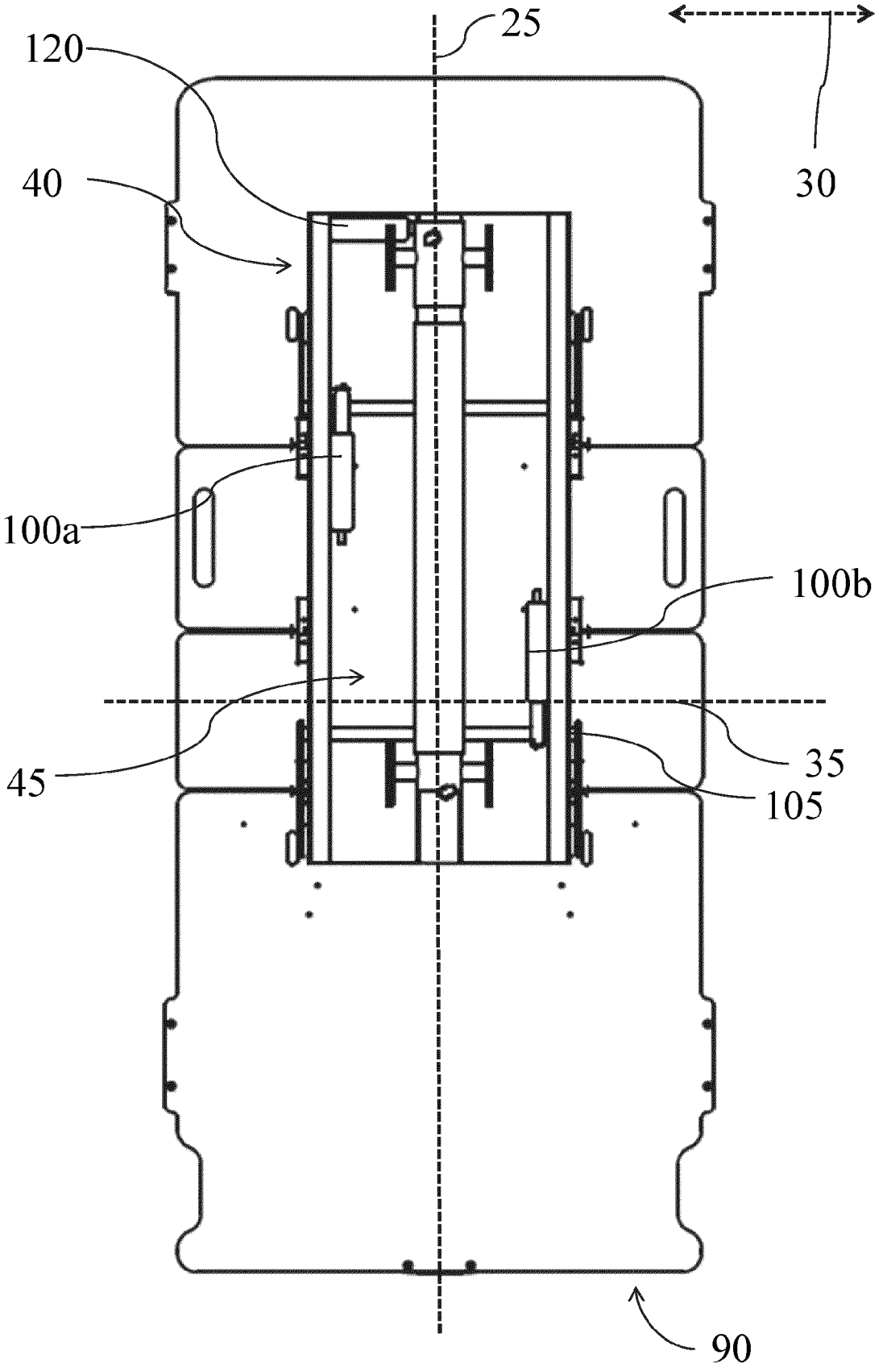


Fig. 13

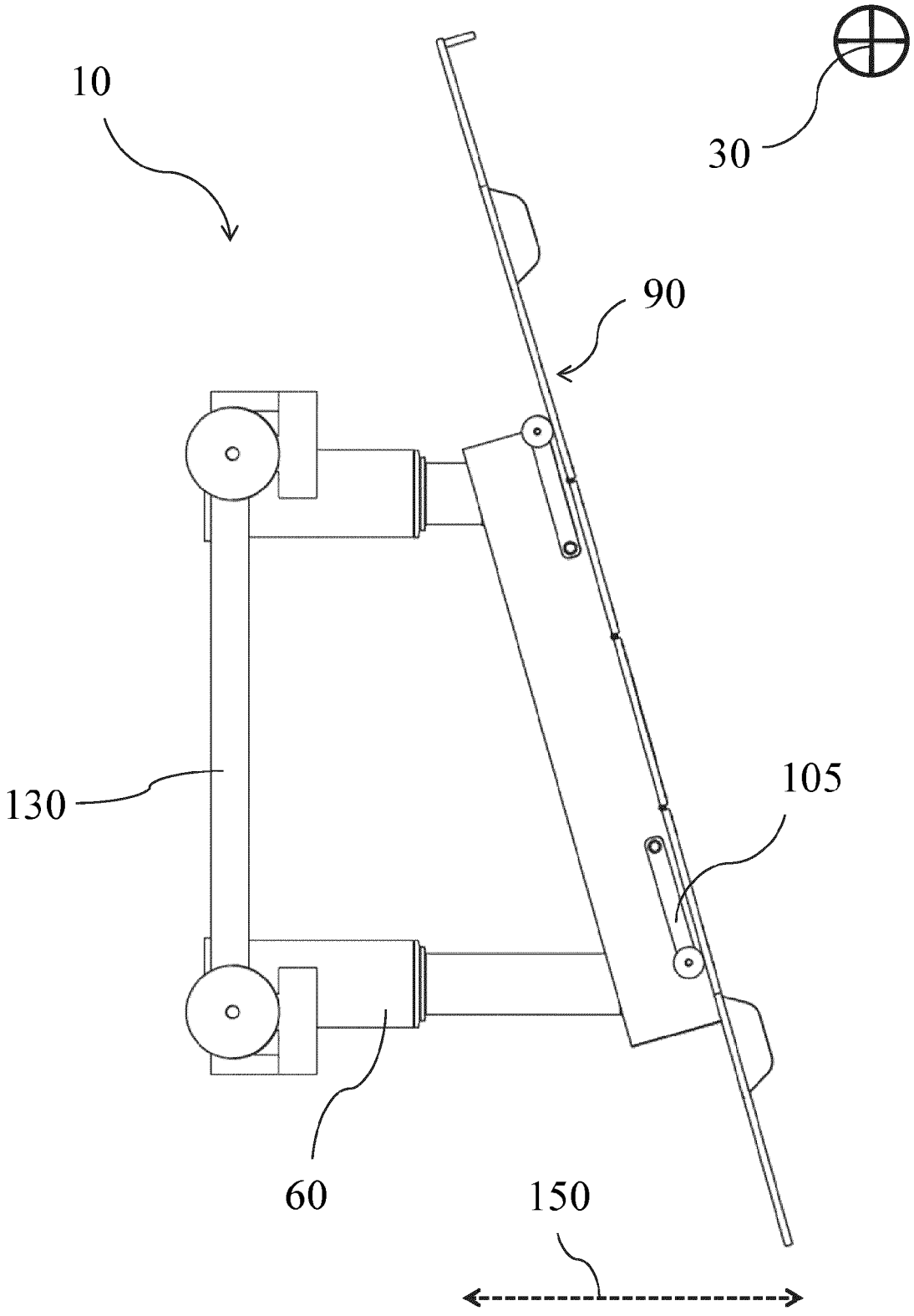


Fig. 14

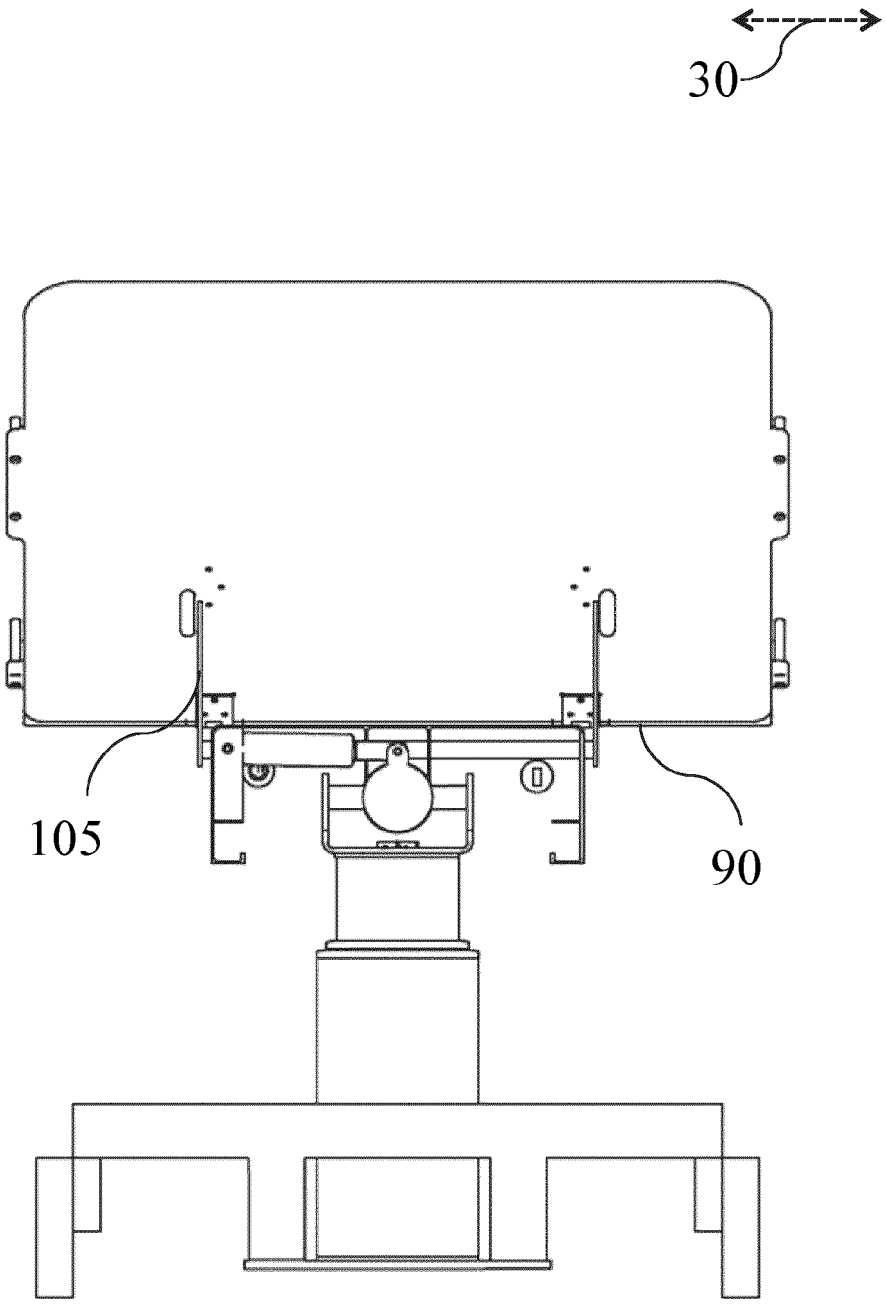
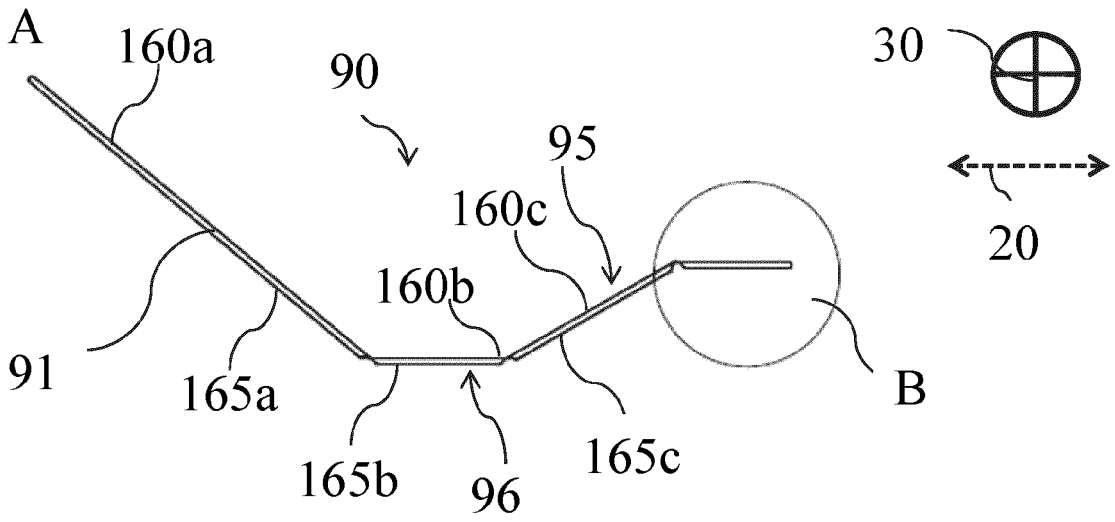
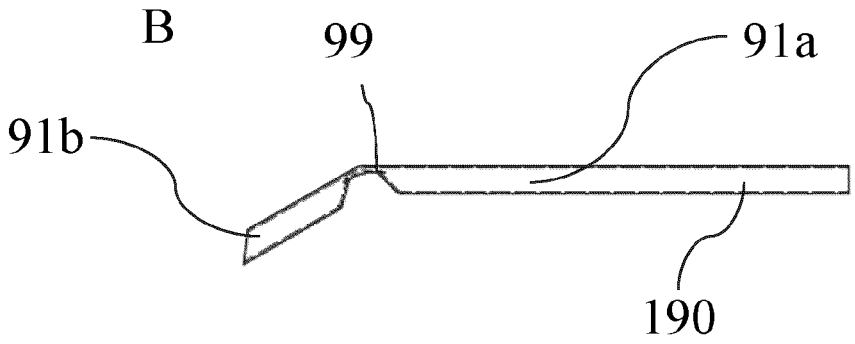


Fig. 15


A
160a
90
95
160c
160b
91
165a
165b
96
165c
B
30
20


B
99
91a
91b
190

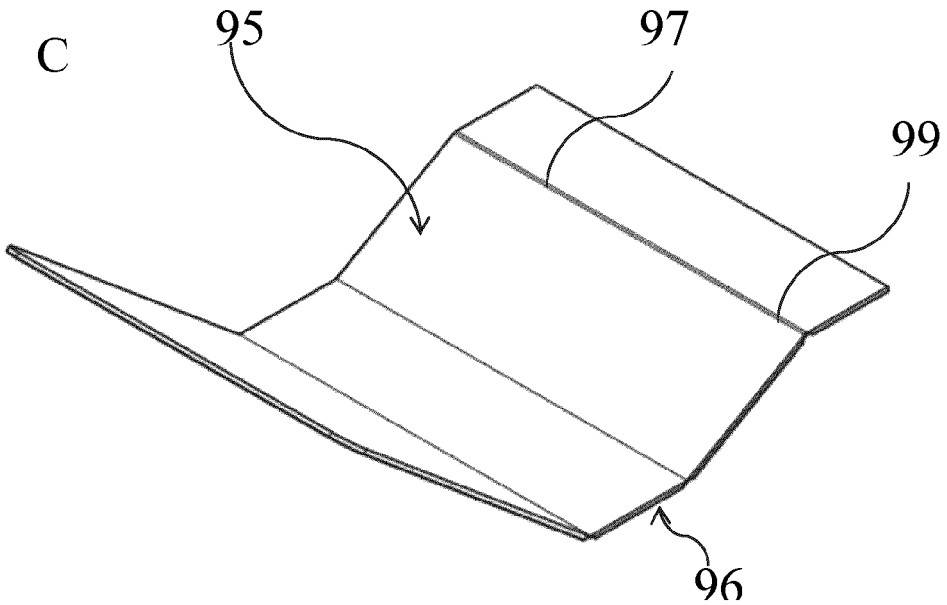

C
95
97
99
96

Fig. 16

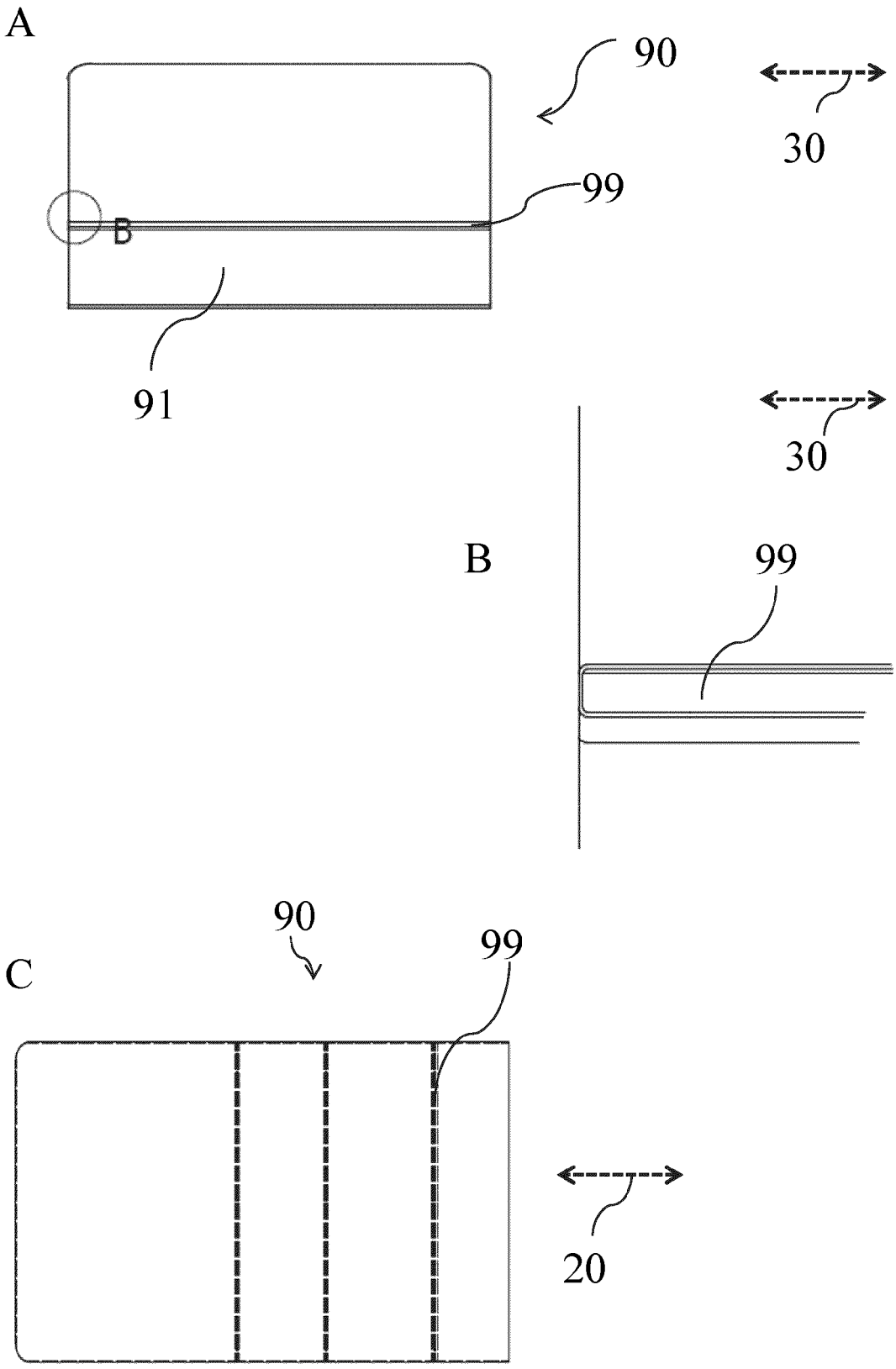


Fig. 17

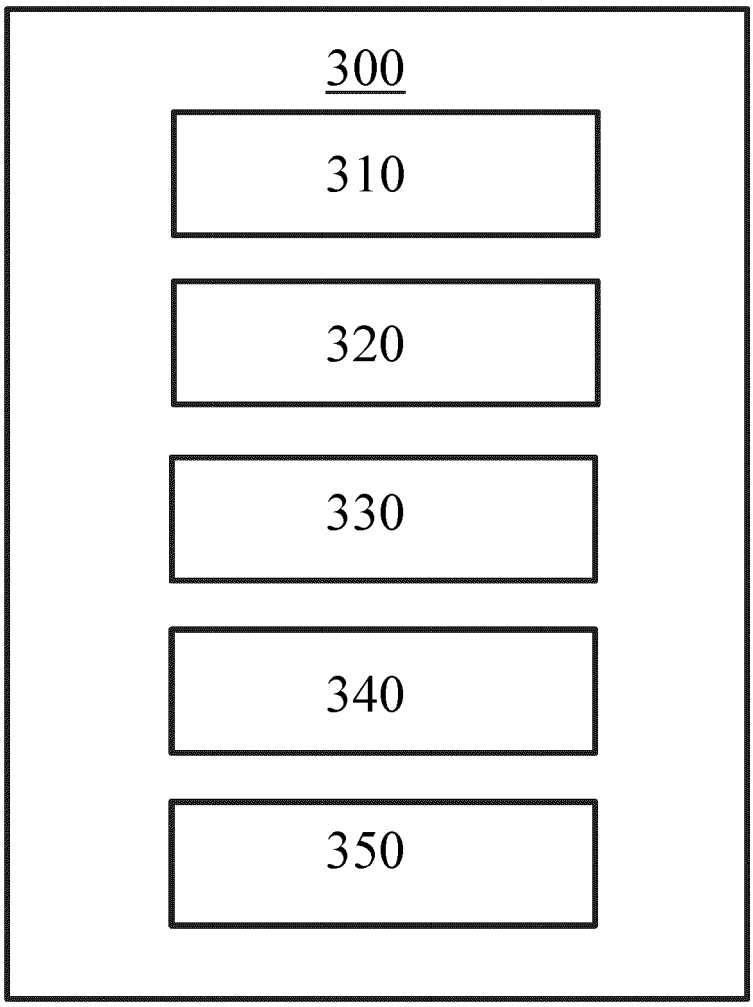


Fig. 18

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20110010858 A1 **[0005] [0008]**
- US 20140208512 A1 **[0006]**
- CN 1065800586 A **[0008]**