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

(11) **EP 2 873 404 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.05.2015 Bulletin 2015/21

(51) Int Cl.:
A61G 13/00 *(2006.01)*

(21) Application number: **14193867.0**

(22) Date of filing: **19.11.2014**

(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
Designated Extension States:
BA ME

(30) Priority: **19.11.2013 FI 20136157**

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(54) **An orthopedic device for mutual movements of leg and hips area**

(57) An orthopedic apparatus (1) intended for moving a leg and a hip area relative to each other, comprising a backing plate (2) which is intended for supporting the hip area and under which is coupled a first end (3b) of an elongated support rail (3) adapted to carry a leg propping portion (8), and said support rail (3) having its second, free end (3a) provided with a handle (6) for an adjustment mechanism intended for clamping and releasing motions of the support rail, and the leg propping portion (8) being mountable on the support rail (3) in a slidable manner, **characterized** in that the apparatus (1) includes a first adjustment mechanism, which comprises a pair of gas springs (4), which is located between the support rail's first end (3b) and brackets (20) attached under the backing plate (2) and which is used for adjusting the clamping of motion paths of the support rail and the force required for pivoting the support rail, as well as additionally a second adjustment mechanism, which is provided with a universal joint (5) and which, together with the first adjustment mechanism, defines horizontal and vertical motion paths for the support rail with respect to the backing plate (2), and which couples the first end (3a) of the support rail (3) pivotably under the backing plate or to the brackets (20) attached under the backing plate.

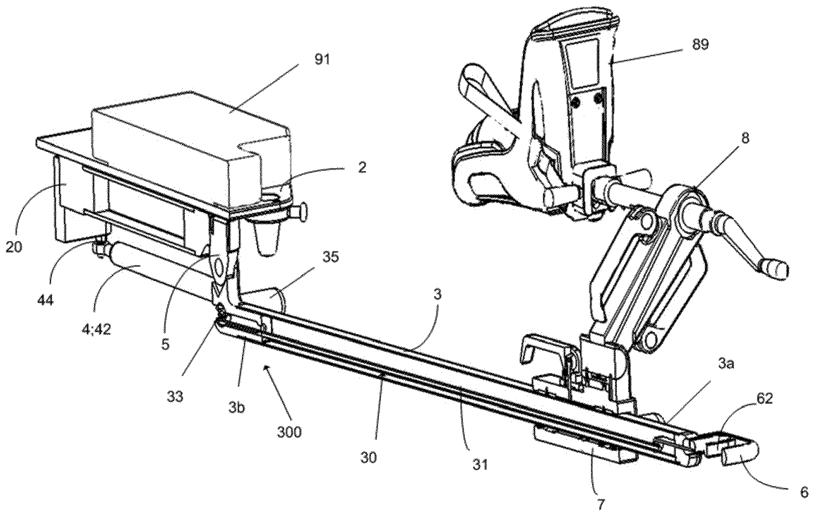

Fig. 1B

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Description

[0001] The invention relates to an orthopedic apparatus intended for moving a leg and a hip area relative to each other.

[0002] The invention relates also to a method for moving a leg and a hip area relative to each other with an orthopedic apparatus.

[0003] The invention relates further to a method for the treatment of a hip area by conducting the method with an orthopedic apparatus.

[0004] The prior art discloses orthopedic equipment intended for moving a leg and a hip area relative to each other, wherein the hip area is supported with a backing plate under which is coupled a first end of an elongated support rail adapted to carry a leg propping portion, and said support rail having its free end provided with a handle for an adjustment element intended for restricting motions of the support rail, and the leg propping portion being connectable to the support rail in a slidable manner. In these pieces of orthopedic equipment, the support rail linked to the backing plate has its horizontal and vertical trajectories controlled by means of two ball joints with a lockable relative position. Such a construction of the orthopedic apparatus is complicated in terms of both a design and a locking mechanism for the ball joints.

[0005] With the foregoing prior art as a departure point, the inventor set an objective of providing an orthopedic apparatus with a capability of producing leg movements relative to the hip joint, which from the standpoint of a user are similar to those obtained in prior art orthopedic equipment, but in which the construction of an actual apparatus, in terms of controlling and locking the trajectories of a support rail, would be remarkably simpler and more reliable than in equipment known from the prior art.

[0006] The above objectives are attained with an orthopedic apparatus of claim 1, as well as with a method of claim 11 for moving a leg and a hip area relative to each other with the orthopedic apparatus of claim 1.

[0007] More specifically, the invention relates to an orthopedic apparatus intended for moving a leg and a hip area relative to each other, comprising a backing plate which is intended for supporting the hip area and under which is coupled a first end of an elongated support rail adapted to carry a leg propping portion, and said support rail having its second, free end provided with a handle for an adjustment mechanism intended for clamping and releasing motions of the support rail, and a leg propping portion which is mountable onto the support rail in a slidable manner. The apparatus includes a first adjustment mechanism, which comprises a pair of gas springs located between the support rail's first end and brackets attached to the backing plate, preferably under the backing plate, and which is used for adjusting the clamping of motion paths of the support rail and the force required for pivoting the support rail, as well as additionally a second adjustment mechanism, which is provided with a universal joint and which, together with the first adjustment mechanism, defines horizontal and vertical motion paths for the support rail with respect to the backing plate, and which couples the first end of the support rail pivotably under the backing plate or to the brackets attached under the backing plate.

[0008] A preferred embodiment of the invention is based on having the support rail in the apparatus connected to the backing plate by way of a universal joint used for controlling the support rail in terms of the extent of its vertical and horizontal trajectories. In addition, the support rail's vertical and horizontal trajectories, as well as the support rail's clamping and the force required for moving the rail, are controlled by means of two pairs of gas springs, which on the one hand are connected to brackets present under the backing plate and on the other hand to a horizontal rotating shaft (center shaft) extending through the universal joint, whereby the gas springs always remain co-directional with the backing plate. Pivoting the support rail in horizontal or vertical direction relative to the backing plate changes a length of the gas springs present between the brackets and the center shaft and thereby makes a difference in the force required for pivoting the support rail. The position of the gas springs' piston rod relative to a respective cylinder and, at the same time, the position of the support rail relative to the universal joint and the backing plate, are clamped by means of a lever system which is operated from a handle present at the support rail's free end. Such a universal joint that controls the trajectories of a support rail, and a pair of gas springs clamping the same, constitute a structure which is remarkably simple.

[0009] The invention relates also to an orthopedic apparatus intended for moving a leg and a hip area relative to each other, comprising a backing plate which is intended for supporting the hip area and under which is coupled a first end of an elongated support rail adapted to carry a leg propping portion, and said support rail having its second, free end provided with a handle for an adjustment mechanism intended for clamping and releasing motions of the support rail, and the leg propping portion being connectable to the support rail in a slidable manner. The method comprises

- placing a foot on the leg propping portion in a way that the same leg has its hip area supported on the backing plate in such a manner that the hip joint is positioned in the direction of a plane of the backing plate at a location other than a longitudinal axis of the universal joint, i.e. a vertical shaft extending through the universal joint,
- releasing a clamping mechanism acting on a pair of gas springs of the first adjustment mechanism, as well as a locking engagement of the leg propping portion with the support rail,
- moving the support rail and the leg supported thereon through the intermediary of the propping portion

for repositioning the leg in relation to the hip joint supported on the backing plate, whereby the motion paths of the support rail and at the same time those of the leg in vertical and horizontal directions with respect to the backing plate are defined by the first adjustment mechanism, including the pair of gas springs which is located between the support rail's first end and brackets attached under the backing plate, together with a second adjustment mechanism provided with a universal joint,

- clamping the position of a piston of each gas spring with respect to a cylinder of the respective gas spring, as well as a locking engagement of the leg propping portion with the support rail, while at the same time clamping also the position of a leg in relation to the respective hip joint.

[0010] The invention relates also to a method of treating a hip area by conducting the method with an orthopedic apparatus according to any of claims 1-10 for moving a leg relative to a hip joint placed on a backing plate. The method comprises

- placing a foot on the leg propping portion in a way that the hip area is at the same time supported on a backing plate in such a manner that the hip joint is positioned in the direction of a plane of the backing plate at a location other than a vertical shaft extending through the universal joint,

- releasing a clamping engagement of the first adjustment mechanism comprising a pair of gas springs,

- moving the support rail and the foot propped up thereon, such that the support rail has the extent of its motion paths in vertical and horizontal directions defined by the first adjustment mechanism provided with a universal joint,

- clamping a position of the piston (rod) of each gas spring with respect to a cylinder of the gas spring,

- treating the hip area for example by imaging.

[0011] A further benefit gained by the use of a gas spring in clamping the motions of a support rail connected to the support rail's universal joint is that the support rail's raising motions are lightened by the gas springs.

[0012] In another preferred embodiment of the invention, the clamping mechanism's lever arm system comprises a tension rod or the like, which extends inside the support rail, is attached to the handle, and which is adapted to act by way of elongated coupling elements on an end of the piston of each gas spring in such a way that a position of the piston of said gas springs in the respective cylinder is releasable and lockable simultaneously.

[0013] In yet another preferred embodiment of the invention, the coupling elements have a first end thereof connected to the tension rod and have a free end thereof provided with a horizontally pivotable claw. The protrusions are adapted to rotate along with the center shaft. The lever arm system's coupling elements are coupled, in the proximity of a claw present at the free end thereof, in a horizontally pivotable manner, to an upright pin attached respectively onto the center shaft which extends inside the protrusion. Each claw, along with the coupling element acting on an end of the gas spring, is located on a gas spring fastener. By bringing the claw into a contact with the gas spring coupling element, the engagement between the claw and the upright pin, i.e. the gas spring fastener, will be released. At the same time, the clamping between the gas spring's piston and cylinder is released. The coupling element is preferably spherical and the claw and the coupling element have preferably an equal radius of curvature.

[0014] Restriction of the support rail's horizontal motions is implemented in such a way that the horizontal motions are restricted by a feature limiting the rotation of a rotating shaft extending through an upper joint member of the universal joint, such as a groove present on a surface of the upper joint member, which is matched by a counterpart of the groove located in a joint member opening present in the backing plate or in a joint member opening present in the brackets thereunder. On the other hand, adapted to restrict the support rail's vertical motions is preferably a mutual form-locking engagement of the lower joint member and the upper joint member, which prevents the rotation of these joint members relative to an articulated shaft of the universal joint.

[0015] Briefly, the support rail's horizontal motions are adapted to be restricted by a feature limiting the rotation of a rotating shaft P1 extending through an upper joint member of the universal joint, such as a groove present on a surface of the upper joint member, which is matched by a counterpart present on the backing plate or on its brackets, and the support rail's vertical motions are adapted to be restricted by a mutual form-locking engagement of the lower joint member and the upper joint member.

[0016] The support rail's horizontal or vertical motion is in this context perceived as the support rail's horizontal or vertical pivoting motion around an attachment point, which is located at a junction of the support rail's end coupled to the lower joint member and the lower universal joint.

[0017] The invention and benefits gained thereby will now be further illustrated with reference to the accompanying figures. Hence,

fig. 1A shows an apparatus of the invention in a perspective view seen from the front left-hand side with an upright cushion;

fig. 1B shows the apparatus of fig. 1A in a partial longitudinal section view without an upright cushion

seen from a direction IB in fig. 1A.

fig. 2A shows in a partially transparent manner a universal joint are for an apparatus of the invention in a perspective view;

fig. 2B illustrates more precisely in a laterally seen section view the universal joint area for an apparatus of the invention;

fig. 3A shows in a (longitudinal) section view seen directly from above the area of gas springs and a universal joint for an apparatus of the invention with the clamping mechanism in an open position;

fig. 3B shows at the viewing angle of fig. 3A and in a section view the area of gas springs and a universal joint for an apparatus of the invention with the clamping mechanism in a locked position; and

fig. 3C shows the area of gas springs and a universal joint for an apparatus of the invention as the apparatus is viewed from below,

fig. 4A shows a carriage in cross-section seen from the side, and

fig. 4B shows a carriage in cross-section seen from the front.

[0018] Subsequently, there will be a brief explanation as to which aspect of the invention is visualized by each figure as well as main structural elements shown in the figures for an apparatus 1.

[0019] The apparatus 1 best visible from the overall figures 1A and 1B is intended for moving a leg and a hip area relative to each other, and it comprises a backing plate 2 which is intended for supporting the hip area and under which is coupled a first end 3b of an elongated support rail 3 adapted to carry a leg propping portion 8. The support rail 3 has its second, free end 3a provided with a handle 6 for an adjustment mechanism intended for clamping the motions of the support rail, whereby the leg propping portion 8 is connectable onto the support rail 3 in a slidable manner. The aforementioned components of the apparatus can also be found in most of the prior art publications, which is why conventional modifications of the discussed components are regarded as being included in the scope of protection for an apparatus of the invention.

[0020] The apparatus 1 includes also a first adjustment mechanism, comprising a pair of gas springs 4 which is located between the support rail's first end 3b and brackets 20 attached under the backing plate 2. The first adjustment mechanism is used for counterbalancing motions of the support rail 3 as well as for controlling the clamping of the support rail's trajectories by means of a clamping mechanism 300 partially visible in fig. 1B.

[0021] In addition, the apparatus includes a second adjustment mechanism, which is provided with a universal joint 5 and which defines the extent of horizontal and vertical motion paths for the support rail 3, possibly together with the first adjustment mechanism, and which connects the first end 3b of the support rail 3 under the backing plate 2 or to (gas spring) brackets 20 attached to an underside of the backing plate 2. Fig. 1A also visualizes per se conventional cushions 91, 92 for the backing plate.

[0022] Figs. 2A and 2B illustrate more precisely a construction of the aforementioned universal joint 5. The universal joint 5 has an upper joint member 51, which is coupled by its top end to the backing plate 2 or to brackets 20 attached to and extending downward from the backing plate 2. By its bottom end, the upper joint member 51 is in turn coupled by way of an articulated shaft 53 to a lower joint member 52, which is L-shaped in its overall configuration and which is in turn coupled by its bottom end fixedly to the support rail's first end 3; 3b. The universal joint has its upper joint member 51 and lower joint member 52 disposed relative to the articulated shaft in a manner to enable rotation of the upper joint member 51 around the universal joint's longitudinal axis P1 in horizontal sense and rotation of the lower joint member 52 in vertical sense around the articulated shaft 53 which functions as a fulcrum. Hence, it is the universal joint 5 by which are enabled vertical and horizontal motions of the support rail 3 fixedly linked with the lower joint member 52; the vertical pivoting motion occurs around a horizontal axis P2 extending through the articulated shaft 53 and the vertical rotating motion occurs around the vertical axis P1 extending through the universal joint 5. Restriction of the horizontal and vertical motions of the support rail 3 occurs respectively by limiting the horizontal pivoting of the upper member 51 of the universal joint 5 around the longitudinal axis P1 and the vertical rotation of the lower member 52 relative to the articulated shaft 53.

[0023] In this context, the horizontal and vertical motions of the support rail 3 refer respectively to the support rail's motions relative to a horizontal direction defined by the plane of the horizontal backing plate 2 and a vertical direction transverse to this horizontal direction. The support rail 3 is generally placed in a horizontal direction or in a direction deviating slightly therefrom.

[0024] By means of figs. 3A-3C, and partially also fig. 2A, there is illustrated the construction and operation of a first adjustment mechanism used for counterbalancing and clamping motions of the support rail 3. As earlier pointed out in the context of figs. 1A and 1B, the first adjustment mechanism includes a pair of gas springs 4, which is located between a first end 3b of the support rail and brackets 20 attached under the backing plate 2. More specifically, the discussed pair of gas springs 4 extends by way of gas spring fasteners 38 from the backing plate's brackets 20 to a horizontal rotating shaft 39, or a center shaft 39, extending through a universal joint. Both protrusions 35 and the center shaft 39 (a body of rotation)

are provided with concentric openings 35a, 39d at a location by which the gas spring is brought inside the protrusion 35 and to edge grooves present at the ends of the center shaft 39.

[0025] Clamping of the gas springs is adjusted with a clamping mechanism 300, comprising a handle 6 which is present at a free end 3a of the support rail 3 and which is adapted to employ a lever arm system 30 for acting upon ends 41 c, 42c of the gas spring's piston rods 41 a, 42a in such a way that a position of the gas spring's piston rod 41 a, 42a with respect to a respective cylinder 41 b, 42b is capable of being clamped and released.

[0026] Once the gas springs 4; 41, 42 have been connected to the lever arm system's coupling elements 32; 32' and 32; 32" present in end grooves 34 of the shaft 39, the position of the gas spring's piston rods 41 a, 42a relative to cylinders is clamped, as is also the relative position between the lever arm system 30 and the gas springs 4, which prevents a motion of the tension rail 3 relative to the gas springs 4 since the lever arm system extends inside the tension rail.

[0027] The pivoting motion of the gas springs 4 connected in a releasable manner to the end grooves 34 of the center shaft 39, and at the same time the pivoting motion of the support rail 3 relative to the gas springs 4, is adapted to be restricted on the one hand by limiting surfaces 34a of the end groove 34 of the center shaft 39 as well as an inner edge 34b of the groove and, on the other hand, by an outer edge 34c of the groove 34. Likewise, the edges of the opening 35a, 39a may also function for their part as limiters for pivoting motions of the gas springs 4.

[0028] A pivoting angle of the support rail 3 with respect to the gas springs is adapted to be restricted also by the gas springs' fasteners 38, which connect to the end grooves 34 present at the ends of the center shaft 39. The gas springs 4; 41, 42 have the ends 41 c, 42c of their piston rods connected to these gas springs' fasteners 38 in a way to enable a release of the engagement between the gas spring's piston and cylinder. Even though the engagement between cylinders and piston rods is uncoupled, the relative rotating motion between the gas springs 4 and the center shaft 39 in a plane extending through the gas springs is nevertheless prevented by engagements between the ends 41 c, 42c of the piston rods 41 a, 42a and the gas springs' fasteners 38.

[0029] The fasteners 38, which connect to the end grooves 34, function also as motion limiters 38 restricting a rotating motion of the shaft 39 around its longitudinal axis.

[0030] By means of figs. 4A and 4B there is illustrated a clamping arrangement on the support rail 3 regarding a carriage 7 which holds up the propping portion 8.

[0031] The invention will next be described in even more detail with reference to the foregoing general description of the invention as well as to figures 1-4.

[0032] Inside the hollow support rail 3 in an apparatus of the invention extends a tension rod 31, which is included in a lever arm system 30 of the clamping mechanism 300 and which extends all the way to a free end 3a of the support rail 3. Connected to the end of the tension rod 31 is a trigger 62 intended for the handle 6 and present at the free end of the support rail 3. The trigger 62 acts on the tension rod 31 of the lever arm system 30 in a way that enables the cylinder and the piston of gas springs 4 to be clamped relative to each other.

[0033] The tension rod 31 of the lever arm system 30 extends to a hollow center shaft 39 connected perpendicularly with a junction of an end 3b of the support rail 3 and a lower member 52 of the universal joint 5 at the end of the support rail 3 proximal to the backing plate 2.

[0034] Through the end 3b of the support rail 3, associated with the lower member 52 of the universal joint 5, extends a rotation axis, i.e. a center shaft 39, which is horizontal in a transverse direction, i.e. co-directional with the backing plate 2. The center shaft 39 has its ends, which protrude from the support rail 3, surrounded by hollow protrusions 35. The center shaft 39 comprises a stub axle through which extends a center opening, such as a center bore. At each end of the center shaft 39, the center bore expands to form an end groove 34, which is limited in a lengthwise direction of the center shaft 39 by a first guide or limiting surface 34a which passes diagonally relative to a transverse direction of the center shaft (stub axle) 39, as well as by an inner edge 34b of the groove 34 proximal to the center bore. A second limit surface lengthwise of the groove 34 of the center shaft 39 is made up by an outer edge 34c of the groove 34. If the center shaft 39 has been designed to be open at its ends, the pivoting of the gas springs relative to the center shaft 39, in a direction transverse to said center shaft, will be limited by internal surfaces of the protrusion 35.

[0035] Inside an opening running through the center shaft 39 extend the lever arm systems coupling elements 32; 32', 32', connecting by their first, inner ends 32; 32b; 32b', 32b" pivotably to the tension rod 31. Connection with the tension rod 31 is effected from an engagement point of the support rail and the center shaft by means of an articulated joint 33, such as a stud nut 33. The outer ends of the coupling elements 32, which are free as far as the center shaft 39 is concerned, are designed as claws 32'a and 32"a which extend to the fasteners 38 of the gas springs 4 disposed in the end grooves 34 of the center shaft 39. The lever arm system has its coupling elements 32; 32' and 32; 32" connected to an upright pin 36, such as a cotter pin 36, extending through the stub axle in a horizontally pivotable manner in the proximity of the claw 32'a or 32"a present at the free end thereof.

[0036] The center shaft has its end grooves 34 provided with the gas springs' fasteners 38, which are set in a horizontally pivotable manner in the end grooves 34 present at both ends of the center shaft 39. Seen from lateral sides 3c, 3d of the support rail 3, the end grooves 34 lie at an approximately right angle in the ends of the center shaft. Inside each of these is disposed the claw 32'a, 32a" of an elongated coupling element 32' or 32"of

the lever arm system 30 so as to attach themselves, in a manner pivotable in a transverse direction or towards the gas springs, to attachment pins 38a present at an upper end of the gas springs' fasteners 38. The gas springs fasteners 38 have also engaged thereon the gas springs' piston ends 41 c, 42c, such that a functional communication between the lever arm system 30 and the gas springs 4 is openable and closable by means of ball-shaped coupling elements 44 which travel at the gas springs' ends 41 c, 42c. Once the communication between the gas springs' cylinders 41 b, 42c and piston ends 41 c, 42c has been opened by connecting the lever arm system 30 to the gas spring 4, the shaft will be connected thereby at the same time functionally to the gas spring 4, whereby the gas springs 4 can be pivoted relative to the shaft 39 in a horizontal direction within a range defined by the motion limiters 34a, 34b as well as 34c present in the end grooves. Since the shaft 39 can be additionally pivoted from the tension rod 3 around its longitudinal axis and laterally in the direction of the backing plate, the gas spring has an effect also on these trajectories of the shaft 39 and the tension rod 3 coupled to the shaft.

[0037] It is possible to arrange each claw 32's and 32"a in contact with the piston rod end 41 c or 42c of the gas spring 4 by pulling the tension rod 31 by means of the trigger 62 of the handle 6 towards the free end 3a of the support rail 3. When the lever arm system 30 is operated from the handle's trigger in such a way that the tension rod 31 travels towards the free end of the support rail 3, the inner ends 32b', 32b" of the coupling elements 32 will also be pulled by the tension rod 31 through the intermediary of the articulated joint 33 towards the support rail's free end 3a. The result of this is that the claws 32'a and 32"a, which are present at the free ends of the coupling elements 32' and 32" mounted pivotably by way of the upright pins 36 on the gas springs' fasteners 38, shall turn in the end grooves 34 around the upright pins 36 in a horizontal direction towards the cylinders 41b, 42b of the gas springs 41, 42. When the claws 32'a and 32"a present at the gas springs' fasteners 38 turn away from the gas springs' fasteners 38, the result is that the tension rods' claws 32'a and 32"a push themselves into contact with the gas springs' ball-shaped coupling elements 44. The coupling elements 44 and the claws 32'a and 32"a move away from the fasteners 38, which releases the clamping engagement between the piston and the cylinder 41 b, 42b of the gas springs 41, 42 and allows the gas springs 4 to turn along with motions of the shaft 39 and at the same time those of the support rail 3.

[0038] Accordingly, the pulling of a trigger, included in the handle 6 that operates the lever arm system 30 of the clamping mechanism 300, brings about a horizontal turning movement of the claws 32'a and 32"a present at the end of the elongated coupling elements 32; 32', 32' attached to the tension rod 31 extending inside the support rail 3. These act upon the end 41 c, 42c of the piston 41 a, 42a of each gas spring 41, 42 simultaneously with the gas springs' coupling elements 44.

[0039] The gas springs' free ends 41 c, 42c are in attachment with the gas springs' fasteners 38 in a pivotable manner. Hence, the clamping of the free ends 41 c, 42c of the gas springs 41, 42 on the fasteners 38 as the claws 32'a, 32"a become coupled again to the gas springs' fasteners away from the gas springs, causes also the clamping of the support rail 3 with respect to the gas springs 4 because the tension rod 31, extending inside the support rail 3, is coupled by way of the claws to the fasteners 38, thereby preventing a relative rotation between the center shaft 39 and the tension rod around a longitudinal axis of the center shaft. The clamping engagement is promoted by the fact that the claws 32'a, 32"a and the gas springs' coupling elements 44 have a substantially equal radius of curvature.

[0040] When the clamping is not engaged between the piston rods and the cylinders 41 b, 42b of the gas springs 41, 41 of the pair of gas springs 4, these will be capable of having a counterbalancing and exacting effect on the motions of the support rail 3. The fasteners 38 of the gas springs 41, 42 are fitted in the end grooves 34, which also enables a rotation of the mutual lengthwise direction of the gas springs 4 and the support rail 3 in a plane extending through the gas springs 41, 42 once the clamping engagement between the gas springs 4 and the lever arm system 30 has been released.

[0041] The gas springs 41, 42, which are capable of being brought to the gas springs' fasteners 38 for a clamping engagement, have the ends 41 c, 42c of their piston rods 41, 42 mounted, in horizontal and vertical directions, i.e. both in a plane extending through the gas springs and in a direction transverse to the plane of the gas springs, pivotably on the gas spring's fastener 38 remaining inside the end protrusion 34 of the center shaft 39.

[0042] The gas springs' fastener 38 is coupled to the center shaft 39, which is able to rotate relative to the tension rod 3 within a range allowed by the opening 35a, 39a, thus enabling on its part the vertical motions of the tension rod 3 as the gas springs rotate along with the center shaft. Consequently, the pivoting of the support rail 3 relative to the end of the gas springs 41, 42 brings about a change in a distance between the ends 41 c, 42c of the gas springs 41, 42 mounted on the center shaft 39 and the part mounted on the backing plate's brackets 20, resulting in a respective change in the length of the gas springs 41,42.

[0043] Pivoting the support rail 3 in a horizontal direction around the vertical axis P1 extending by way of the universal joint 5 brings about a lengthening of the first gas spring and a shortening of the second gas spring.

[0044] On the other hand, pivoting the support rail 3 in a vertical direction around the articulated shaft 53 brings about a shortening or lengthening of each gas spring 41, 42 simultaneously. It is the lengthening of each gas spring 41, 42 which counterbalances an upward pivoting motion of the support rail 3. Hence, pivoting the lower joint mem-

ber 52, fixedly connected to the end of the support rail 3, in a vertical direction around a horizontal axis P2 of the universal joint 5 located on the articulated shaft 53 brings about pivoting of the support rail 3 relative to the center shaft 39 which is horizontal or co-direction with the backing plate and extends through the universal joint's lower member 52. As a result, the coupling elements 32', 32", mounted centrally on the center shaft 39, and the gas springs' ends 42c, 41 c pivot along with the center shaft 39 with respect to the support rail 3 in such a way that the direction of the gas springs 41, 42 relative to the backing plate 2 remains the same.

[0045] When the engagement is clamped between the piston rod ends 41 c, 42c and the fasteners 38 of the gas springs 41, 42, the position between the piston and the cylinder of each gas spring will be locked at the same time and a motion of the support rail in vertical and horizontal directions will be prevented.

[0046] Fig. 3A depicts a condition in which the claws 32'a and 32"a, present on the gas springs' fasteners 38, have been brought into contact with the ball-shaped coupling elements 44 acting upon the free piston ends 41 c, 42c of the gas springs 41, 42. At this point, the ends 41 c, 42c of the gas springs' piston rod 41 a, 42a continue to be coupled to the gas springs' fasteners 38, 38, but the position between the piston rod 41 a, 42a and the lever arm system 30 is no longer clamped. The piston rods 41 a, 42a can be pivoted relative to the fasteners 38 in a plane extending by way of the gas springs 4; 41, 42, whereby the angle of a lengthwise direction of the shaft 39 relative to a lengthwise direction of the gas springs 4 will be pivoted at the same time in said plane extending by way of the gas springs 4. The angle between a lengthwise direction of the shaft 39 and a lengthwise direction of the gas springs can be pivoted within a range defined by the limiting surfaces 34a, 32b as well as 34c of the groove 34.

[0047] In case the shaft 39 is open at its ends, the angle between a lengthwise direction of the shaft 39 and a lengthwise direction of the gas springs can be pivoted within a range defined by the limiting surfaces 34a, 32b of the groove 34 as well as by a surface of the protrusion 35 present on top of the groove. Because the support rail 3 is connected to the universal joint 5 in such a way that the shaft 39 extends through the lower joint member 52 of the universal joint and through the support rail and always in a transverse direction relative to the support rail 3, the angle between a lengthwise direction of the shaft 39 and a lengthwise direction of the gas springs defines also an angle between the support rail 3 and the gas springs 4, i.e. the extent by which the support rail 3 can be pivoted with respect to the lengthwise direction of the gas springs 4 in a plane extending by way of the gas springs 4.

[0048] Because the ends 41 c, 42c of the piston rods 41 a, 42a are mounted in a horizontally pivotable manner on the fasteners 38 of the center shaft 39 and the center shaft 39 pivots in a horizontal direction relative to the support rail 3, the pivoting of the support rail 3 forces the gas springs 41 and 42 to either lengthen or shorten, depending on a motion direction of the support rail 3.

[0049] It is also possible to clamp the ends 41 c, 42c of the piston rods 41 a, 42a of the pair of gas springs 4 by way of the gas springs' fasteners 38 to the claws 32'a, 32"a of the lever arm system 30, which prevents pivoting of the gas springs 4 on the center shaft 39 in a horizontal direction as well as prevents rotation of the center shaft 39 with respect to the support rail 3, thereby locking a relative position of the pair of gas springs 4 and the support rail 3.

[0050] The support rail 3 can be additionally pivoted to the extent defined by the universal joint 5 in horizontal and vertical directions when the horizontal direction is perceived as a plane extending by way of the backing level 2.

[0051] In an apparatus of the invention described in the foregoing exemplary embodiment, the extent of motions of the support rail 3 in horizontal and vertical directions (as the direction of the backing plate 2 is regarded as a horizontal direction) can be adjusted primarily by means of the universal joint 5 coupled between the end 3b of the support rail 3 and the backing plate 2.

[0052] Restriction of the horizontal and vertical motions of the support rail 3 can also be conducted with the universal joint 5. In the above-described preferred exemplary embodiment of the invention, the protrusions 35 are adapted to rotate along with the center shaft 39 and the restriction of horizontal motions of the support rail 3 is mainly implemented in such a way that the horizontal motions are restricted by a feature, such as a groove on a surface of the upper joint member 51, which limits rotation of the rotating shaft P1 extending through the upper joint member 51 and which is matched by a counterpart of the groove located in a joint member opening in the backing plate or in a joint member opening in the brackets 20 thereunder. Hence, it is possible to restrict the vertical motions of the support rail 3 by means of a relative form-locking engagement of the lower joint member 52 and the upper joint member 51.

[0053] The universal joint 5 has its upper joint member 51 mounted in a horizontally rotatable manner on the backing plate 2 or on the brackets 20 attached thereto so as to enable horizontal pivoting motions of the support rail 3 around a longitudinal axis P1 of the universal joint. The underlying or lower joint member 52 is in turn coupled by way of the articulated shaft 53 to the overlying or upper joint member 51 so as to enable vertical pivoting motions of the support rail 3 around the articulated shaft 53.

[0054] Next follows a still further description regarding operation of the apparatus 1 according to the invention as perceived from the standpoint of a user.

[0055] When the orthopedic apparatus 1 of the invention is used, the patient places first his/her foot on the leg propping portion 8. Thus, the patient's hip area, and particularly the hip joint, is supported on the backing plate 2 in such a way that a vertical plane extending by way of

the hip joint comes across the plane of the backing plate 2 at a location other than the universal joint's longitudinal axis P1. This is followed by releasing the clamping mechanism 300 acting on the pair of gas springs 4 of the first adjustment mechanism by pulling a trigger of the handle 6, whereby the lever arm system 30 has its tension rod 31 pulling the coupling elements 32 towards the support rail's free end 3a and the claws 32a at the coupling elements' ends turn into a contact with the gas springs' coupling elements 44, releasing the clamping engagement of the pair of gas springs 4 even though the ends 41 c, 42c of the gas springs' piston rods are continuously in engagement with the fasteners 38.

[0056] Because the vertical plane extending by way of the hip joint of leg comes across the plane of the backing plate 2 at a location different from the universal joint's longitudinal axis P1, it is necessary that, after this or simultaneously, the clamping engagement of a carriage 7 of the leg propping portion 8 be released from a locking handle 88 so as to make the carriage 7 slidable along the support rail 3 as the support rail 3 is being pivoted.

[0057] Upon pressing down the carriage's handle 88, the eccentric shape of the handle applies pressure by way of a washer 86 to a locking block 84 with four cylindrically shaped protrusions chamfered at their ends to an angle of about 45 degrees. These beveled surfaces apply a wedging pressure on two topmost corners of a tension rod present inside the traction device, thereby pushing a bottom surface of the tension rod against a slide block 82 present inside the traction device. The slide block 82 has a higher friction than other sliding surfaces and the locking works more effectively. At the same time, the three-point locking eliminates a clearance from the carriage 7 with respect to the tension rod.

[0058] The handle 88 has an eccentrically bored hole for a stud nut 8 present inside the handle. When turning the handle 88 upward, the locking block 84 rises upward by the force of a spring thereunder, the slide block 82 thereby coming out of its contact with the support rail, thus enabling the carriage 7 to be slid along the support rail 3.

[0059] The support rail 3 can now be pivoted in horizontal and vertical directions of the backing plate 2 around its vertical and horizontal axes P1, P2 located on the universal joint within a range allowed by both the universal joint 5 and the engagement of the gas springs 4 and the shaft 39. At the same time, the leg supported by means of the propping portion 8 will change its position with respect to the hip joint supported on the backing plate 2.

[0060] After reaching a desired position for the leg in relation to the hip joint resting on the backing plate 2, the position of the piston rod 41 a, 42a of each gas spring 41, 42 with respect to the cylinder 41 b, 42b of a respective gas spring is locked by clamping the piston rod's end 41 c, 42c by means of the gas spring's fastener to the lever arm system 30, thereby locking, at the same time, the position of the leg in relation to the hip joint. The gas springs 4 are clamped by operating the lever arm system 30 of the clamping mechanism 300 with the trigger 62 of the handle 6 so as to bring about pivoting of the claws 32'a and 32"a, present at the end of the elongated coupling elements 32; 32', 32' attached to the tension rod 31 extending inside the support rail 3, in a plane defined by the gas springs out of the contact with the coupling element 44 acting on the end 41 c, 42c of the piston rod 41 a, 42a of each gas spring 41, 42. This is followed by clamping the relative position of the backing plate 2 and the carriage 7 of the leg propping portion 8 and the area of a hip joint lying on the backing plate can be treated for example by imaging.

[0061] What has been described above includes just a few preferred embodiments of the invention and it is obvious for a skilled artisan that there is a multitude of other possible ways of implementing the invention within the inventive concepts presented in the claims.

[0062] Accordingly, in one embodiment of the invention, the protrusions 35 are mounted fixedly on the support rail 3 and vertical motions of the support rail 3 are adapted to be restricted not only by the universal joint 5 but also by motion limiters restricting a rotational motion of the center shaft 39, such as by journals extending through the center shaft 39 and the lever arm system's coupling elements 32', 32", which are possible to bring into contact with the protrusions 35 mounted fixed on the support rail 4. Useful as such motion limiters can be attachment studs 38a of the gas spring's fastener, which are brought into contact with grooves present on internal surfaces of the protrusions 35, which preclude rotation of the center shaft 39.

Claims

1. An orthopedic apparatus (1) intended for moving a leg and a hip area relative to each other, comprising a backing plate (2) which is intended for supporting the hip area and under which is coupled a first end (3b) of an elongated support rail (3) adapted to carry a leg propping portion (8), and said support rail (3) having its second, free end (3a) provided with a handle (6) for an adjustment mechanism intended for clamping and releasing motions of the support rail, and a leg propping portion (8) which is mountable onto the support rail (3) in a slidable manner, **characterized in that** the apparatus (1) includes a first adjustment mechanism, which comprises a pair of gas springs (4) located between the support rail's first end (3b) and brackets (20) attached to the backing plate (2), preferably under the backing plate, and which is used for adjusting the clamping of motion paths of the support rail (3) and the force required for pivoting the support rail, as well as additionally a second adjustment mechanism, which is provided with a universal joint (5) and which, together with the first adjustment mechanism, defines horizontal and

vertical motion paths for the support rail with respect to the backing plate (2), and which couples the first end (3b) of the support rail (3) pivotably under the backing plate or to the brackets (20) attached under the backing plate.

2. An apparatus (1) according to claim 1, **characterized in that** the second adjustment mechanism's universal joint (5) comprises an upper joint member (51), which couples by its upper end to the backing plate (2) or to the brackets (20) attached thereto and by its lower end, through the intermediary of an articulated shaft (53), to a lower joint member (52), which in turn couples by its lower end to the support rail's first end (3; 3b).

3. An apparatus (1) according to claim 1, **characterized in that** the universal joint's upper joint member (5; 51) is fitted on the backing plate (2) or on the brackets (20) attached thereto so as to enable, together with the first adjustment mechanism, the support rail's horizontal pivoting motions around the universal joint's longitudinal axis (P1) at a certain angle, such as an angle of ±45 degrees, as perceived from an O-level of the horizontal motion, and that the lower joint member (52) is coupled, through the intermediary of the articulated shaft (53), to the upper joint member (51) so as to enable, together with the first adjustment mechanism, vertical pivoting motions of the support rail (3) around the articulated shaft (53) over a certain range of pivot angles, such as at a pivot angle of ±75 degrees, as perceived from an 0-level of the vertical pivoting motion.

4. An apparatus (1) according to any of the preceding claims, **characterized in that** the first adjustment mechanism comprises a pair of gas springs (4), wherein each gas spring (41, 42) has its piston rod ends (41 c, 42c) extending to a center shaft (39), which is co-directional with a plane of the backing plate (2) and which extends through the universal joint's lower joint member (52) in a rotatable manner, and the second ends extend to brackets (20), under the backing plate, to a distance from attachment points of the piston rod ends (41 c, 42c) of the gas spring (41, 42) on the center shaft.

5. An apparatus (1) according to claim 4, **characterized in that** the pair of gas springs (4) has its piston rod ends (41 c, 42c) capable of being coupled releasably to the gas spring's fastener (38) mounted on the center shaft (39) and the pair of gas springs has its second ends coupled to the brackets (20) attached under the backing plate (2), such that the gas springs (41, 42) are substantially co-directional with the backing plate (2) as well as, at least with the apparatus in a state of rest, also substantially co-directional with the support rail (3).

6. An apparatus (1) according to claim 5, **characterized in that** the pair of gas springs (4) has each of its gas springs (41, 42) adapted to be acted upon by a clamping mechanism (300) of the first adjustment mechanism, by means of which the position of the piston rod (41 a, 42a) of the gas spring (41, 42) is capable of being released and clamped with respect to a cylinder (41 b, 42b) of the respective gas spring.

7. An apparatus (1) according to claim 6, **characterized in that** the clamping mechanism (300) comprises a handle (6), which is present at a free end (3a) of the support rail (3) and which is adapted to act, through the intermediary of a lever arm system (30), upon the gas spring's piston rod end (41 c, 42c) in such a way that the position of the gas spring's piston rod (41 a, 42a) with respect to the respective cylinder (41 b, 42b) and the lever arm system (30) is capable of being released and clamped.

8. An apparatus (1) according to claim 7, **characterized in that** the lever arm system (30) of the clamping mechanism (300) comprises a tension rod (31) or the like, which extends inside the support rail (3), is attached to the handle (6), and which is adapted, through the intermediary of free ends (32'a, 32"a) of elongated coupling elements (32; 32', 32") coupled to the center shaft (39) extending in a rotatable manner through the lower joint member (52) of the universal joint (5), to act upon the end (41 c, 42c) of the piston rod (41 a, 42a) of each gas spring (41, 42) in such a way that the positions of said gas springs' piston rod (41 a, 42a) in relation to the respective cylinders (41 b, 42b) are capable of being released and clamped simultaneously.

9. An apparatus (1) according to any of the preceding claims, **characterized in that** the leg propping portion (8) connects onto the support rail (3) by way of a carriage (7) which is slidable along the support rail.

10. An apparatus (1) according to any of the preceding claims, **characterized in that** horizontal motions of the support rail (3) are adapted to be restricted by a feature, such as a groove on a surface of the upper joint member (51), which limits rotation of a rotating shaft (P1) extending by way of the upper joint member (51) of the universal joint (5) and which is matched by a counterpart present on the backing plate (2) or on its brackets (20), and vertical pivoting motions of the support rail (3) around the universal joint's lower joint member (52) and an attachment point of the support rail (3) are adapted to be restricted by a mutual form-locking engagement of the lower joint member (52) and the upper joint member (51).

11. A method for moving a leg and a hip area relative to each other with an apparatus (1) according to claim

1, comprising a backing plate (2) which is intended for supporting the hip area and under which is coupled a first end (3b) of an elongated support rail (3) adapted to carry a leg propping portion (8), and said support rail having its second, free end (3a) provided with a handle (6) for a first adjustment mechanism intended for clamping and releasing motions of the support rail, and the leg propping portion (8) being connectable to the support rail (3) in a slidable manner, **characterized in**

- placing a foot on the leg propping portion (8) in a way that the same leg has its hip area supported on the backing plate (2) in such a manner that the hip joint of the discussed leg is positioned in the direction of a plane of the backing plate (2) at a location other than a longitudinal axis of the universal joint, i.e. a vertical shaft (P1) extending through the universal joint,
- releasing a clamping mechanism (300) acting on a pair of gas springs (4) of the first adjustment mechanism, as well as a locking engagement of the leg propping portion (8) with the support rail (3),
- moving the support rail (3) and the leg supported thereon through the intermediary of the propping portion (8) for repositioning the leg in relation to the hip joint supported on the backing plate, whereby the motion paths of the support rail and at the same time those of the leg in vertical and horizontal directions with respect to the backing plate (2) are defined by the first adjustment mechanism, including the pair of gas springs (4) which is located between the support rail's first end (3b) and brackets (20) attached under the backing plate, together with a second adjustment mechanism provided with a universal joint (5),
- clamping the position of a piston rod (41 a, 42a) of each gas spring (41, 42) with respect to a cylinder (41 b, 42b) of the respective gas spring, as well as a locking engagement of the leg propping portion (8) with the support rail, while at the same time clamping also the position of a leg in relation to the respective hip joint.

12. A method according to claim 11, **characterized in that**, when the support rail (3) is pivoted in horizontal and vertical directions with respect to respective vertical and horizontal rotation axes (P1, P2) located on the universal joint (5) mounted on the backing plate (2), the leg supported on the support rail (3) through the intermediary of the propping portion (8) is at the same time turned relative to the hip joint present on the backing plate (2), the vertical axis extending through said hip joint being present, with respect to a plane of the backing plate, at a location other than the vertical axis (P1) of the universal joint (5).

13. A method according to claim 12, **characterized in that** pivoting the support rail (3) in a horizontal direction with respect to the vertical rotation axis (P1) extending by way of the upper joint member (51) of the universal joint (5) and with respect to the backing plate (2) brings about pivoting of both gas springs (4) respectively relative to coupling elements (32', 32") of the lever arm system (30) I such a way that the mutual direction of the longitudinal axes of the gas springs (4) and the support rail (3) is changed but the angle between a plane extending by way of the gas springs (4) and the backing plate (2) remains the same, preferably the plane extending by way of the gas springs (4) remaining co-directional with a horizontal plane that is co-directional with the backing plate (2).

14. A method according to claim 12, **characterized in that** pivoting the support rail (3), as well as the lower joint member (52) fixedly mounted on the support rail, in a vertical direction with respect to the horizontal rotation axis (P2) extending by way of the universal joint (5) and with respect to the backing plate (2) brings about pivoting of the center shaft (39) extending through the lower joint member (52) and the gas springs (4) mounted thereon with respect to said support rail (3) in such a way that the gas springs (4) remain co-directional with respect to a plane that is co-directional with the backing plate (2).

15. A method according to any of claims 12-14, **characterized in that** the clamping mechanism (300) of the first adjustment mechanism, acting upon each gas spring (41, 42) of the pair of gas springs (4), is used for clamping a position of the backing plate (2) with respect to the universal joint (5), as well as a mutual position of the leg supported on the support rail (3) through the intermediary of the propping portion (8) as well as the hip area supported on the backing plate (2), followed by using said clamping mechanism (300) for releasing a locking engagement between the support rail (3) and the backing plate (2) as well as the universal joint (5).

16. A method according to any of claims 11-15, **characterized in that** pivoting the support rail (3) in a horizontal direction brings about a lengthening of the first gas spring and a shortening of the second gas spring, while pivoting the support rail (2) in a vertical direction brings about a lengthening or shortening of each gas spring (41, 42) simultaneously.

17. A method according to any of claims 11-16, **characterized in that**, when a friction brake (71) of the carriage is released, the support rail (3) can be pivoted in a vertical direction in such a manner that the distance of a carriage (7) sliding on the support rail from the universal joint (5) is determined on the basis of

a distance between the hip and the foot of a leg.

18. A method of treating a hip area by conducting the method with an orthopedic apparatus according to any of claims 1-10 for moving a leg relative to a hip joint placed on a backing plate (2), **characterized in**

- placing a foot on a leg propping portion (8) in a way that the hip area is at the same time supported on the backing plate (2) in such a manner that a vertical axis extending by way of the hip joint passes through the backing plate at a location other than a vertical axis (P1) of a universal joint (5),
- releasing a clamping engagement of a first adjustment mechanism comprising a pair of gas springs (4), as well as a clamping engagement of the propping portion (8) with a support rail (3),
- moving the support rail (3) and the leg supported thereon through the intermediary of the propping portion (8) for changing a position of the leg in relation to the hip joint supported on the backing plate, whereby the extent of motion paths of the support rail (3), and at the same time that of the leg, in vertical and horizontal directions is defined by said first adjustment mechanism as well as by a second adjustment mechanism provided with the universal joint (5),
- clamping the position of a piston rod of each gas spring (41, 42) with respect to a cylinder of the respective gas spring, as well as a locking engagement of the leg propping portion (8) with the support rail (3),
- treating the hip area for example by imaging.

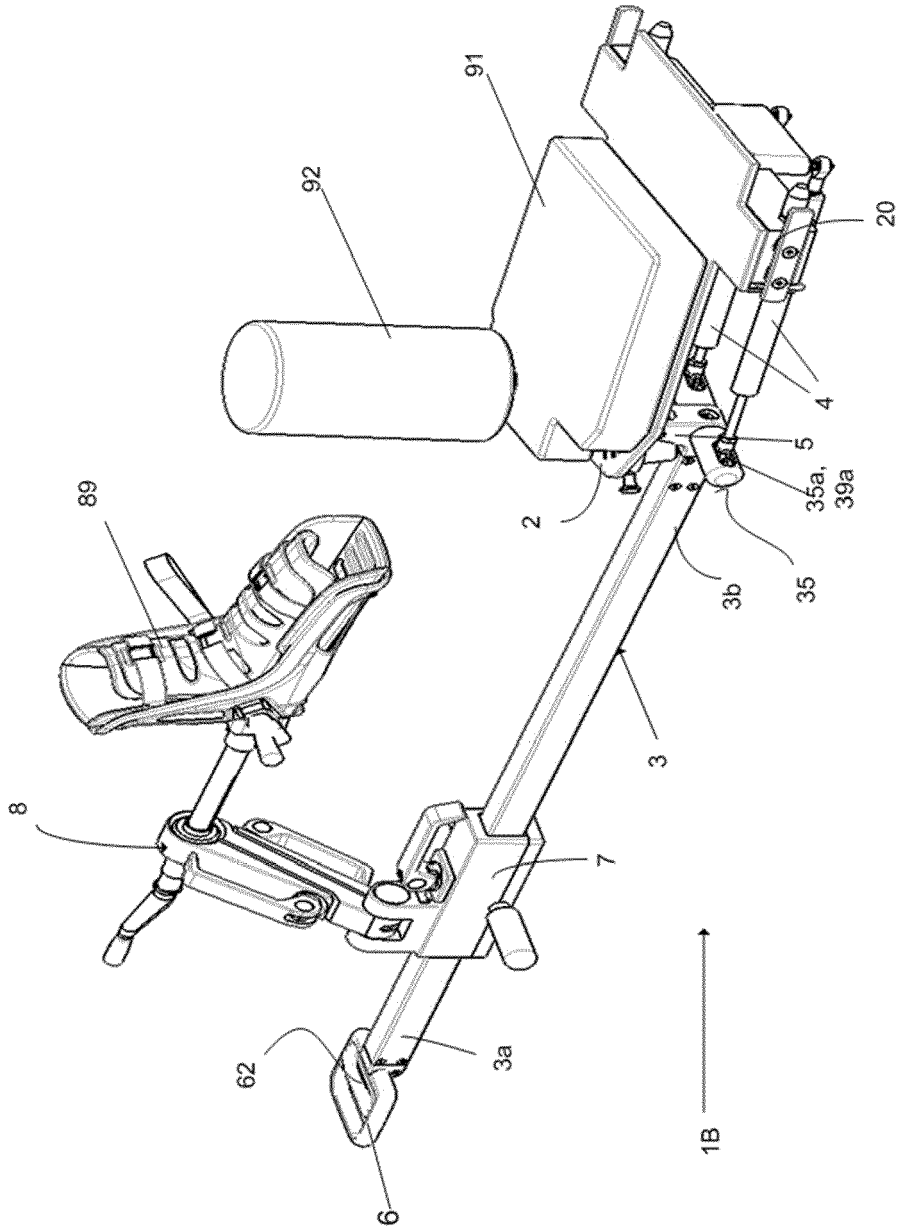


Fig. 1A

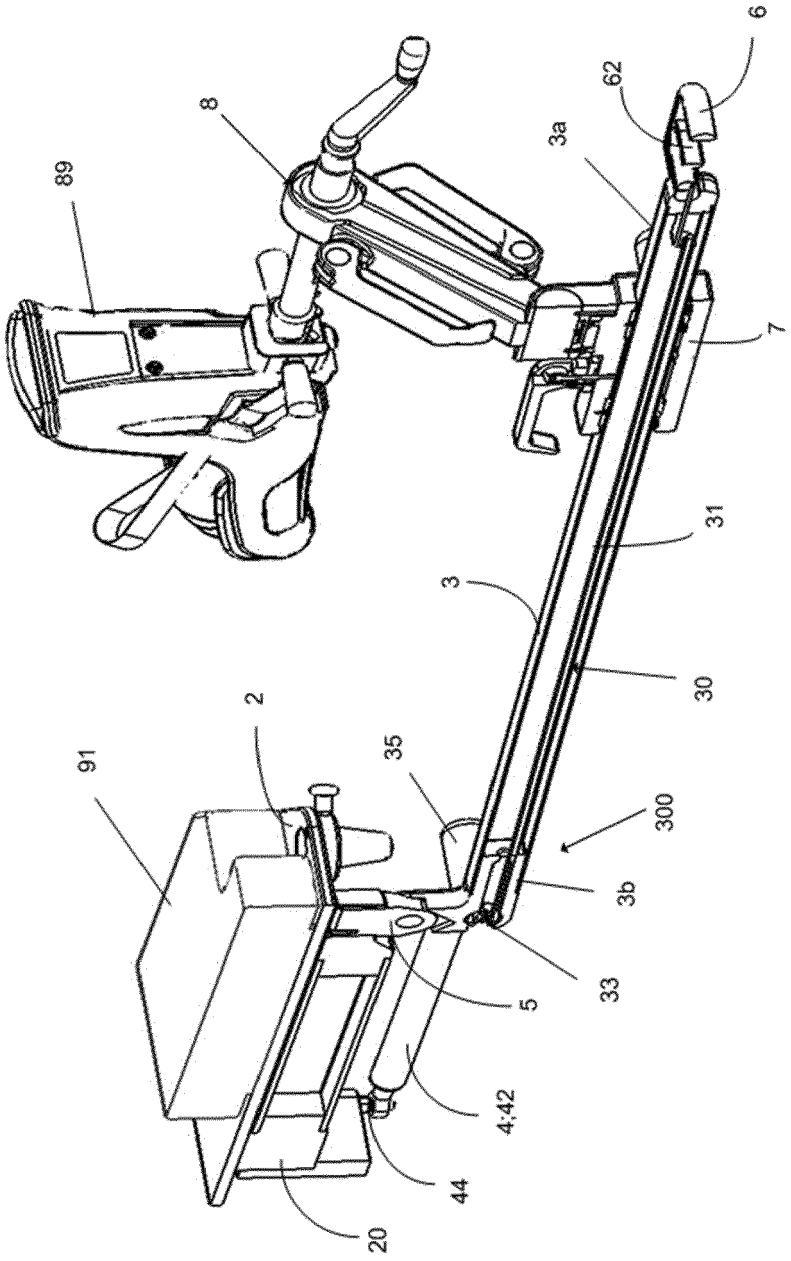


Fig. 1B

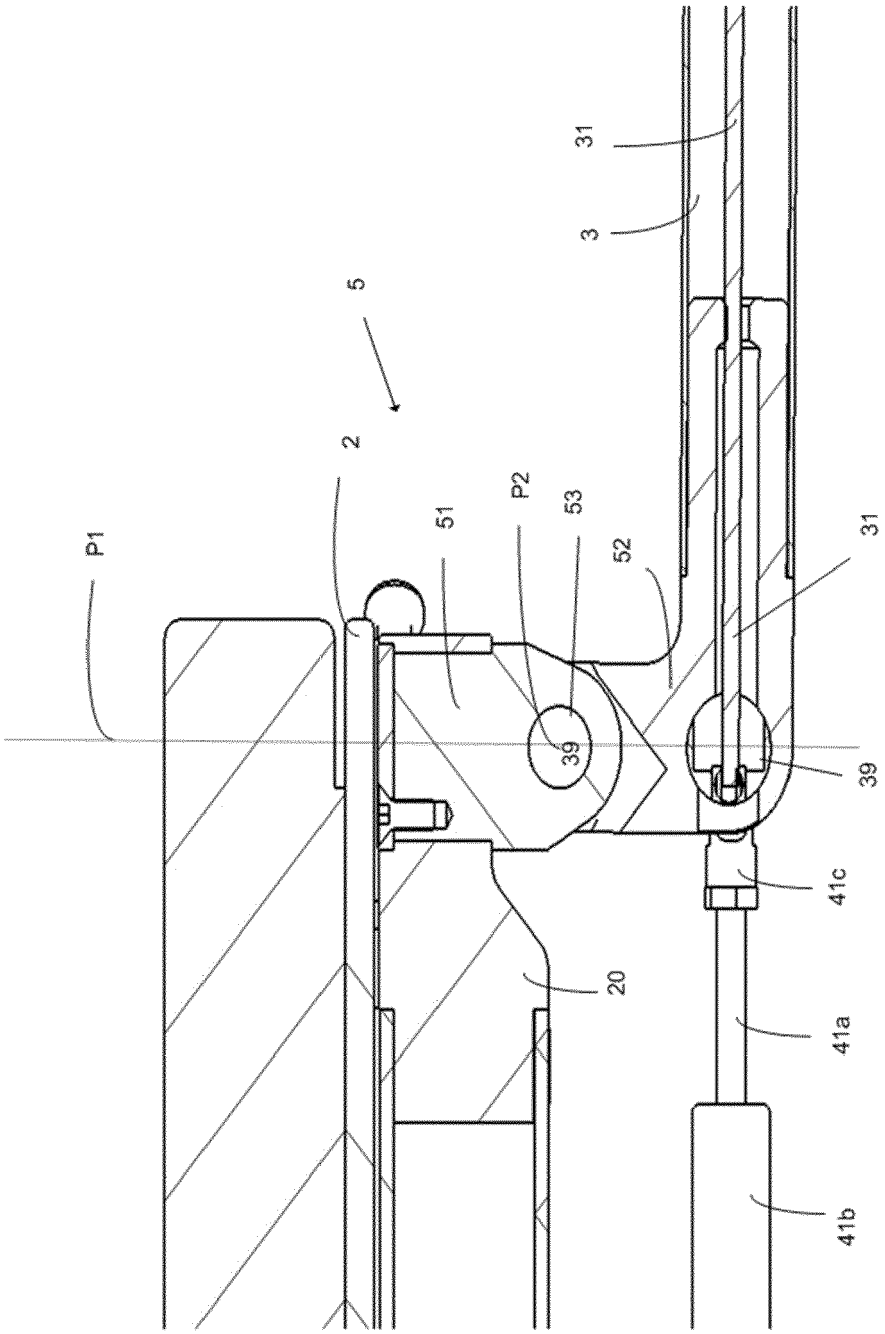
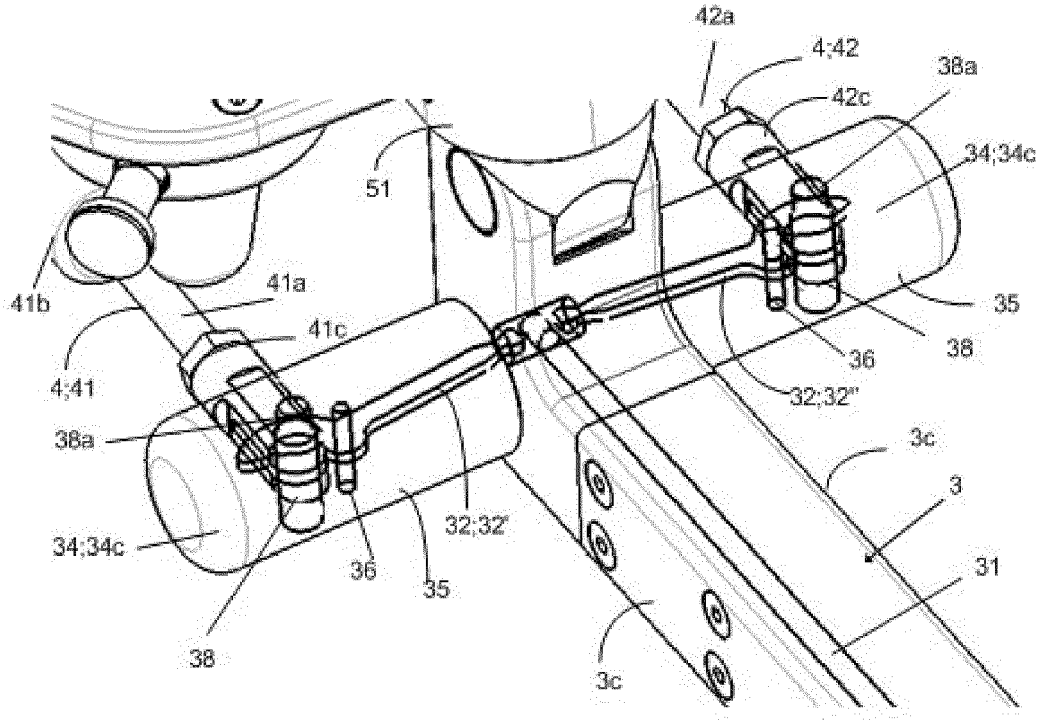


Fig. 2B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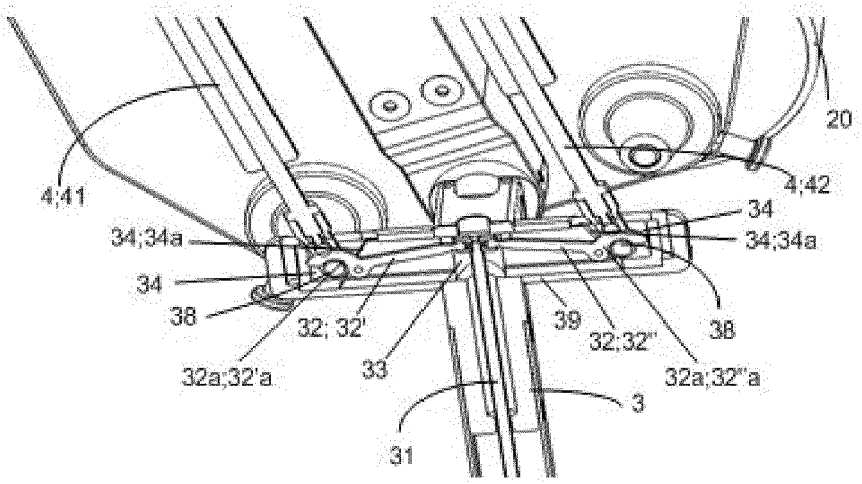
3c
3
32;32'
34;34c
36
35
31
38
3c

Fig. 2A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32; 32'
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32;32"
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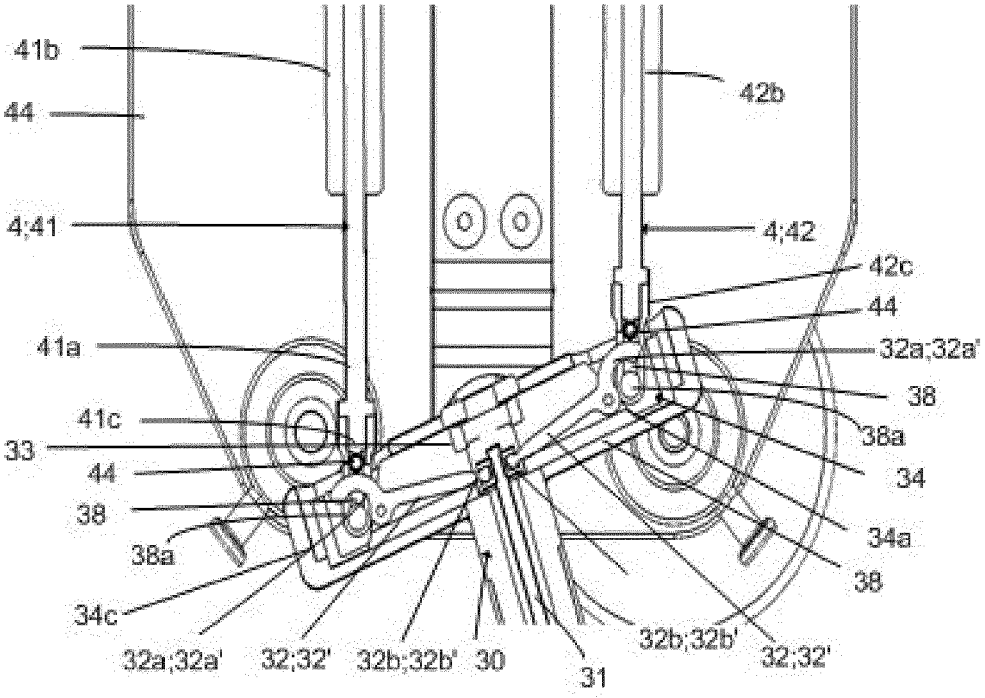
32a;32"a
3
31

Fig. 3C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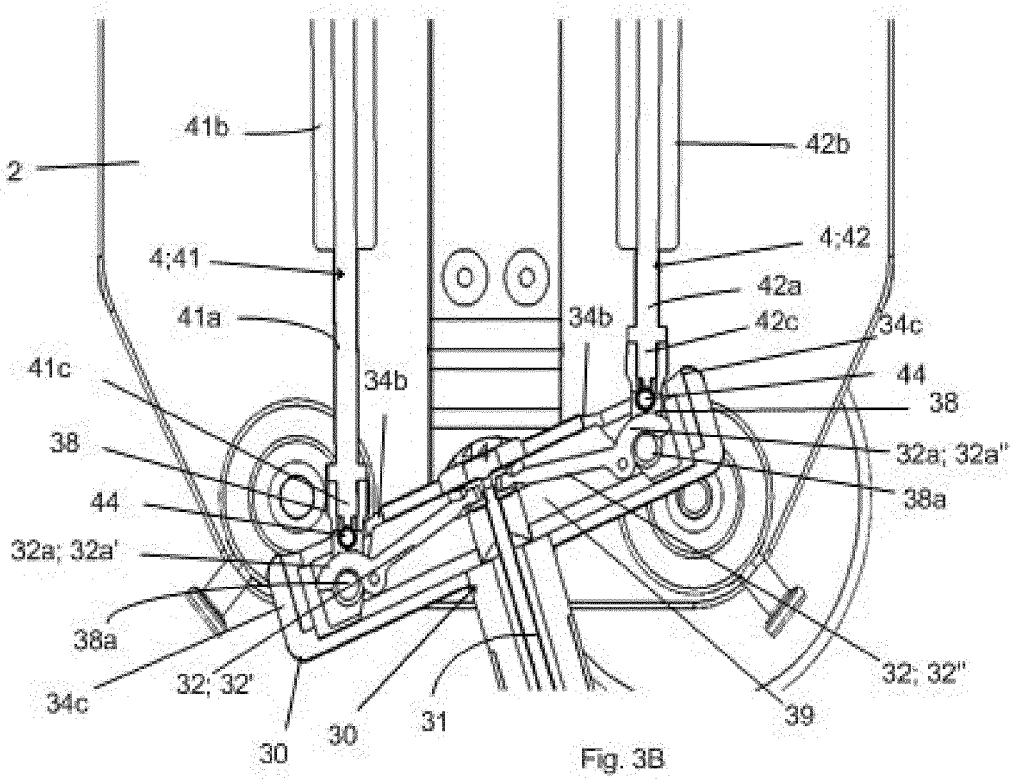
34
34a
38
32b;32b'
32;32'

Fig. 3A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4;41
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34c
32; 32'
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31
42b
4;42
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42c
34c
44
38
32a; 32a''
38a
32; 32''
39
34b

Fig. 3B

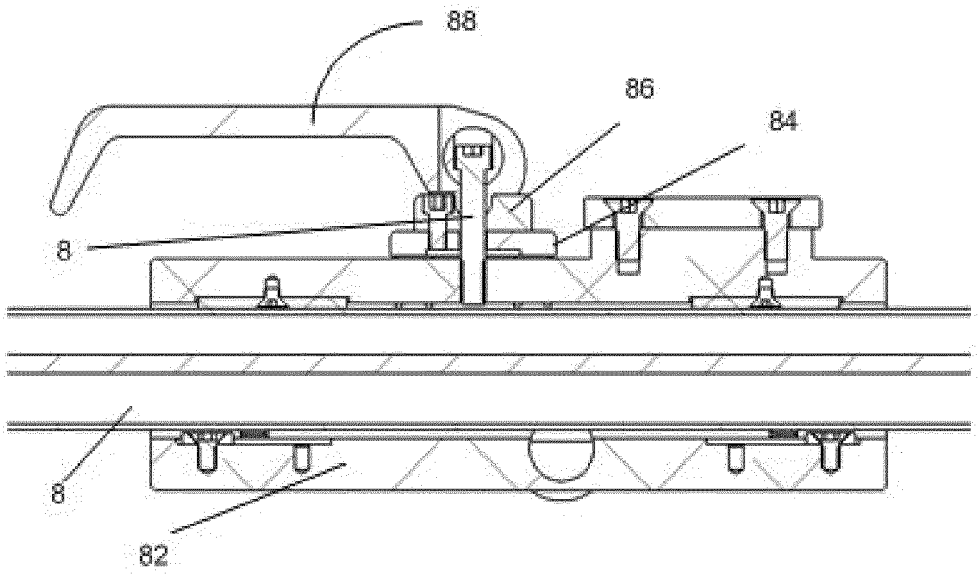

Fig. 4A

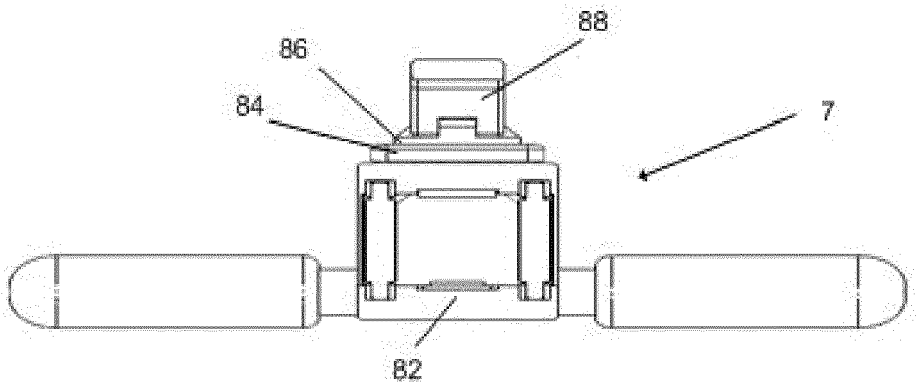

Fig. 4B

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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 3867

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	CA 2 862 302 A1 (AMERICAN STERILIZER CO [US]) 1 August 2013 (2013-08-01) * paragraphs [0065] - [0066]; figures 1-2 * -----	1-18	INV. A61G13/00
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 April 2015	Kroeders, Marleen

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