



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**24.11.2021 Bulletin 2021/47**

(51) Int Cl.:  
**B25H 1/00 (2006.01) B66F 11/00 (2006.01)**

(21) Application number: **21174768.8**

(22) Date of filing: **19.05.2021**

(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**  
Designated Validation States:  
**KH MA MD TN**

(72) Inventors:  
• **Balzarín, Dario**  
**27050 Codevilla (IT)**  
• **Chiapparoli, Marco**  
**27050 Codevilla (IT)**  
• **Taini, Elisa**  
**27050 Codevilla (IT)**  
• **Taini, Pietro**  
**27050 Codevilla (IT)**

(30) Priority: **19.05.2020 IT 202000011515**

(71) Applicant: **MA.R.E.A. S.r.l.**  
**27050 Codevilla (IT)**

(74) Representative: **Crugnola, Pietro et al**  
**Luppi Intellectual Property Srl**  
**Viale Corassori, 54**  
**41124 Modena (IT)**

(54) **TOOL SUPPORT DEVICE CONNECTABLE TO AN OVERHEAD WORK PLATFORM**

(57) Support device (1; 1') arranged to support a work tool (U), connectable to a protecting railing (11) of a lifting device (10) to assist an operator (O) during a manual work activity performed at height with the work tool (U). The support device (1; 1') comprises support means (2, 26, 27) removably mountable on the protecting railing (11) and is characterized by the fact that it comprises a compensation unit (12) connected removably to the support means (2, 26, 27), the compensation unit (12) comprising a linear actuator (4a, 4b, 4c) that is movable in a direction (D) that is parallel to the direction of gravity, and an arm (32) connected to the linear actuator (4a, 4b, 4c) and arranged to support the tool (U); the compensation unit (12) being associated with a source of compressed air drivable for sending a compressed air flow to the compensation unit (12). The compensation unit (12) is further provided with inner pneumatic conveying means (15, 19, 20, 21) arranged to be crossed by the compressed air flow to convey the compressed air flow to the linear actuator (4a, 4b, 4c), and pneumatic adjusting means (16, 17, 18, 22, 23) arranged to adjust a value of the compressed air flow conveyed to the linear actuator (4a, 4b, 4c) so that the linear actuator (4a, 4b, 4c) compensates for a weight of the tool (U) and enables the operator (O) to carry out the manual work activity at a height in the absence of said weight.

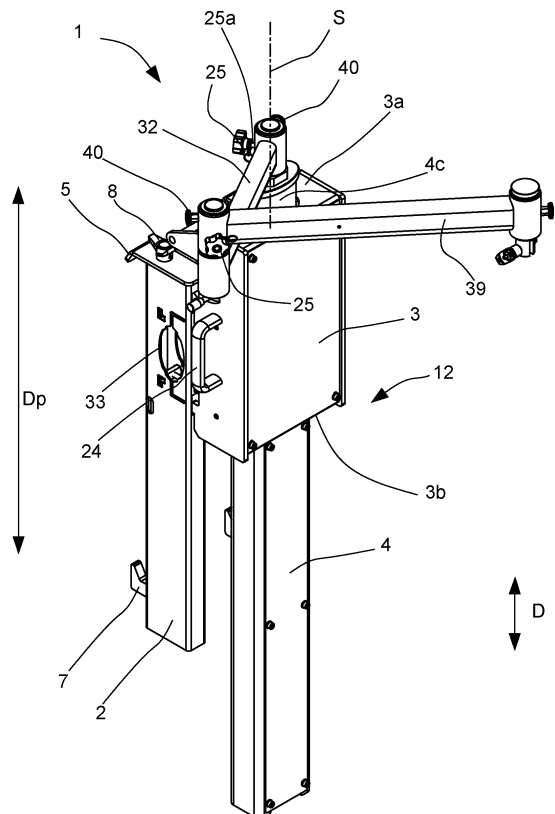


Fig. 1

## Description

**[0001]** The invention relates to a support device arranged to support a work tool, connectable to a work platform.

**[0002]** The invention in particular relates to a support device mounted on an overhead work platform, this support device being arranged to support a weight of a work tool and assist an operator during the work tasks that are performed on the work platform.

**[0003]** The invention can be applied to the field of "working at a height", i.e. a work task performed by one or more operators in a position at a set height in relation to a steady plane, for example the same as or greater than two metres.

**[0004]** The invention can nevertheless also be applied in the field of "on the ground work" i.e. a work task performed at less than two metres from the steady plane.

**[0005]** A support device is known that is arranged to support a work tool of any type, for example a pneumatic drill, an electric screwdriver, a welding machine, and so on, connectable to an overhead work platform.

**[0006]** The known support device is slidable on a rail of the platform to be moved horizontally and linearly on the rail. The device comprises a base mounted on a support plane of the platform that is rotatable around a vertical axis. An articulated arm comprising a first and a second arm is mounted rotatably on the base. A first end of the first arm is mounted rotatably on the base and can vary its own angular position between a position in which it is substantially vertical, and one in which it is substantially horizontal. The second arm is mounted rotatably on a free end of the first arm and can vary its own angular position between a first position in which it is aligned with the first arm, and a second position in which it forms an acute angle with the first arm. The first and the second arm are each provided with an actuator to permit the respective rotations thereof. To the end of the second arm, a support unit is mounted that is dimensioned to house a work tool and maintain the work tool suspended in air. The support unit is moreover provided with a pair of handles grippable by an operator to move the tool. The support unit is connected to the second arm such that the operator has the possibility of moving in a three-dimensional space, defined for example by a trio of Cartesian axes, and of rotating the support unit in the aforesaid space, around any one of the axes of this trio. The movement of the support unit causes the first and/or the second arm and/or the base to rotate.

**[0007]** An articulated arm is further known that is arranged to support a work tool provided with a toolholder on which a tool is housed. The articulated arm enables the position of the tool to be adjusted with respect to the support arm. The articulated arm is provided with springs and viscous dissipaters that enable the vertical position of the tool to be maintained. The articulated arm comprises stiff elements, for example rods, brackets and so on, connected together by hinges/joints. The articulated

arm comprises a bar to which an upper hook and a lower hook are connected. The hooks are "J"-shaped so as to be able to hook the articulated arm to crosspieces of a platform. With the lower hook, a slide is coupled that is slidable along the bar, thus enabling the position of the lower hook to be adjusted on the crosspieces of the platform and the articulated arm to be fixed steadily on the platform. The upper hook and the lower hook are both provided with locking elements suitable for ensuring fixing of the articulated arm to the platform.

**[0008]** The aforementioned support devices have certain limits and drawbacks.

**[0009]** First of all, in these support devices the weight of the tool has to be counterbalanced by a force exerted by the operator. The movement of the tool, and possibly of the supports in which the tool is housed, is neither controllable nor precise. Also maintaining the tool in position during operation in the work zone is difficult.

**[0010]** Secondly, it must be remembered that during operation the tool is often subjected to vibrations and/stress that are transmitted directly to the operator bearing the weight of the support unit and of the tool; this makes it even more difficult to maintain the tool in position and to perform the work safely. The effort of the operator is not insignificant, considering that this situation occurs at a height and not on a steady plane.

**[0011]** Another limit to the aforesaid devices relates to the mounting/assembly of the device before use, in addition to dismantling thereof, which is complex and lengthy.

**[0012]** From US 2017/225320 A1, a support device (100) is known that is arranged to support a work tool and to assist an operator during a manual work task performed by said operator with said work tool.

**[0013]** The support device is provided with a foot that is fixed to the ground or to another suitable support surface and comprises a compensation unit (250) arranged to support a weight of the tool. The compensation unit comprises a linear actuator to which an arm is fixable to support the work tool. The linear actuator, when the support device is fixed to the support surface, is movable in a direction that is parallel to the force of gravity.

**[0014]** The linear actuator is driven by a source of compressed gas by pneumatic conveying means a pneumatic adjusting means suitable for conveying to the linear actuator and regulating a flow of gas, to drive the actuator.

**[0015]** The device disclosed in US 2017/225320 A1 is designed to be fixed to a flat surface and is completely unsuitable for being mounted on the railings of an overhead work platform.

**[0016]** One object of the invention is to improve known support devices of a work tool, which are connectable to an overhead work platform.

**[0017]** Another object is to provide a support device that is able to assist the operator during a work task performed at a height.

**[0018]** Yet another object of the invention is to provide a support device arranged to compensate for the weight

of the tool instead of the operator.

**[0019]** A further object of the invention is to provide a support device of a tool that is easy to make and to mount on or dismantle from an overhead work platform.

**[0020]** According to the invention, a support device of a work tool is provided as defined by the attached claims.

**[0021]** Owing to the invention, a support device of a work tool is provided with a compensation unit of pneumatic type arranged to compensate a weight of the tool. This enables an operator to perform a manual work task at a height in the absence of the weight of the tool.

**[0022]** Owing to the compensation unit, in particular owing to pneumatic elements and to pneumatic adjusting means positioned inside the compensation unit, it is possible to adjust a flow of compressed air conveyed to a linear actuator of the compensation unit to compensate for the weight of the tool. This enables the operator to move the tool in space to position the tool in a work zone and maintain the tool in position during operation, precisely and without effort. The operator's efforts are directed only at compensating for possible vibrations transmitted by the tool during operation, the manual work being in fact performed in the absence of weight of the tool.

**[0023]** The invention can be better understood and implemented with reference to the enclosed drawings that illustrate embodiments thereof by way of non-limiting examples, wherein:

Figure 1 is a perspective view of a first embodiment of a support device of a work tool according to the invention;

Figures 1A and 1B are enlarged views of an articulated arm of the support device of Figure 1;

Figure 1C illustrates a variant of the articulated arm of the support device of Figure 1;

Figure 2 is a perspective view of a second embodiment of the support device of a work tool according to the invention;

Figure 2A shows two constructional details of the second embodiment of the support device of Figure 2;

Figure 3 is a perspective view of a compensation unit of the support device of Figure 1 or of Figure 2.

Figure 3A is a section view of the compensation unit of Figure 3;

Figure 3B is an enlarged view of part of Figure 3A;

Figure 4 is a schematic view of pneumatic conveying means and pneumatic adjusting means provided inside the compensation unit of Figure 3;

Figure 5A is a side view of a support bar of the support device of Figure 1 or of Figure 2, which is fixable to an overhead platform;

Figure 5B is a section view of Figure 5A;

Figure 5C is a perspective view of a pair of support bars like that of Figure 5A, support device of Figure 1 or of Figure 2 that are fixable to an overhead platform;

Figures 6A and 6B are, respectively, a frontal view

and a side view of the support device of Figure 1; Figures 7, 8, 9, and 10 are enlarged perspective views that show different versions of housing elements that are connectable to an articulated arm of a support device according to the invention;

Figures 11, 12 and 13 show assembly steps of a support device according to the invention on an overhead platform;

Figures 11A and 11B are, respectively, a frontal view and a side view of Figure 11;

Figure 11C is an enlarged detail of Figure 11;

Figures 12A and 12B are, respectively, a frontal view and a side view of Figure 12;

Figures 12C and 12D are enlarged views of details of Figure 12;

Figures 13A and 13B are, respectively, a frontal view and a side view of Figure 13;

Figures 14A, 14B and 14C are perspective views of the support device of Figure 1 assembled and mounted on an overhead platform.

Figures 15A, 15B and 15C are perspective views of the support device of Figure 2 assembled and mounted on an overhead platform;

Figures 16A, 16B illustrate a version of mounting the support device of Figure 1 on an overhead platform;

Figure 16C illustrates the support device of Figure 1 prearranged for mounting according to the mounting version of Figures 16A and 16B.

**[0024]** With reference to the attached Figures, with 1 and with 1' two embodiments are indicated of a support device, arranged to support a work tool, and connectable to a lifting device 10 provided with a protecting railing, for example an overhead work platform, or any device provided with a work surface and with a protecting railing (commonly known in the industry as a "work basket"). Hereinafter, the term "overhead work platform" 10 can be used in place of the term "lifting device" 10.

**[0025]** A lifting device, or overhead work platform 10 is a work surface, having in a plan view a quadrangular shape mounted on a carriage, which can be raised or lowered along a direction that is parallel to the force of gravity. Some lifting devices/overhead platforms can also be moved horizontally, i.e. in a direction perpendicular to the direction of the force of gravity. Some overhead platforms can be supported by a telescopic or articulated device, which is mounted on a motor vehicle.

**[0026]** The overhead platforms are used by an operator O, or several operators, for repair, mounting and cleaning work tasks, film or television shoots, restoration of buildings, works in mines and galleries, ship building, metal structural works, fixing works, polishing works, manual drilling, metal finishing, riveting, cutting works, grinding, or in general for all those tasks that are performed at a height, i.e. at a vertical distance (measured along a direction that is parallel to the direction of gravity) from the ground, this distance being not less than 1.5 metres and also being able to be more than 70 metres.

The movements of the overhead platform 10 can be driven with known driving/motor means of hydraulic type (for example with a hydraulic telescopic column), or alternatively with known driving/motor means of hydraulic or mechanical type.

**[0027]** The lifting device/the overhead platform 10 comprises a support plane Q and a protecting railing 11 comprising in turn a plurality of horizontal and vertical elements suitable for hindering the fall of operators into an empty space.

**[0028]** With reference to U, in the attached Figures a work tool has been indicated, which is shown by way of example as a pneumatic drill. It remains understood that, in the context of the invention, a work tool U can indicate any tool suitable for performing, when driven by the operator O, the work tasks listed above, or in general any work task that can be performed at a height, for example a drill, an electric or pneumatic hammer, a screw gun, a welding machine, or a camera, a bucket containing paint, and so on. The tool can have a mass comprised between one and twenty kilograms.

**[0029]** The support device 1, 1' can be connected to the overhead platform 10, for example can be connected to the protecting railing 11, in particular between two parallel horizontal elements of the railing, positioned one above the other, as shown in Figures 14A-14C and 15A-15C, or between two pairs of horizontal elements of the railing, converging in an angle of the railing, as shown in Figures 16A and 16B.

**[0030]** In Figures 1, 6A, 6B, 14A-14C, 16A and 16B, a first embodiment of the support device 1 according to the invention is shown, in which the support device 1 is connected to the overhead platform 10; the support device 1 is fixed to the protecting railing 11, i.e. is not movable/slidable along the horizontal elements of this protecting railing 11.

**[0031]** The support device 1 can comprise support means that is suitable for being connected, in particular fixed, to the protecting railing 11. The support means can comprise at least one pair of support bars 2, each support bar 2 being spaced apart from one another. Further, each support bar 2 is fixed between two horizontal elements of the protecting railing 11, one above and one below, in the manner explained below. The support bar 2 is shown in detail in Figures 5A, 5B and 5C, and can be internally hollow or solid.

**[0032]** Obviously, the number of support bars 2 can be varied, in particular increased, in order to ensure greater stability during use of the support device 1.

**[0033]** As shown in Figures 5, 5A, 5B, one end of the support bar 2 can comprise a protrusion 5 that extends in a direction that is substantially transverse to a prevalent dimension Dp of the support bar 2. The protrusion 5 is shaped to abut, in a mounting step of the support bar 2 on the overhead platform, the protecting railing 11 such that the support bar 2 rests on the protecting railing 11. In other words, the protrusion is shaped to abut on an upper face, or an upper surface of the upper horizontal

element of the protecting railing 11, such that this face, or surface of the horizontal element acts as a support for the support bar 2.

**[0034]** The protrusion 5 can have an arc or curved profile, of hook type, facing downwards, shown in Figures 5A-5C. The expression "facing downwards" means that the profile of the protrusion 5, when the support bar 2 is mounted on the protecting railing 11, faces the support plane Q of the overhead platform 10. Owing to the hook profile of the protrusion 5, in a mounted state, the abutment between the protrusion 5 and the horizontal element of the protecting railing 11 ensures reduction of any undesired movements of the support bar 2 that cause an accidental fall and further enables the support bar 2 to be hooked to elements of protecting railing having sections of a different shape, for example, circular, quadrangular, or polygonal. Further, the hook shape enables the contact surface to be maximized between the protrusion 5 and the horizontal element of the protecting railing 11. This enables possible deformation to be limited, in particular flexural deformations, of the horizontal element of the protecting railing 11 caused by the weight of the support device 1 mounted on the protecting railing 11, or by the weight of an operator resting on the protecting railing 11. Owing to the profile of the protrusion 5, as already said, the probability is reduced that the support device 1, in a mounted configuration on the horizontal element of the protecting railing 11, comes unhooked and falls accidentally.

**[0035]** On a side face of the support bar 2, for example on a face that extends along the prevalent dimension Dp, a slot 6 is obtained. The slot 6 also extends parallel to the prevalent dimension Dp and defines a housing seat for a cursor 7. The slot 6 can have an end positioned near a lower end of the support bar 2, as shown in Figure 5C.

**[0036]** The cursor 7 protrudes from the slot 6 in a direction substantially transverse to the prevalent dimension Dp of the support bar 2, and is turned towards, or faces, the protrusion 5.

**[0037]** The cursor 7 is movable along a direction that is parallel to the prevalent dimension Dp inside the slot 6 between the two ends of the slot 6.

**[0038]** The cursor 7 is shaped to abut on the protecting railing 11 in a mounting configuration of the support bar 2 on the overhead platform 10. The cursor 7 is shaped to abut on a lower face, or on a lower surface of the lower horizontal element of the protecting railing 11. For example, the cursor 7 can have an identical shape to the shape of the protrusion 5, i.e. can have an arc or curved profile, of hook type, and face the protrusion 5, as shown in Figures 5A-5C, to abut below on the lower horizontal element of the protecting railing 11. Similarly, to the protrusion 5, the arc or curved profile of hook type of the cursor 7 makes it possible to hook the support bar 2 to elements of protecting railing having sections of different shape, for example circular, quadrangular or polygonal. Further, the hook shape enables the contact surface to be max-

imized between the cursor 7 to come into contact and the protecting railing 11. Owing to the profile of the cursor 7, as already said with reference to the protrusion 5, the probability is reduced that the support device 1, in a configuration mounted on the horizontal element of the protecting railing 11, comes unhooked and falls accidentally.

**[0039]** The cursor 7 is movable to abut on a lower face, or on a lower surface of an element of the protecting railing 11. The cursor 7 is moved along the direction that is parallel to the prevalent dimension Dp by a mechanical coupling for transmitting motion, for example a screw-nut screw coupling. As shown in Figure 5B, the cursor 7 is connected to or is made of a monobloc with a drilled and suitably threaded nut screw element. The nut screw element is positioned inside the support bar 2 and is dimensioned for cooperating with a screw 9, which is also provided inside the support bar 2. The screw 9 extends parallel to the prevalent dimension Dp and is fixed rotatably between the two ends of the support bar 2 to rotate around an axis of revolution R. In one of the two ends, the screw 9 is connected to a knob 8 which is also rotatable around the axis of revolution R. A rotation of the knob 8 causes a rotation of the screw 9 around the axis of revolution R and a subsequent movement of the nut screw of the cursor 7 in the direction of the axis of revolution R. The movement of the nut screw of the cursor 7 is proportional to a pitch of the screw 9. Obviously, depending on the direction of rotation set for the knob 8, clockwise or anticlockwise, the movement of the cursor will be upwards or downwards. The rotation of the knob 8 can be set manually by an operator O.

**[0040]** This enables a position of the cursor 7 to be adjusted along the direction that is parallel to the prevalent dimension Dp.

**[0041]** A mounting step of mounting the support bars 2 on the protecting railing 11 is shown in Figures 11-11B. Mounting can be performed manually by an operator O.

**[0042]** In use, an operator moves the support bar 2 so as to make the protrusion 5 abut on the upper horizontal element of the protecting railing 11, moving the support bar 2 from top to bottom in a direction substantially parallel to the prevalent dimension Dp, and adjusts in position the cursor 7 such that it abuts on the lower horizontal element of the protecting railing 11. In this manner, the support bar 2 is fixed to the protecting railing 11 of the platform 10.

**[0043]** This step of mounting the support bars 2 can be performed when the overhead platform 10 is substantially near the ground P, as shown in Figures 11, 12, 13 or rather when it is not at a height.

**[0044]** Figures 11-11A show that the support bars 2 are mounted on the protecting railing 11 of the overhead platform 10 so as to be outside an inner workspace bounded by the railing and occupied by the operator O when the latter performs work tasks at a height. In other words, the support bars 2 are mounted so as to face the outside of the overhead platform 10.

**[0045]** Alternatively, the support bars 2 can be mount-

ed on the protecting railing 11 so as to face the inner workspace of the overhead platform 10, bounded by the railing 11, as shown in Figures 14A-14C, 15A-15C, 16A and 16B.

**[0046]** In order to dismantle the support bars 2 from the protecting railing 11, the operator O will substantially have to perform the same tasks disclosed for mounting, but in reverse order: adjusting the position of the cursor 7 such that the cursor 7 no longer abuts on the horizontal element of the railing 11, and lifting upwards the support bar in a direction substantially parallel to the prevalent dimension Dp so as to free the protrusion 5 from the abutment with the upper horizontal element of the protecting railing 11.

**[0047]** Other types of mechanical coupling can be provided for transmitting motion to the cursor 7, for example by using a ball screw. It is also possible to transmit motion to the cursor by an electromechanical or hydraulic or pneumatic drive. Obviously, the skilled person will have to take all the design steps required for these drives to be operationally effective.

**[0048]** Obviously, the position of the cursor 7 and of the protrusion 5 can be reversed, such that the cursor occupies a position that is higher than the protrusion 5 and the position disclosed and shown in the attached Figures. Also in this case, the skilled person will have to take all the design steps necessary to ensure that this reversal is operationally effective.

**[0049]** The support device 1 comprises a compensation unit 12, which is removably connectable to the support means, for example to the pair of support bars 2.

**[0050]** The compensation unit 12 is configured to compensate for a weight of the work tool U, as explained below.

**[0051]** In general, the compensation unit 12 is configured to compensate for a weight of any equipment or other object provided with weight. The compensation unit 12 can comprise a container body 3 and a casing 4, connected to the container body 3. The casing 4 is fixed, for example it is welded to the container body 3. The container body 3 is operationally positioned above the casing 4. The casing 4 has a hollow box shape and has a prevalent dimension compared with the remaining two dimensions. The prevalent dimension of the casing 4 extends parallel to a main direction D that is parallel to the direction of gravity in a mounted configuration of the support device on the railing 11 of the overhead platform 10.

**[0052]** In a configuration in which the compensation unit 12 is connected to the support bars 2 as shown in Figure 1, the main direction D is substantially parallel to the direction of the prevalent dimension Dp of the support bars 2.

**[0053]** The container body 3 is connected removably to the support means, for example to the support bars 2. The expression removably connected means that the container body can be mounted on and dismantled from the support bars 2. When the container body 3 is connected to the support means, the container body 3, con-

sequently also the casing 4, is stationary with respect to these support means.

**[0054]** The container body 3 can be provided with a protection bar 28 (Figure 3) to avoid accidental contacts between the operator O and the container body 3. In order to be clearer, the aforesaid protection bar avoids accidental contacts between the operator and elements of the compensation unit 12 (disclosed below) that protrude outside the container body 3, to prevent the operator touching or handling the elements unintentionally. Further, the protection bar is arranged to prevent accidental contacts between the container body 3 and work tools, for example during the steps of mounting the work tools on or dismantling the work tools from the support device 1, or during the mounting/dismantling of the support device 1 itself.

**[0055]** With reference to Figures 3A-3C, inside the casing 4 a linear actuator of known type is provided, comprising a cylinder 4a and a stem 4b, the stem 4b being movable with respect to the cylinder 4a along the direction D between two ends of the cylinder 4a. The linear actuator can comprise a tubular element 4c extending parallel to the direction D and surrounding the stem 4b and the cylinder 4a. The tubular element 4c is connected, for example by mechanical connections of known type, for example threaded connections, to the stem 4b, for example in an upper end of the stem 4b, as shown in Figure 3A. The tubular element 4c is movable with the stem 4b along the main direction D. The tubular element 4c can have in a top plan view, an elliptical, oval or any other compatible shape, for example circumferential or quadrangular.

**[0056]** On two faces of the container body 3 opposite one another, for example an upper base face 3a and a lower base face opposite the upper base face 3a, a through hole can be obtained, sized to enable the linear actuator 4 to be inserted inside the container body 3, in particular inside the tubular element 4c.

**[0057]** An end portion of the tubular element 4c can protrude beyond the upper base face 3a along the direction D both when the stem 4b is at the lower end of the cylinder 4a, and when it is at the upper end of the cylinder 4a.

**[0058]** The tubular element 4c is movable inside the container body 3; the container body 3 is in fact provided with pairs of rollers 14 (commonly called wheels), which are visible in Figure 3B, which are mounted respectively on two opposite side walls of the container body 3, arranged for supporting slidably the tubular element 4c in movement along the main direction D, both upwards and downwards.

**[0059]** The compensation unit 12 further comprises an arm 32, connected to the linear actuator 4, and arranged to support the work tool U.

**[0060]** The arm 32 can be connected rotatably to the end portion of the tubular element 4c as explained below, for example providing a pin 47 on this end portion, and pivoting the arm 32 on this end portion. The arm 32 can

be rotatable around a rotation axis S to rotate relative to the tubular element 4c. The arm 32 can be provided with locking means, for example a locking stem 25a drivable by a locking handwheel 25, arranged to lock a rotation thereof in a desired angular position and be provided with an anti-detachment safety piston 40 suitable for preventing detachment of the arm 32 from the end of the tubular element 4c. Advantageously, the rotation of the arm 32 can be locked in preset positions, which are separated from one another by a constant angle, for example by providing in the pin 47 a plurality of notches 48 distributed with a constant angular pitch along the circumference of the pin 47. The arm 32 can be rotated by 360°.

**[0061]** In use, as shown in Figures 13A, 13B and 13C, the operator O can insert from above the arm 32, or also other arms connected to the arm 32 as will be explained below, on the pin 47 of the end portion of the tubular element 4c, drive the anti-detachment safety piston 40 and possibly lock the angular position of the arm 32 by acting on, i.e. rotating, the locking handwheel 25.

**[0062]** The linear actuator 4a, 4b, 4c can be of pneumatic type. The support device 1 is in fact associated with a source of compressed air, for example a compressor, which is not shown in the figures, which is suitable for sending a compressed air flow to the compensation unit 12, in particular to the linear actuator 4a, 4b, 4c. The compressor can be an element outside the support device 1. Alternatively, the compressor can be integrated into the support device.

**[0063]** The compensation unit 12 is provided with inner pneumatic conveying means 15, 19, 20, 21 arranged to be crossed by the compressed air flow so as to convey the compressed air flow to the linear actuator 4a, 4b, 4c, in particular to the cylinder 4a.

**[0064]** The compensation unit 12 is further provided with pneumatic adjusting means 16, 17, 18, 22, 23 arranged to adjust a flow of the compressed air conveyed to the linear actuator 4a, 4b, 4c so that the linear actuator 4a, 4b, 4c compensates for a weight of the tool.

**[0065]** The pneumatic conveying means 15, 19, 20, 21 and the pneumatic adjusting means 16, 17, 18, 22, 23 define a conveying path for conveying compressed air from the compressor to the linear actuator 4a, 4b, 4c, as explained below.

**[0066]** Owing to the pneumatic conveying means 15, 19, 20, 21 and to the pneumatic adjusting means 16, 17, 18, 22, 23, the operator O is allowed to perform the manual work task at a height in the absence of weight.

**[0067]** The pneumatic conveying means 15, 19, 20, 21 can be positioned inside the container body 3, and at least partially inside the linear actuator 4a, 4b, 4c; the pneumatic adjusting means 16, 17, 18, 22, 23 can be positioned inside the container body 3.

**[0068]** The pneumatic conveying means can comprise an inlet joint 15 sized to be connected to the compressor, in particular to be connected to an outlet pipe of the compressor.

**[0069]** The pneumatic conveying means can comprise

a plurality of conveying pipes 19, 20, 21 sized to be traversed by the compressed air and convey a flow of compressed air to the linear actuator 4a, 4b, and 4c.

**[0070]** The pneumatic adjusting means can comprise a check valve 16, also called non-return valve, positioned downstream of the inlet joint 15 (with reference to the direction that the compressed air stream follows to be conveyed from the compressor to the linear actuator) and in fluid connection with the latter by means of a first conveying pipe 19. The check valve 16 is of known type and enables the compressed air to traverse the check valve 16 only in one direction, to move to the linear actuator 4 and prevent the compressed air traversing the inlet joint 15 to go to the compressor.

**[0071]** The pneumatic adjusting means can comprise a shut-off valve 17, located for example downstream of the check valve 16 and in fluid connection with the check valve 16.

**[0072]** The shut-off valve can be of the on/off type. The shut-off valve 17 can be of the "three ways" type, i.e. be provided with three ports, an inlet port, a delivery port and a discharge port that can be placed or not placed in fluid communication with one another, according to a position occupied by a shutter of the shut-off valve 17, drivable manually by a button 17a.

**[0073]** The shut-off valve 17 can be a valve of the "ball" type.

**[0074]** The inlet port is traversed by the compressed air coming from the check valve 16. The discharge port can be traversed by the compressed air discharged to the outside of the conveying path conveying compressed air. The delivery port is traversed by the compressed air directed towards the linear actuator 4a, 4b, and 4c.

**[0075]** When the shut-off valve 17 is in the "on" configuration, i.e. in the open configuration, the inlet port is connected fluidly to the delivery port; when on the other hand the shut-off valve 17 is in the "off" configuration, i.e. in the closed configuration, the delivery port is in fluid connection with the discharge port.

**[0076]** The shut-off valve 17 can be provided with a first discharge regulator 22 drivable to regulate/dose a flow of the compressed air flow which is discharged, in a closed configuration of the shut-off valve 17, i.e. in the off configuration, outside the shut-off valve 17, i.e. outside the conveying path.

**[0077]** The pneumatic adjusting means can comprise a pressure regulator valve 18 configured to control a flow-rate of the compressed air to be conveyed to the linear actuator 4a, 4b, 4c, in particular to the cylinder 4a.

**[0078]** The regulator valve 18 is placed downstream of the shut-off valve 17; the regulator valve 18 is placed in fluid connection with the shut-off valve 17, in particular with the delivery port of the shut-off valve 17, by a second conveying pipe 20.

**[0079]** The regulator valve 18 is provided with a shutter, which is movable between an open position, in which it frees a passage area of the regulator valve 18 and enables a compressed air flow to pass through the pas-

sage area, and a closed position, in which it closes the passage area of the regulator valve 18 and prevents the compressed air flow passing through the passage area.

**[0080]** Between the closed position and the open position, the shutter can assume intermediate positions, adjusting in this manner the compressed air flow that traverses the passage area of the regulator valve 18. When the shutter assumes the intermediate positions, a certain compressed air flow that does not traverse the passage area of the regulator valve 18 can be discharged outside this regulator valve 18. When the shutter assumes the intermediate positions, the valve thus assumes a discharge configuration.

**[0081]** The regulator valve 18 can be provided with a second discharge regulator 23, which is structurally similar to the first discharge regulator 22, which is also drivable in the discharge configuration of the regulator valve 18, to adjust a further compressed air stream which is discharged outside the regulator valve 18, i.e. outside the conveying path.

**[0082]** The regulator valve 18 can be connected to the linear actuator, in particular to the cylinder 4a, by a third conveying pipe 21.

**[0083]** It is possible to adjust the position of the shutter of the regulator valve 18 between the open and closed position, in addition to the first discharge regulator 22 and the second discharge regulator 23, to adjust the flowrate of the compressed air flow conveyed to the linear actuator and possibly the flows of compressed air discharged to the outer environment, so that the linear actuator 4a, 4b, 4c compensates for a weight of the tool U and enables the operator O to perform the manual work task at a height in the absence of the weight of the tool U.

**[0084]** Adjusting the shutter of the regulator valve 18, in addition to the first discharge regulator 22 and the second discharge regulator 23, can be performed manually by the operator O. Alternatively, with suitable design measures, pneumatic, electropneumatic or in general hydraulic valves can be used, provided with a slave command, used for example in a servosystem.

**[0085]** The expression compensating for the "weight of the tool" means that by supplying the linear actuator with a compressed air flow, relative pressure that is greater than zero is generated. The scalar product of the corresponding pressure and of the area of the cylinder 4a generates on the stem 4b a compensating force having a direction substantially parallel to and opposite that of the force of gravity acting on the tool U, and having a module that is substantially the same as that of the weight force of the tool U so as to compensate for the weight force. In other words, the vectorial difference between the two forces returns a nil vector. Obviously, the flow of compressed air with which to supply the linear actuator changes depending on the weight of the tool to be compensated for.

**[0086]** As has been said already, the stem 4b, connected to the tubular element 4c of the linear actuator, is movable in the direction D that is parallel to the direction

of the force of gravity.

**[0087]** The stem 4b, and consequently the tubular element 4c, can be driven for example by an outer force exerted by the operator O, to be moved upwards or downwards along the main direction D. On the basis of what has been disclosed before, the operator O does not have to compensate for or support the weight of the tool to drive movement of the stem 4b, and thus the tubular element 4c.

**[0088]** In detail, if the stem 4b is driven to move downwards, a corresponding pressure that is greater than zero is generated inside the cylinder 4a. The scalar product of the aforesaid pressure and of the area of the cylinder 4a returns the module of a force with which at least one part of the compressed air flow is moved away from the cylinder 4a and is directed to the pressure adjuster 18 and discharged into the outer environment, by the adjustment made to the second discharge regulator 23.

**[0089]** When the outer force is interrupted, conveying of the flow of compressed air to the linear actuator 4a, 4b, 4c is resumed, in the manner disclosed previously, and the stem 4b downward movement is interrupted.

**[0090]** Owing to the second discharge regulator 23, it is possible to adjust a speed at which the compressed air is discharged into the outer environment, in particular to slow the exit speed of the air, increasing the load losses and decreasing the noise during the step of discharging the compressed air. The stem 4b can then move downwards not in a sudden and brusque manner but in a slower and more gradual manner.

**[0091]** If the stem 4b is driven to move upwards, a corresponding relative pressure that is less than zero is generated inside the cylinder 4a. The scale product of the aforesaid pressure and of the area of the cylinder 4a returns the module of a force with which a further compressed air flow inside the cylinder 4a is aspirated to compensate almost instantaneously for the generated vacuum status.

**[0092]** When the outer force is interrupted, conveying of the flow of compressed air to the linear actuator 4a, 4b, 4c is resumed, in the previously disclosed manner, and the upward movement of the stem 4b is interrupted.

**[0093]** On the basis of what has been disclosed, owing to the pneumatic conveying and pneumatic adjusting means, both during driving of the stem 4b upwards or downwards the operator does not have to deal with supporting the weight of the tool U; and the effort made to move the tubular element 4c or the stem 4b upwards or downwards is negligible. This makes positioning of the tool U along the main direction D much more precise than that of prior art support devices.

**[0094]** The compensation unit 12 can be connected removably to the support means, as explained below.

**[0095]** For example, according to the first embodiment, the compensation unit 12 can be connected to the pair of support bars 2.

**[0096]** On each support bar 2, at least one opening 13 is obtained that is visible for example in Figure 11C. The

at least one opening 13 can be obtained on a side face of the support bar 2 extending parallel to the prevalent dimension Dp, in particular on the side face opposite the side face in which the slot 6 is obtained.

**[0097]** The at least one opening 13 can have a plan shape of quadrangular type, or other compatible shapes (circumferential for example).

**[0098]** For example, on the side face of each support bar 2 of the pair of support bars, two openings 13 can be obtained, placed at a set distance along the prevalent dimension Dp, for a total of four openings 13.

**[0099]** The at least one opening 13 can define a seat for housing the compensation unit 12.

**[0100]** The compensation unit 12, for example the container body 3 of the compensation unit 12, is provided with coupling means 29, 31 arranged to detachably connect the container body 3, and thus the entire compensation unit 12, to the support means, in the specific case to the support bars 2.

**[0101]** The coupling means can comprise at least one hook 29 and at least one gripping element 31.

**[0102]** The at least one gripping element 31 is shaped to engage with the opening 13, in particular with the lower edge of the opening 13, as shown in Figures 12C and 12D. The gripping element 31 can comprise a concave surface that is in a positive mechanical engagement with the lower edge of the opening 13, so as to be inserted and engage with the lower edge.

**[0103]** As shown explicitly in Figure 3, the container body 3 is provided with a plurality of gripping elements 31, positioned on the side edges of a side face 3c of the container body 3. Specifically, the container body 3 can comprise four gripping elements 31, two gripping elements 31 being positioned above, and aligned with, the remaining two gripping elements 31.

**[0104]** Each gripping element 31 is shaped to engage with a respective opening 13 in a mounted configuration of the compensation unit 12 on the support bars 2, in particular with the lower edge of the opening 13. In particular, each gripping element 31 has a profile of hook type that permits suitable fixing of the gripping element 31 on the lower edge of the opening 13.

**[0105]** The hook 29 can be mounted rotatably on a side face 3d of the container body 3, for example the side wall that is orthogonal to the upper base face 3a.

**[0106]** Two hooks 29 can be provided, one on each side face 3b of the container body 3, positioned at a height that is substantially equal along a direction orthogonal to a plane containing the main direction D.

**[0107]** In the embodiment shown in Figures 12C and 12D, each hook 29 can be mounted on the inner side of the side face 3d, so as to be housed inside the container body 3. In an embodiment that is not illustrated, alternatively, the hook can be mounted on the outer side of the side face.

**[0108]** The hook 29 is provided with a shaped end portion curved upwards, for example folded into a hook, to enable the hook to engage another edge of the opening

13. Each hook 29 can be connected rotatably to the inner side of the side face 3d, for example by a pin. Each hook 29 is rotatable around a rotation axis thereof in a rotation direction V, for example an anticlockwise rotation direction, and another rotation direction W, for example a clockwise rotation direction to engage with this other edge of the opening 13, as will be explained below. Each hook 29 is provided with a gripping element 30 that is drivable to rotate the hook 29 in the rotation direction V or in the other rotation direction W.

**[0109]** The end portion of the hook 29 can protrude, during an operating step, from a slit obtained on a face of the container body 3, for example a side face facing the opening 13 of the support bar 2. The hook 29 can be rotated (in the rotation direction V or W depending on cases) between a first configuration, in which the end portion is contained inside the container body 3, and a second configuration in which the at least one part of the end portion of the hook 29 protrudes outside the slit of the container body 3.

**[0110]** Also, the gripping element 30 can protrude from a further slit obtained on the side face 3d in a direction orthogonal to the side face 3. The gripping element 30 is shaped to be gripped by the operator O to rotate the hook 29.

**[0111]** In the second configuration, the end portion protrudes from the slit and is housed in the opening 13. In detail, an upper surface of the end portion of the hook 29 is in contact with an edge of the opening 13, in particular with the upper edge of the opening 13, as shown in figure 12D.

**[0112]** Owing to the geometry of the hook 29 and positioning thereof in the container body 3, the passage from the first configuration to the second configuration can occur spontaneously, i.e. automatically. As is possible to observe in Figures 12C and 12D, the hook 29 has a geometry and a mass distribution that is such that the action of the force of gravity acts on the centre of gravity of the hook 29 so as to cause a rotation of the hook 29 relative to the rotatable point of connection (pin) in the direction of rotation V. Through the effect of the rotation, the hook can engage spontaneously/automatically in the opening 13 and cannot disengage spontaneously from the opening 13 without an outer force being applied. In other words, to perform the task of disengaging the hook 29 from the opening 13, it is necessary for the operator to grasp the gripping element 30 and rotate the hook in the other rotation direction W to return the hook to the first configuration. Owing to the geometry of the hook 29, the probabilities are minimized that when the hook 29 is engaged in the opening 13, it disengages from the opening 13 in an undesired manner and without the intervention of the operator, causing a disconnection of the entire compensation unit 12 from the support arms 2.

**[0113]** The hook 29 can be associated with a respective gripping element 31 and be inserted into the same opening 13 of the gripping element 31 with which it is associated.

**[0114]** For example, in the embodiment shown in Figures 12A, 12B, 12C and 12D, each hook 29 of the pair of hooks is associated with a respective gripping element 31 of the two upper gripping elements 31. Each hook 29 can engage with a free edge of the opening 13, i.e. with the edge not engaged with the gripping element 31, particular with the upper edge of the opening 13, as shown in figure 12D.

**[0115]** The container body 3 of the compensation unit 12 is further provided with a pair of handles 24 mounted on two side walls of the container body 3, sized for being grasped by the operator O during a task of mounting/connecting the compensation unit 12 on/to the support means.

**[0116]** The container body 3 of the compensation unit 12 can be connected manually to the support means, in particular to the support bars 2.

**[0117]** In use, each hook 29 is provided initially in the first configuration.

**[0118]** In use, the operator O can grasp the handles 24 of the container body 3 and move the container body 3 in space. In particular, the operator O can move the container body 3 to insert the gripping element 31 into the opening 13, for example into the lower edge of the opening 13. In particular, the operator O can move the container body 3 to insert each gripping element 31 into the respective opening 13, i.e. to insert two lower gripping elements 31 into the respective lower openings 13, and two upper gripping elements 31 into the respective upper openings 13.

**[0119]** In use, the operator O can grasp the gripping element 30 to rotate the hook 29 until the hook 29 adopts the second configuration, such that the end portion engages the upper edge of the upper opening 13. In particular, the operator O can grasp each gripping element 30 of each hook 29 to rotate each hook 29 until the hook 29 adopts the second configuration, such that each end portion engages the upper edge of the respective upper opening 13.

**[0120]** This enables the container body 3 to be connected, in particular hooked, to the support means without undesired movements, disconnections (or unhooking) being able to occur. Obviously, the hooks 29 can also be associated with the two lower gripping elements 31, or also alternatively four hooks 29 can be provided, each associated with the respective gripping element 31. The number of hooks and gripping elements can vary according to circumstances.

**[0121]** The elements of the support device 1 disclosed so far, and the advantages arising therefrom, where they are not expressly excluded or incompatible, can be deemed to be included in and applicable to all the embodiments that will be disclosed below, even if they are not mentioned explicitly. Also, the tasks of mounting and dismantling the support device to or from the overhead platform can refer to the other embodiments disclosed below, with suitable expedients.

**[0122]** In Figure 2, a second embodiment of a support

device 1' is shown.

**[0123]** For the description of the second embodiment of the support device 1', the same reference numbers have been adopted to indicate elements that are identical or similar in terms of structure or function to those disclosed with reference to the preceding embodiment. For the details (and variants), reference can be made to the description already given for these elements, where it is not repeated here.

**[0124]** The compensation unit 12 of the support device 1' can be connected removably to the support means.

**[0125]** The compensation unit 12 of the support device 1' can run on this support means along a sliding direction N, as explained below.

**[0126]** The support means can comprise the previously disclosed pair of support bars 2, a guide crossbar 27 mounted between the two support bars, and a carriage 26 mounted slidably on the crossbar 27. The crossbar 27 is arranged horizontally in a mounted configuration, i.e. is oriented transversely relative to the pair of support bars 2.

**[0127]** On each support bar 2 a through hole 33 is obtained that is sized to enable the crossbar 27 to be inserted. Each support bar is further provided with locking elements that are drivable to lock the crossbar in the hole after insertion, for example a spring with pin locking and the like.

**[0128]** The task of mounting and dismantling the crossbar 27 on and from the pair of support bars 2 is thus simple and fast to perform.

**[0129]** On the carriage 26, a through hole can be obtained that is sized to enable the carriage 26 to be inserted and housed on the crossbar 27. The carriage slides on the crossbar 27 between two stop points substantially coinciding with the two support bars 2. The carriage 26 is provided with a locking element 46, arranged to lock a movement of the carriage 26 on the crossbar 27, for example in a work position, which can be chosen at will by an operator. The locking element 46 is drivable by a lever 46a that protrudes outside the carriage 26.

**[0130]** On a side face 26a of the carriage 26, at least one slot 34 is obtained, visible for example in Figure 2A and can have a plan shape of quadrangular type, or any compatible shape.

**[0131]** The at least one slot 34 can define a seat for housing the compensation unit 12. For example, four slots 34 can be obtained on the side face 26A that are placed near the edges of this side face, two slots 34 of the four slots being positioned above and aligned with two further slots 34.

**[0132]** The at least one slot 34 is substantially the same in shape and dimensions as the at least one opening 13 obtained on the support bar 2.

**[0133]** The at least one slot 34 is shaped to couple with the coupling means 29, 31 of the compensation unit 12, in particular of the container body 3, exactly in the manner disclosed previously for the coupling between the coupling means 29, 31 and the least one opening 13.

**[0134]** Thus, if in the first embodiment disclosed, the compensation unit 12 is connected to the pair of support bars 2 that are connected in turn to the protecting railing 11, in the second embodiment the compensation unit 12 is connected to the carriage 26 and slidable in the sliding direction N transverse to the direction D, or rather belonging to a plane oriented transversely to the plane to which the direction D belongs. The compensation unit 12 is thus slidable relative to the overhead platform 10 along this sliding direction.

**[0135]** The support bars 2 of the two embodiments are substantially the same structurally.

**[0136]** The movement of the carriage 26, and of the entire compensation unit 12, is conducted simply by the operator and without excessive effort, still naturally in the absence of weight of the tool.

**[0137]** Depending on needs, the operator O can move from the second embodiment to the first, or vice versa, simply disconnecting the compensation unit 12 from the carriage 26, disconnecting the crossbar 27 from the pair of support bars 2 and reconnecting the compensation unit 12 to the support bars 2.

**[0138]** The mounting and dismantling steps of the support device thus remain identical to those disclosed previously, except for the connection of the compensation unit 12 to the carriage 26, and will therefore not be disclosed again.

**[0139]** As already disclosed previously, the arm 32 is connected rotatably to the end portion of the tubular element 4c to rotate around the rotation axis S.

**[0140]** With reference to both embodiments of the support device 1 and 1', a housing element 35, 36, 37, 38, shaped to house the tool U can be connected to the arm 32.

**[0141]** The housing element can comprise a toolholder 35, shown in Figure 7, connected rotatably to an end portion of the arm 32 to rotate around a further rotation axis Z parallel to the rotation axis S (also by 360°). Obviously, the toolholder 35 is provided with an element for locking the angular rotation thereof around the further rotation axis Z.

**[0142]** The toolholder 35 is shaped to house the tool U such that a work axis X of the tool U is substantially oriented vertically, i.e. parallel to the rotation axis S. Specifically, the toolholder 35 can comprise a fork element 35a having for example a "Y" or "U"-shaped body, a plate 35b connected rotatably to the fork 35a, for example by two side hinges provided on the fork 35a. At least one locking strip arranged to connect/lock the tool U to the plate 35b can be connected to the plate 35b. Owing to the rotatable connection provided between the plate 35b and fork 35a, the tool U can oscillate around a substantially horizontal axis, for example perpendicular to the plane that contains the rotation axis Z. Further, owing to the presence of an element for locking the angular rotation thereof around this horizontal axis, it is possible to lock the tool U in a substantially vertical position, as shown in Figure 7, or also in other angular positions.

**[0143]** Owing to the toolholder 35, the operator O, by gripping the tool U, can perform substantially vertical workings, can further rotate the arm 32 around the rotation axis S to modify an angular position, can move the compensation unit 12, in particular the tubular element 4c, along the direction D, and can, where envisaged, for example in the case of the second embodiment of the support device 1', move the compensation unit 12 along the sliding direction N. This all occurs in the absence of weight of the tool, and each movement is precise and simple to perform.

**[0144]** The housing element can alternatively comprise a toolholder 36, shown in Figure 8, connected rotatably to an end portion of the arm 32 to rotate around a further rotation axis Z parallel to the rotation axis S and around another further rotation axis T, belonging to a plane that is orthogonal to the further rotation axis Z. Obviously, also in this case the toolholder 36 is provided with an element for locking the angular rotation thereof around the further rotation axis Z. The toolholder 36 is shaped to house the tool U such that the work axis X of the tool U, in an operating configuration, is substantially arranged horizontally, i.e. orthogonally to the further rotation axis Z, as shown in Figure 8. Also in this case, however, the tool U can oscillate around the axis T, as explained below.

**[0145]** The toolholder 36 can comprise a plate 36a connected rotatably, by a hinge or a pin, for example, to an end of the arm 32 to rotate around the other further rotation axis T, and at least one pair of locking strips 36b arranged to lock the tool U to the plate 36a. The tool U can oscillate around the other further rotation axis T. Further, owing to the presence of an element for locking the angular rotation thereof around this horizontal axis, it is possible to lock the tool U in a substantially horizontal position, as shown in Figure 8, or also in other angular positions.

**[0146]** Owing to the toolholder 36, the operator O, by grasping the tool U, can perform substantially horizontal workings and can make the tool U oscillate around the other further rotation axis T, can further rotate the arm 32 around the rotation axis S to modify an angular position, can move the compensation unit 12, in particular the tubular element 4c, along the direction D, and can, where envisaged, for example in the case of the second embodiment of the support device 1', move the compensation unit 12 along the sliding direction N. The operator O can further rotate the plate 36a around the other further rotation axis T to perform tasks with the tool U in tilted positions. This all occurs in absence of weight of the tool, and each movement is precise and simple to perform.

**[0147]** The housing element can alternatively comprise a flat toolholder 37, shown in Figure 9, provided with a support surface with a slip-proof material coating and provided with peripheral slots for housing the strips, which are not shown, which are arranged to lock the tool, which is also not shown. This flat toolholder 37 can be hinged on the end of the arm 32 to rotate in space.

**[0148]** Owing to the flat toolholder 37, the operator O grasping the tool U can rotate the flat toolholder 37 in space, can rotate the arm 32 around the rotation axis S to modify an angular position, can move the compensation unit 12, in particular the tubular element 4c, along the direction D, and can, where envisaged, for example in the case of the second embodiment of the support device 1', move the compensation unit 12 along the sliding direction N. This all occurs in absence of weight of the tool, and each movement is precise and simple to perform.

**[0149]** The housing element can alternatively comprise a hook-shaped toolholder 38, shown in Figure 10, to which the tool U that is not shown can be connected removably.

**[0150]** Owing to the hook-shaped toolholder 38, the operator O, by grasping the tool U, can move the tool U in space, can rotate the arm 32 around the rotation axis S to modify an angular position, can move the compensation unit 12, in particular the tubular element 4c, along the direction D, and can, where envisaged, for example in the case of the second embodiment of the support device 1', move the compensation unit 12 along the sliding direction N. All this occurs in absence of weight of the tool, and each movement is precise and simple to perform.

**[0151]** To the arm 32, in particular to an end of the arm 32, a further arm 39 can be connected rotatably, for example with reference to the first embodiment of the support device 1 shown in Figures 1, 1A, 6A, 6B, 13, 13A and 13B. The arm 32 and the further arm 39 define an articulated arm, which assists more greatly the manual work activity of the operator O in absence of weight. It is not ruled out that the further arm 39 may also be provided in the support device as disclosed in the second embodiment.

**[0152]** The further articulated arm 39, similarly to the arm 32, can be provided with a locking stem 25a, which is drivable by a locking handwheel 25 arranged to lock a rotation thereof in a desired angular position and an anti-detachment safety piston 40 that is suitable for preventing detachment of the further arm 39 from the arm 32. The end of the further arm 39 opposite the end connected to the arm 32 is intended to mount a tool U on the further arm 39 and can be equipped with a safety cable 41 that is suitable for preventing the tool U from falling from the platform 10 if the support supporting the tool U gets detached from the end of the further arm 39. Even if only one articulated arm 32 is envisaged, the end thereof to which the support of the tool U is fixed can be equipped with a safety cable 41. Obviously, any one of the housing elements 35, 36, 37, 38, disclosed previously can be connected to the further arm 39.

**[0153]** In Figure 1C, a system of articulated arms is illustrated that enables two tools to be mounted simultaneously on the support device 1, 1' according to the invention.

**[0154]** The system of articulated arms comprises a first

pair of articulated arms 42, 43 and a second pair of articulated arms 44, 45.

**[0155]** The first pair of articulated arms comprises a first articulated arm 43 a first end of which can be connected to the pin 47 of the tubular element 4c.

**[0156]** A second end of the first articulated arm 43, opposite the first end, can be connected to a first end of a second articulated arm 42, to a second end of which a first tool U can be connected.

**[0157]** The second pair of articulated arms comprises a third articulated arm 45, a first end of which can be connected to the pin 47 of the tubular element 4c.

**[0158]** A second end of the third articulated arm 45, opposite the first end, can be connected to a first end of a fourth articulated arm 44, to a second end of which a second tool U can be connected.

**[0159]** The second ends of the second articulated arm 42 and of the fourth articulated arm 44 are provided with respective safety cables 41.

**[0160]** The system of articulated arms with two pairs of articulated arms, each of which can support a tool U, enables an operator to be able to use two tools to perform two different types of tasks, without having to replace the tool to move from one task to the other. Further, if the dimensions of the lifting platform permit, the system of articulated arms with two pairs of articulated arms enables two operators to work simultaneously, each with their own tool, in a respective work area.

## Claims

1. Support device (1; 1') arranged to support a work tool (U) and to assist an operator (O) during a manual work task performed at a height by said operator (O) with said work tool (U), said support device (1; 1') being connectable to a protecting railing (11) of a lifting device (10), said support device (1; 1') comprising support means (2, 26, 27) removably mountable on said protecting railing (11), said support device (1; 1') being **characterised in that** it comprises a compensation unit (12) arranged to support a weight of said tool (U), said unit being removably connectable to said support means (2, 26, 27), said compensation unit (12) comprising a linear actuator (4a, 4b, 4c) that is movable in a main direction (D) that is parallel to the direction of gravity in a mounted configuration of said support device (1, 1') on said protecting railing (11), and at least one arm (32) connected to said linear actuator (4a, 4b, 4c) and arranged to support said tool (U); said compensation unit (12) being associated with a source of compressed air to send a compressed air flow to said compensation unit (12); said compensation unit (12) being further provided with inner pneumatic conveying means (15, 19, 20, 21) arranged to be crossed by said compressed air flow to convey said compressed air flow to said linear actuator (4a, 4b, 4c),

and pneumatic adjusting means (16, 17, 18, 22, 23) arranged to adjust a value of said flow of said compressed air flow conveyed to said linear actuator (4a, 4b, 4c) on the basis of said weight of said tool (U), such that said linear actuator (4a, 4b, 4c) compensates said weight of said tool (U) and enables said operator (O) to perform said manual work task at a height in the absence of said weight.

2. Support device (1; 1') according to claim 1, wherein said compensation unit (12) comprises a container body (3) connectable to said support means (2, 26, 27), and containing at its inside said pneumatic conveying means (15, 19, 20, 21) and said pneumatic adjusting means (16, 17, 18, 22, 23).
3. Support device (1; 1') according to claim 1 or 2, wherein said compensation unit (12) comprises a casing (4) connected to said container body (3), said linear actuator (4a, 4b, 4c) being provided inside said casing (4).
4. Support device (1; 1') according to any one of the preceding claims, wherein said pneumatic conveying means (15, 19, 20, 21) comprises an inlet joint (15) placed in fluid connection with said source of compressed air, and a plurality of conveying pipes (19, 20, 21) arranged to be crossed by and convey said compressed air flow to said linear actuator (4a, 4b, 4c).
5. Support device (1; 1') according to any one of the preceding claims, wherein said pneumatic adjusting means (16, 17, 18) comprises a check valve (16), a shut-off valve (17) placed downstream of check valve (16) and in fluid connection with the check valve (16), and a pressure regulator valve (18), placed downstream of the shut-off valve and in fluid connection with the shut-off valve (17).
6. Support device (1; 1') according to claim 5, wherein said shut-off valve (17) is an "on/off" three-way valve, said pneumatic adjusting means (22) comprising a first discharge regulator (22) which said shut-off valve (17) is provided with, said first discharge regulator (22) being drivable to adjust a compressed air stream of said compressed air flow to be discharged out of said shut-off valve (17) when said shut-off valve (17) adopts a closed configuration.
7. Support device (1; 1') according to claim 5, or 6, wherein said regulator valve (18) is provided with a shutter movable between an open position in which the shutter leaves free a passage area of said regulator valve (18) and enables said compressed air flow to pass through said passage area, and a closed position, in which it closes said passage area and prevents said compressed air flow from passing

through said passage area, in the intermediate positions between said open and closed positions adopted by said shutter, said regulator valve (18) adopting a discharge configuration; wherein said pneumatic adjusting means (23) comprises a second discharge regulator (23) with which said regulator valve (18) is provided, said second discharge regulator (23) being drivable to regulate a further compressed air stream of said compressed air flow to be discharged out of said regulator valve (18), when said regulator valve (18) adopts said discharge configuration.

8. Support device (1; 1') according to any one of the preceding claims, wherein said support means (2) comprises a pair of support bars (2) shaped to be mounted on said protecting railing (11), each support bar of said pair of support bars (2) comprising a protrusion (5) shaped to abut an upper portion of said protecting railing (11) and a cursor (7) that is movable along a direction parallel to said direction (D), shaped to abut on a lower portion of said protecting railing (11), on a lateral face of each support bar (2) at least one opening (13) being further obtained.
9. Support device (1') according to claim 8, wherein said support means (26, 27) further comprises a crossbar (27) shaped to be mounted transversely between the support bars of said pair of support bars (2), and a carriage (26) mounted slidably on said crossbar (27) to slide along a sliding direction (N), on a side face (26a) of said carriage (26) at least one slot (34) being obtained, wherein said carriage (26) is provided with a locking element (46), arranged to lock a movement of the carriage (26) on the crossbar (27), wherein the locking element (46) is drivable by a lever (46a).
10. Support device (1; 1') according to any one of the preceding claims, wherein said compensation unit (12) is provided with coupling means (29, 31) arranged for detachably connecting said compensation unit (12) to said support means (2, 26, 27), said coupling means (29, 31) comprising at least one gripping element (31) and at least one hook (29).
11. Support device (1) according to claim 10 as appended to claim 9, wherein said at least one gripping element (31) is shaped so as to engage in a positive mechanical engagement with an edge of said at least one opening (13) of each support bar (2), or in which said at least one gripping element (31) is shaped so as to engage in a positive mechanical engagement with an edge of said at least one slot (34) of said carriage (26).
12. Support device (1) according to claim 10, as appended to claim 9, wherein said at least one hook (29) comprises a shaped end portion shaped for engaging with another edge of said at least one opening (13), said at least one hook (29) being rotatable around a rotation axis thereof in a rotation direction (V) and in another rotation direction (W), opposite said rotation direction (V), to engage with said other edge of said at least one opening (13) of each support bar (2), or in which said at least one hook (29) comprises a shaped end portion for engaging with another edge of said at least one slot (34) of said carriage (26), said at least one hook (29) being rotatable around a rotation axis thereof in a rotation direction (V) and in another rotation direction (W), opposite said rotation direction (V), to engage with said other edge of said at least one slot (34).
13. Support device (1; 1') according to one of the preceding claims, comprising a system of articulated arms that includes a first articulated arm (32; 43), a first end of which is connected rotatably to an end pin (47) of said linear actuator (4a, 4b, 4c), and a second articulated arm (39; 42) a first end of which is connected rotatably to a second end of said first articulated arm (32; 43), wherein a support element (35; 36; 37; 38) for a work tool (U) can be connected to a second end of said second articulated arm (39; 42).
14. Support device (1; 1') according to claim 13, wherein said system of articulated arms further comprises a third articulated arm (45) a first end of which is connected rotatably to an end pin (47) of said linear actuator (4a, 4b, 4c), and a fourth articulated arm (44) a first end of which is connected rotatably to a second end of said third articulated arm (45), wherein to a second end of said fourth articulated arm (44) a support element (35; 36; 37; 38) can be connected for a work tool (U).
15. Support device (1; 1') according to claim 17, or 18, further comprising a housing element (35, 36, 37, 38) shaped to house a tool (U), said housing element (35, 36, 37, 38) being able to be rotatably connected to the second end of said second articulated arm (39; 42) or of said fourth articulated arm (44).
16. Support device (1; 1') according to claim 15, wherein the housing element comprises a toolholder (35) shaped to house the tool (U) such that a work axis X of the tool (U) is substantially oriented vertically, i.e. parallel to the direction of the force of gravity, or wherein the housing element comprises a toolholder (36) shaped to house the tool (U) such that the work axis X of the tool (U), in one operating configuration, is substantially arranged horizontally, i.e. orthogonally to the direction of the force of gravity, or wherein the housing element comprises a flat toolholder (37) provided with a support surface with a slip-proof ma-

terial coating and provided with peripheral slots for housing strips to lock the tool (U), or wherein the housing element comprises a hook toolholder (38), to which the tool (U) can be hooked removably.

5

17. Lifting device (10) arranged to lift and sustain at a height one or more operators (O) comprising:

- a support plane (Q);
- a protecting railing (11); and
- a support device (1; 1') according to any one of the preceding claims, mounted on said protecting railing (11).

10

18. Lifting device (10) according to claim 17, wherein said support device (1) is fixed with respect to said protecting railing (11) at least along a sliding direction (N), or wherein said support device (1') is movable with respect to said protecting railing at least along a sliding direction (N).

15

20

25

30

35

40

45

50

55

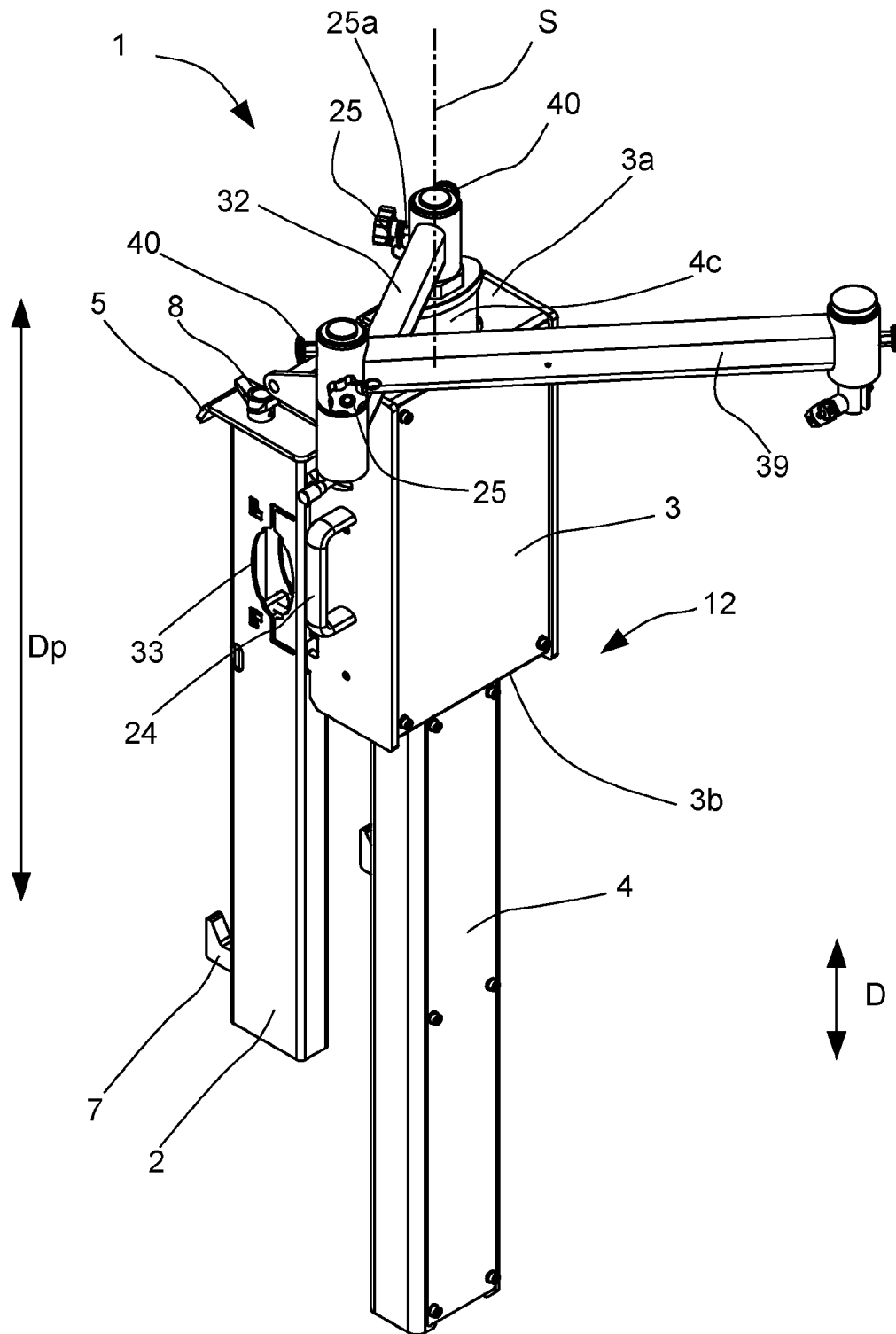
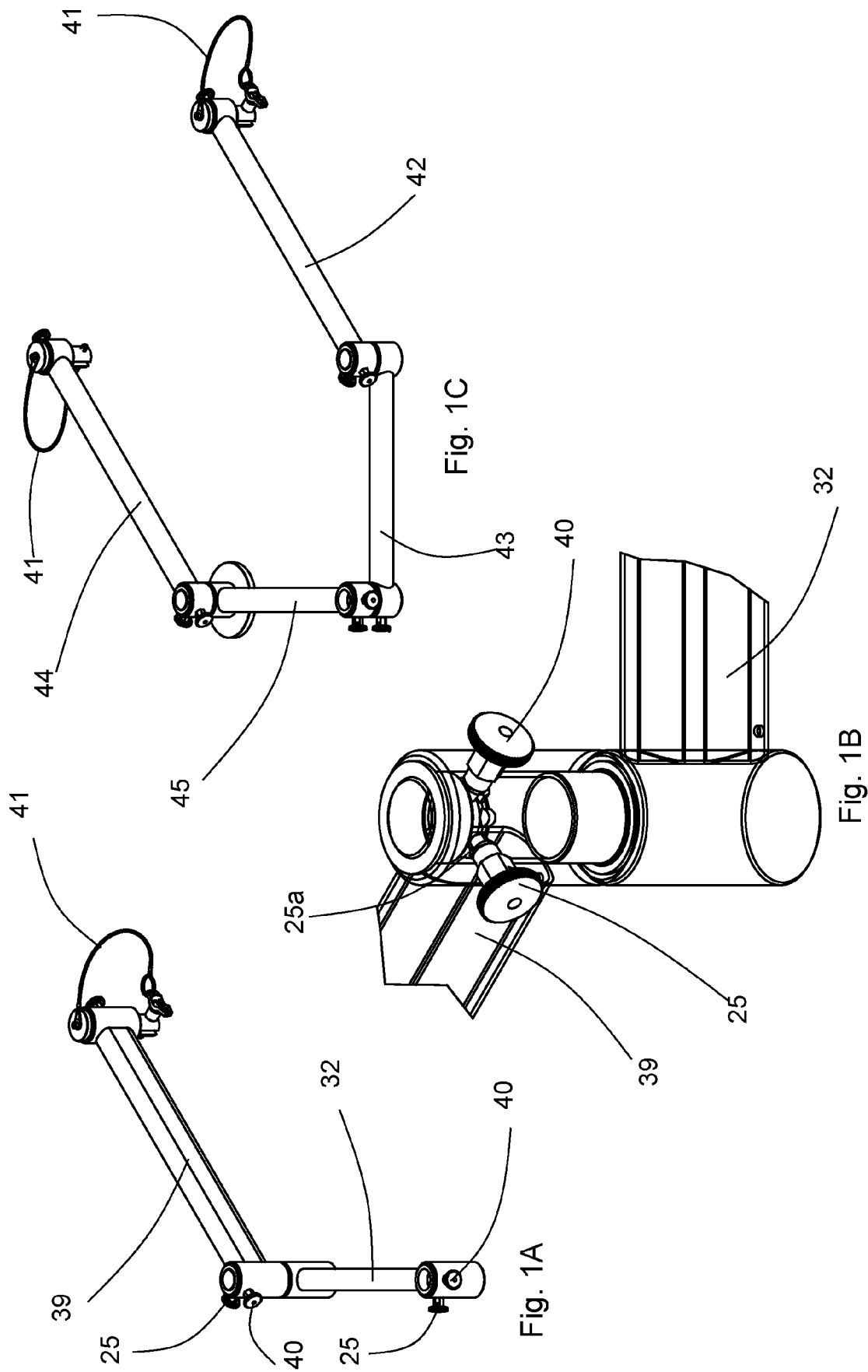


Fig. 1



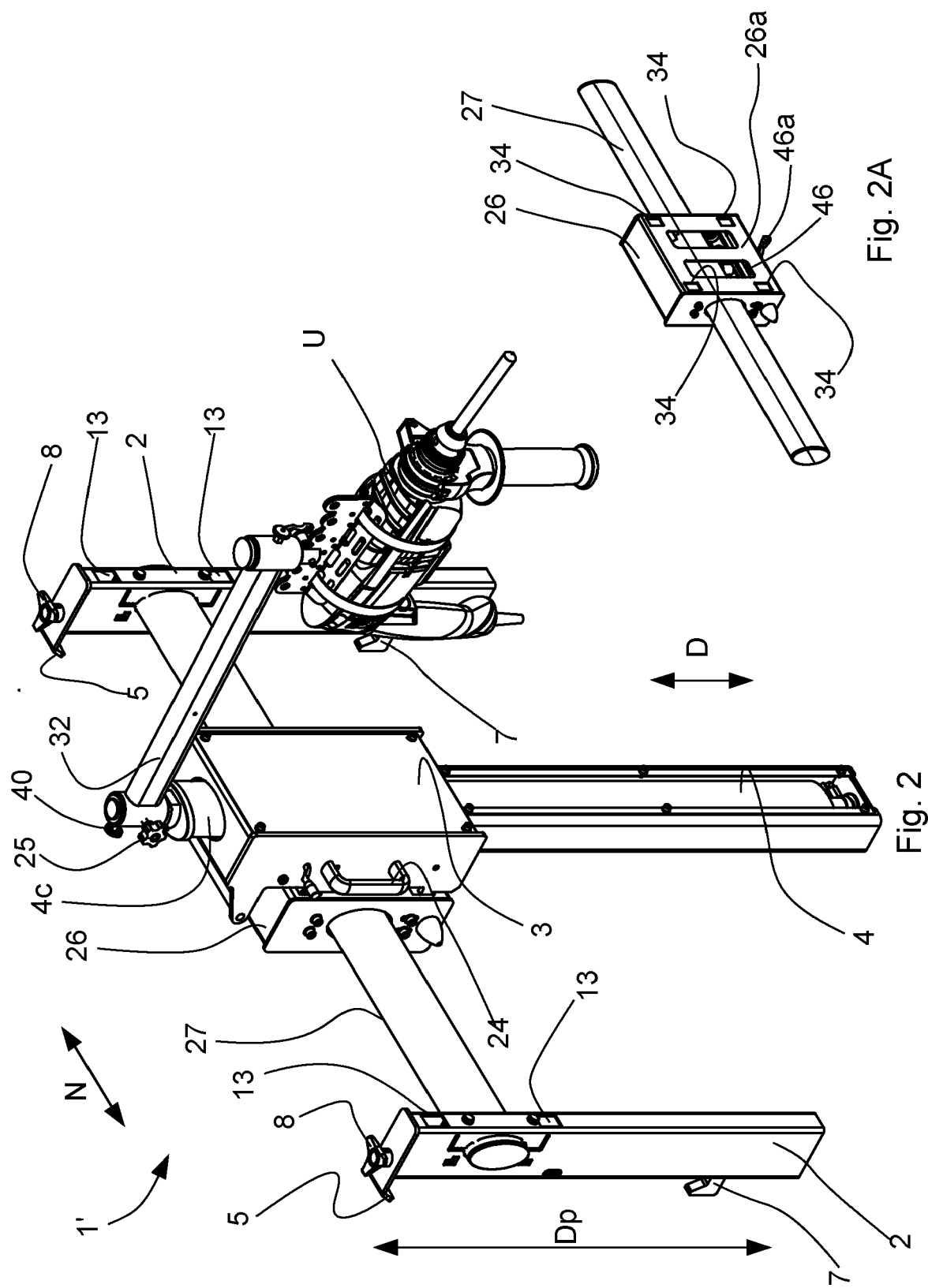
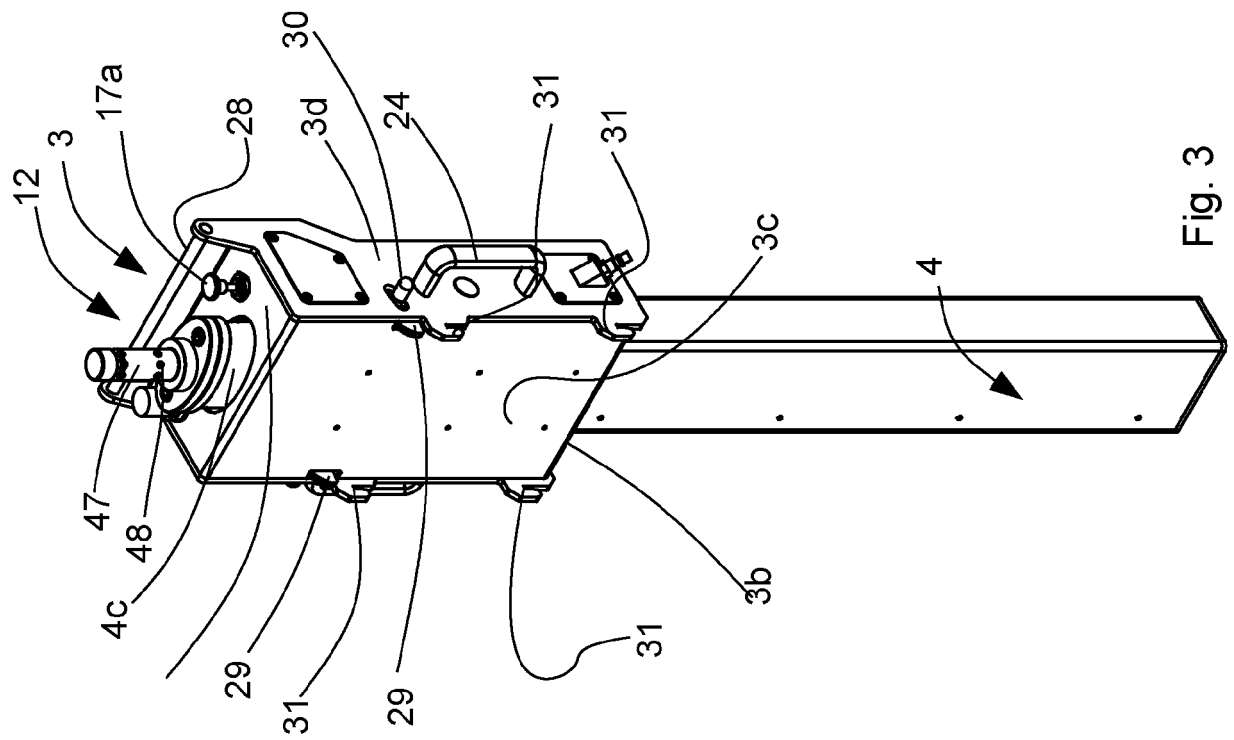
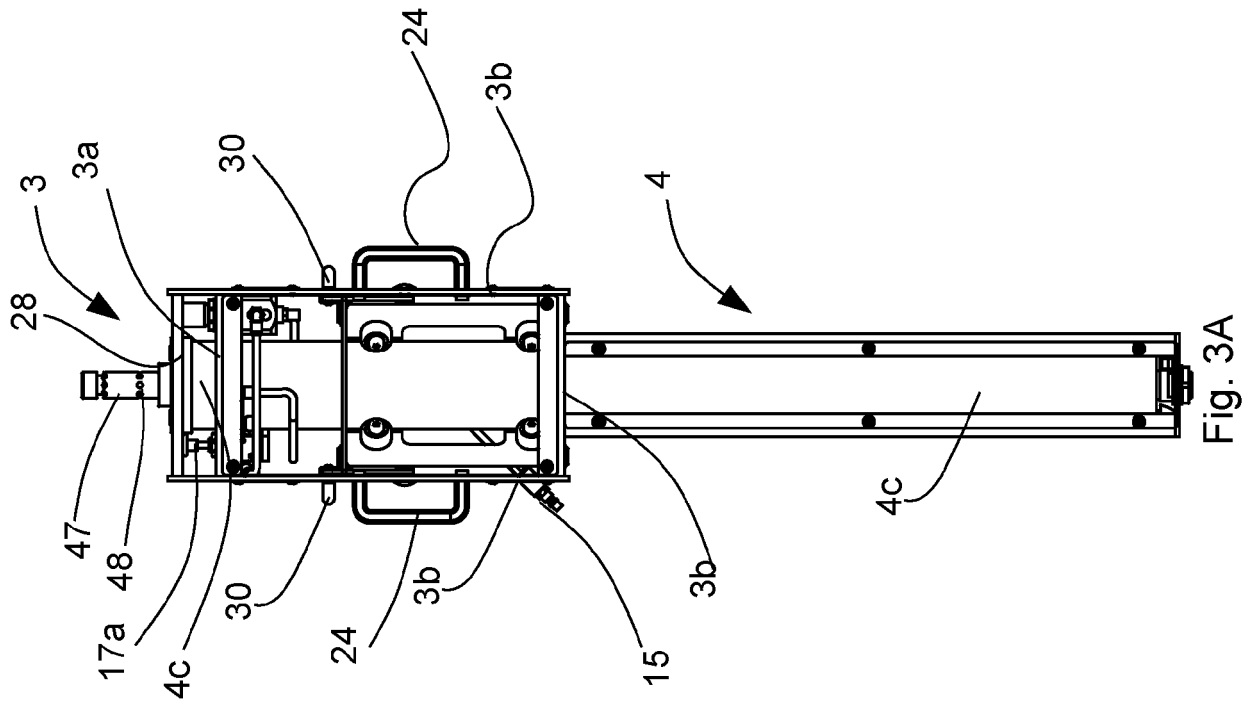


Fig. 2A

Fig. 2



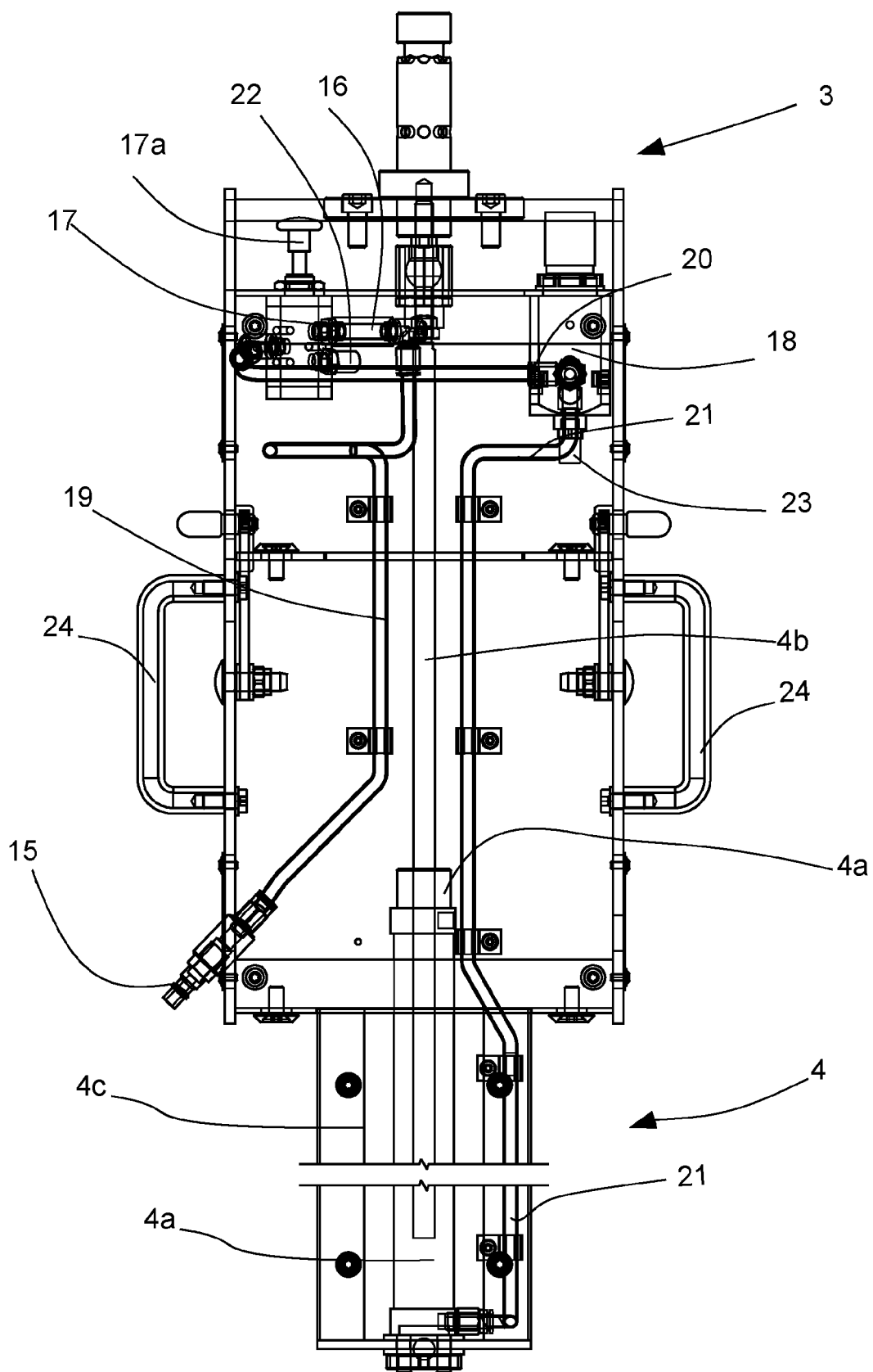


Fig. 3B

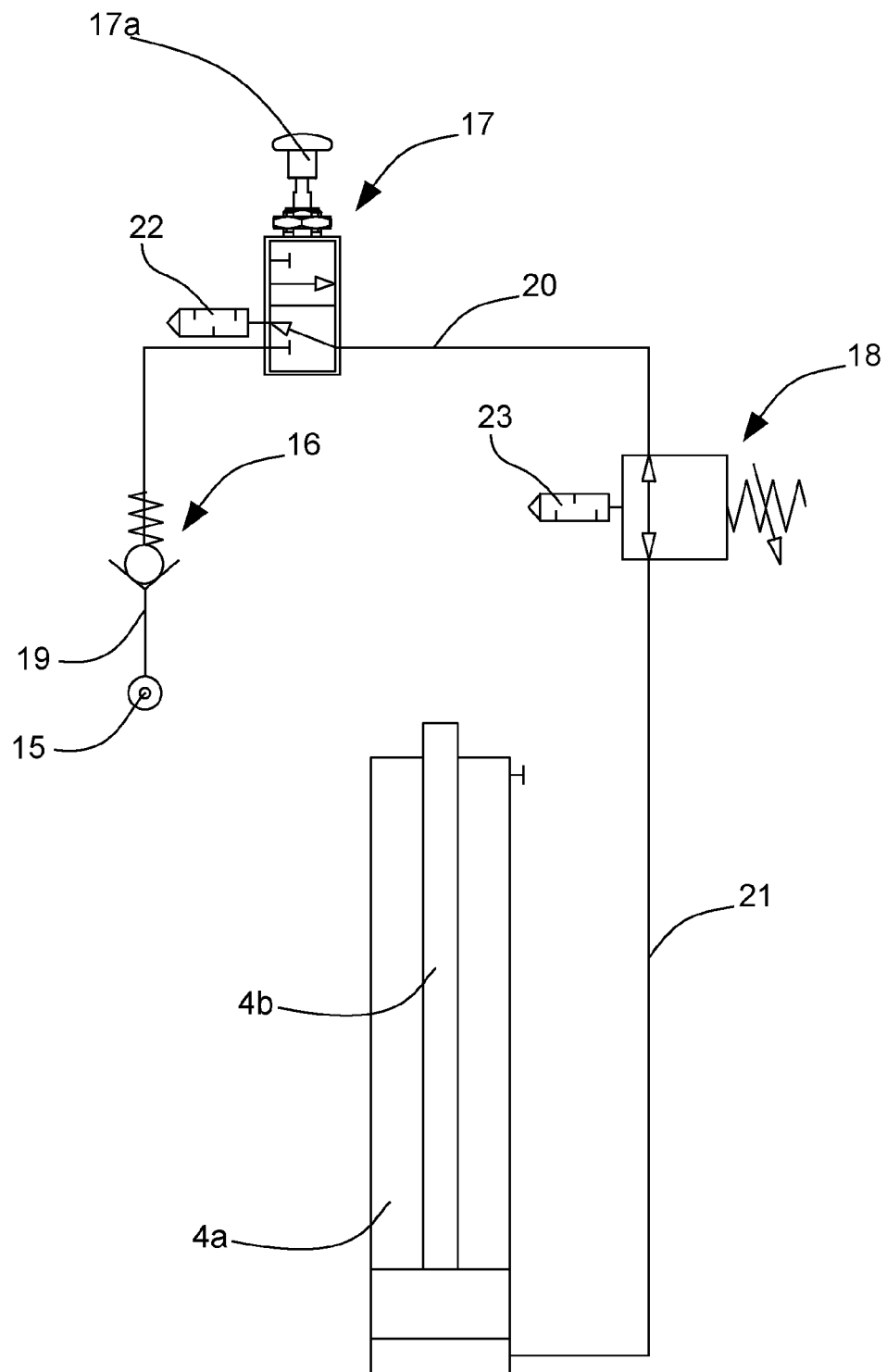


Fig. 4

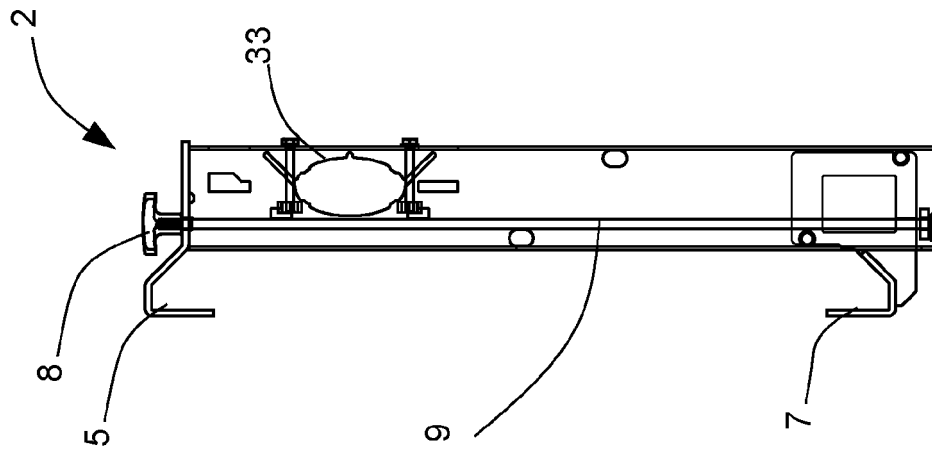


Fig. 5A

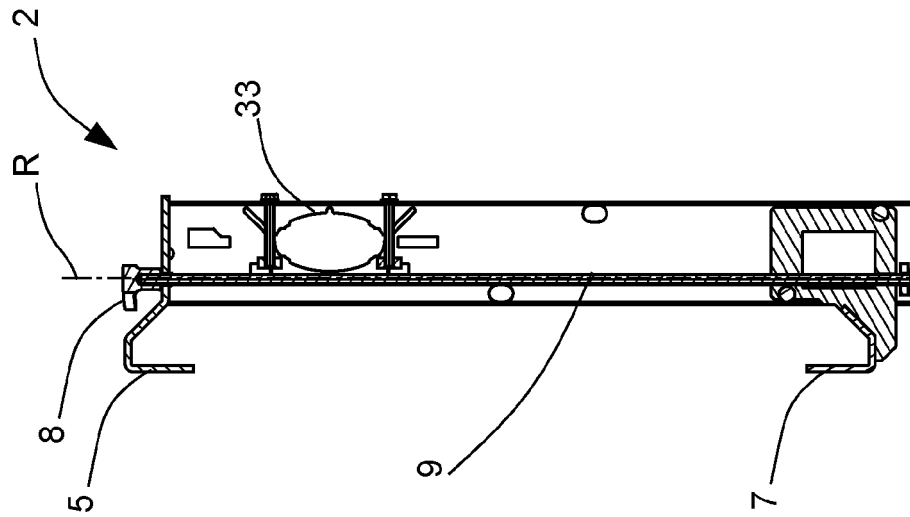


Fig. 5B

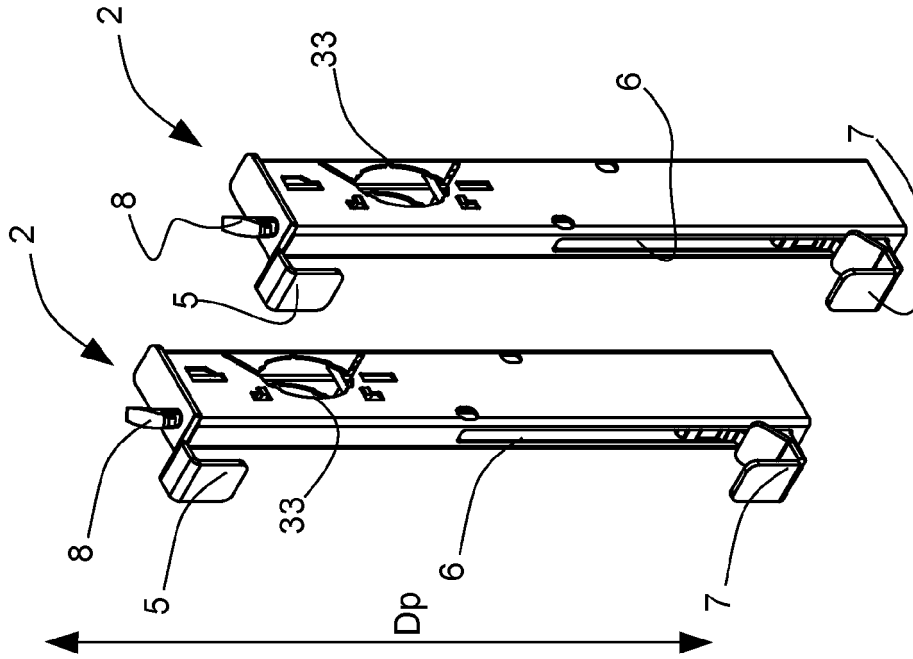


Fig. 5C

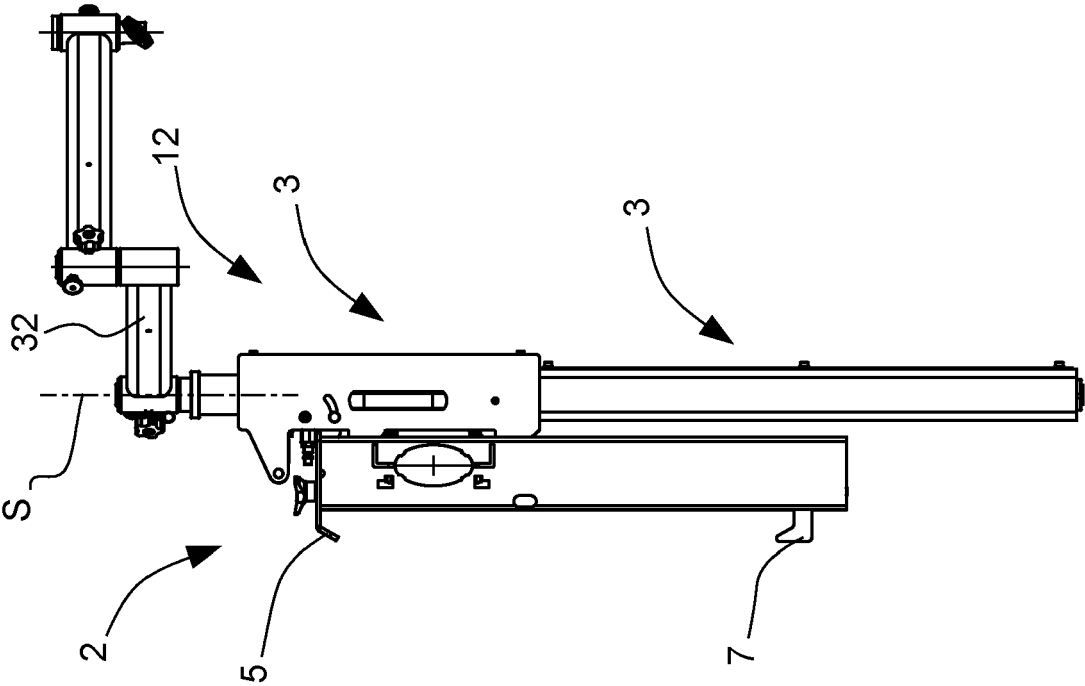


Fig. 6B

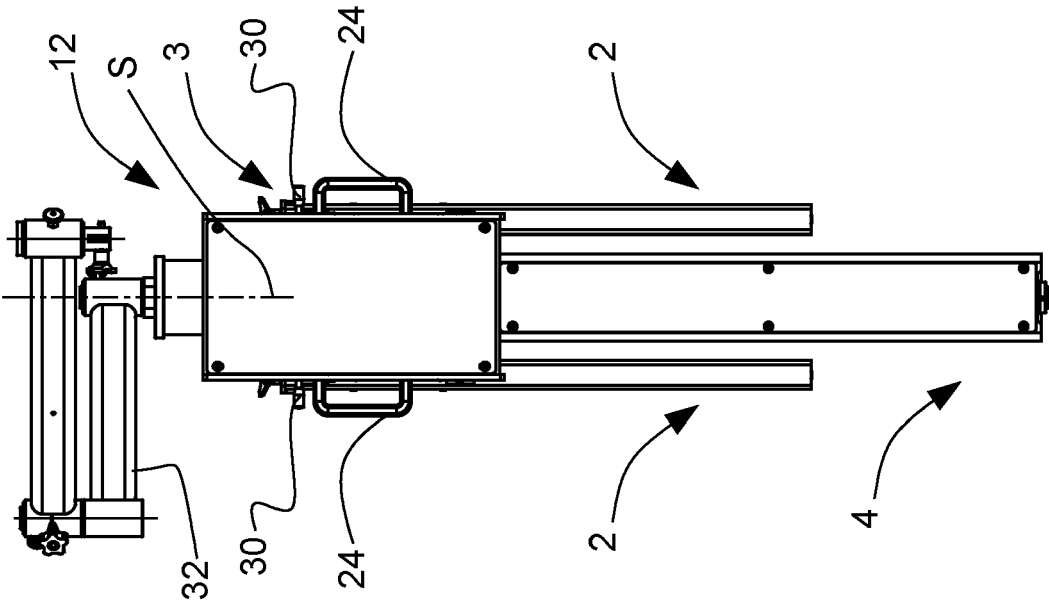


Fig. 6A

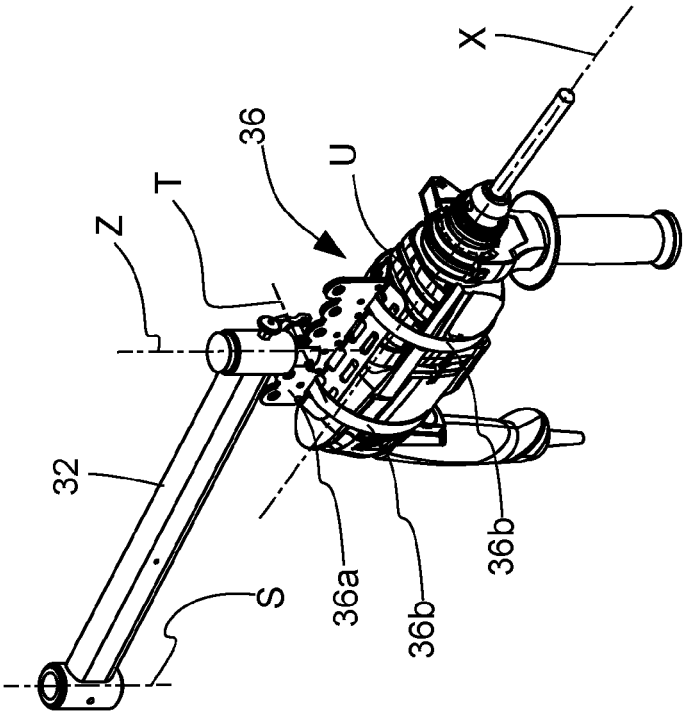


Fig. 8

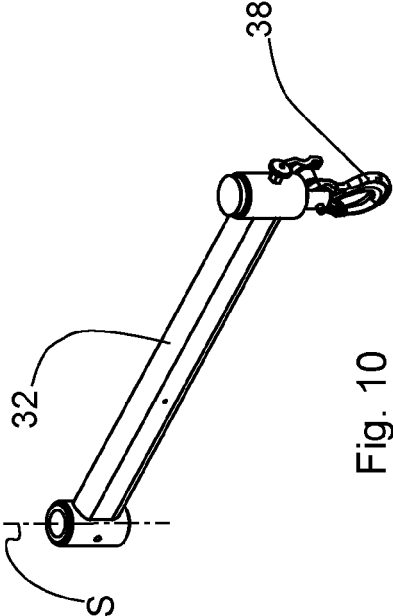


Fig. 10

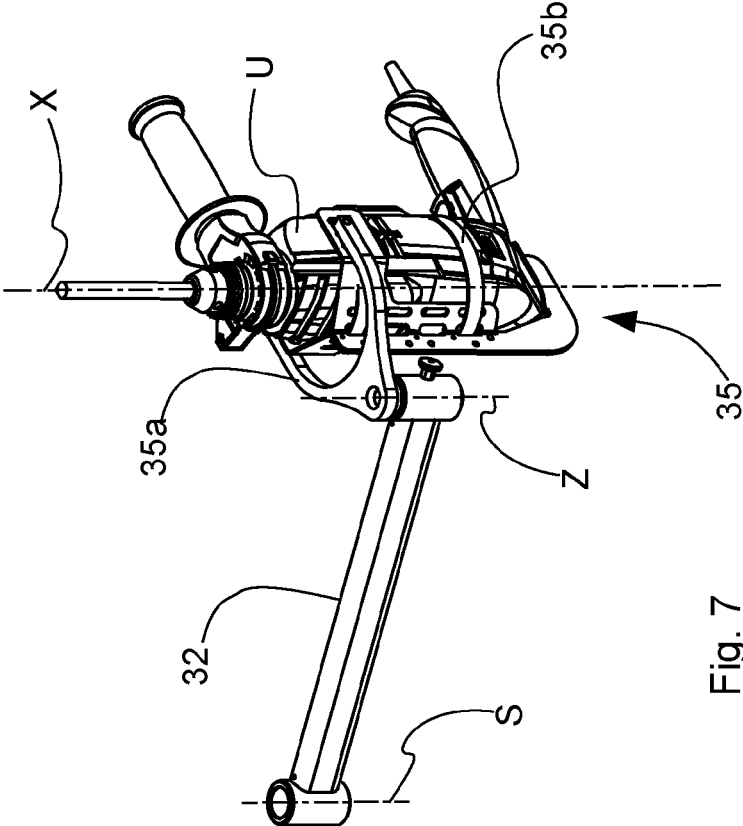


Fig. 7

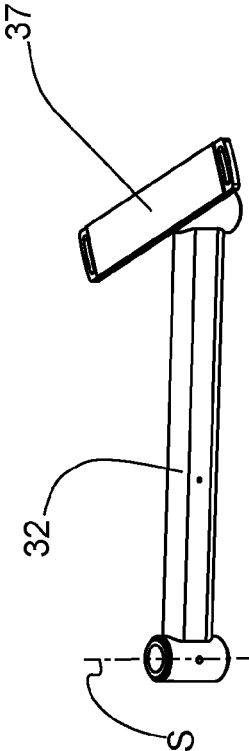


Fig. 9

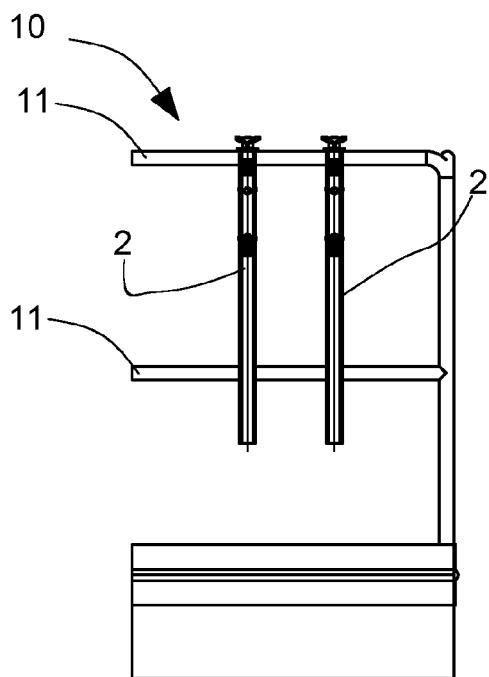


Fig. 11A

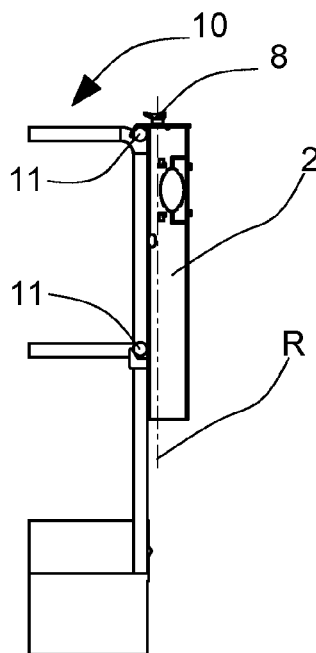


Fig. 11B

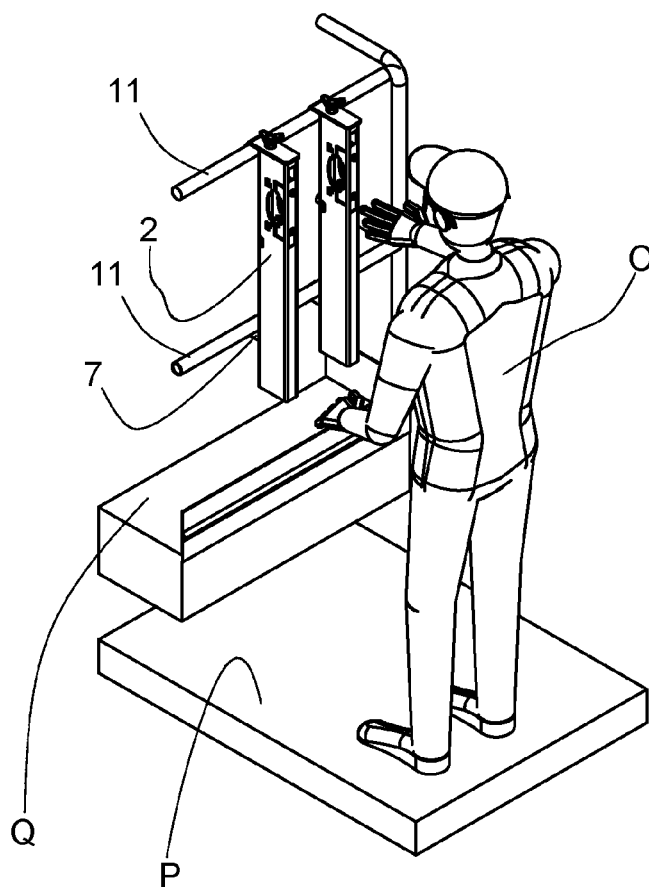


Fig. 11

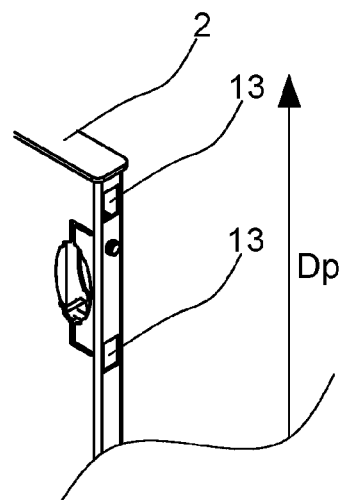


Fig. 11C

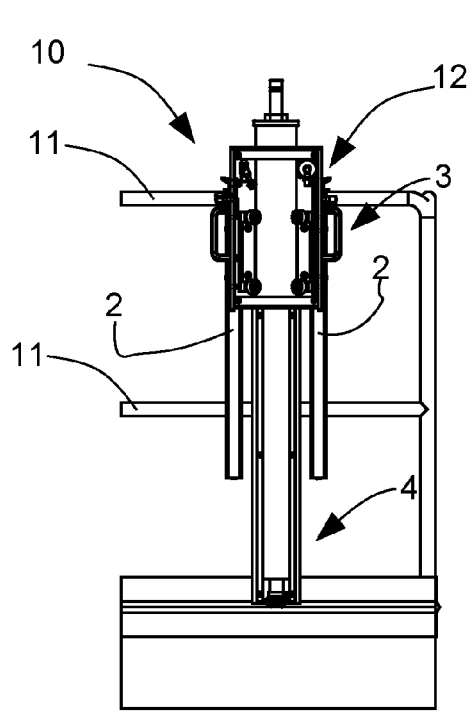


Fig. 12A

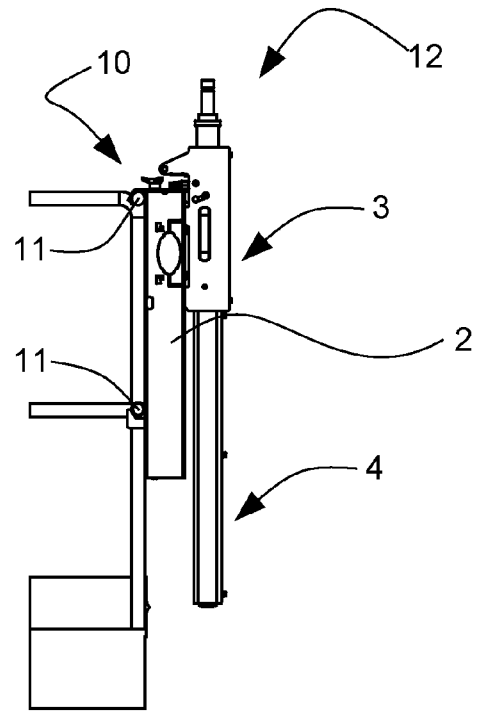


Fig. 12B

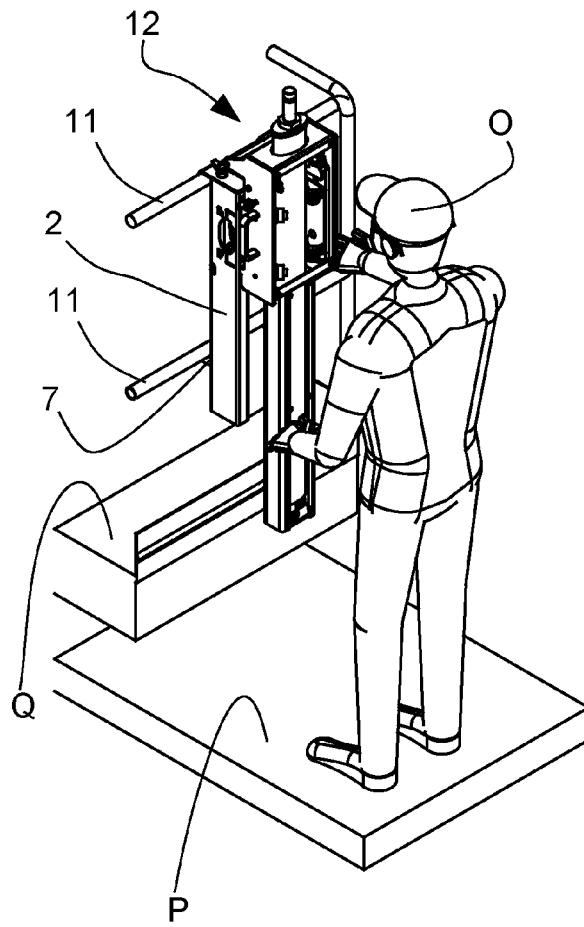


Fig. 12

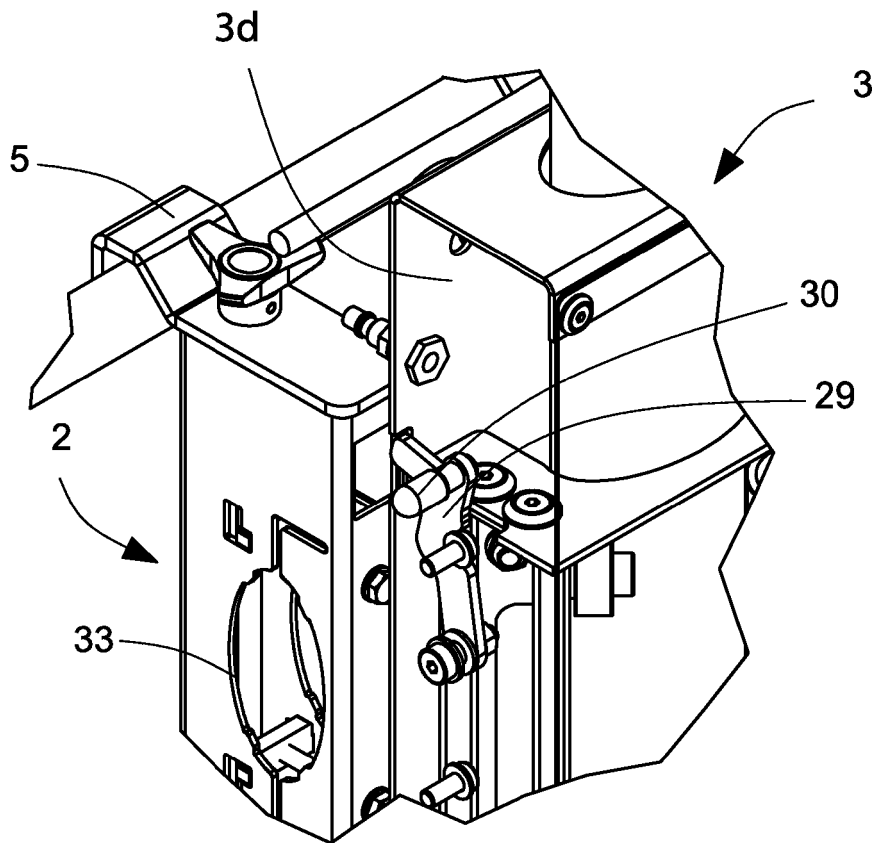


Fig. 12C

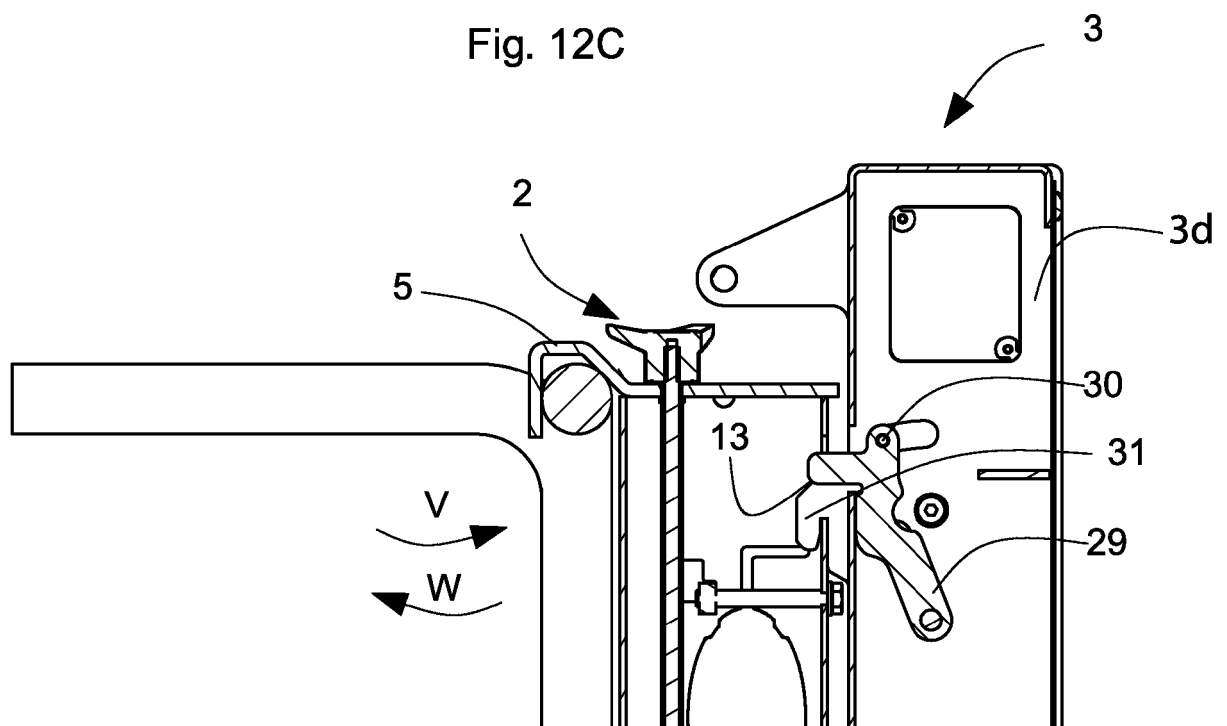
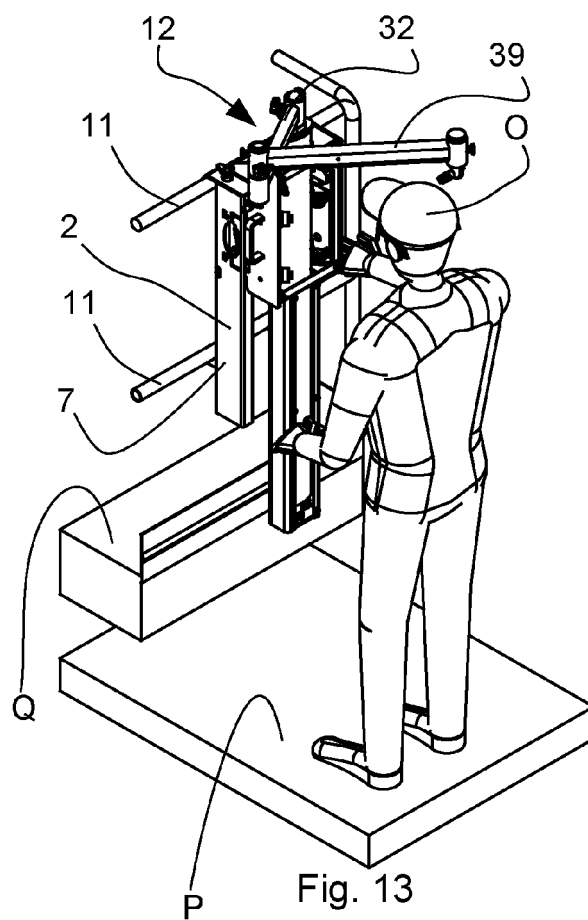
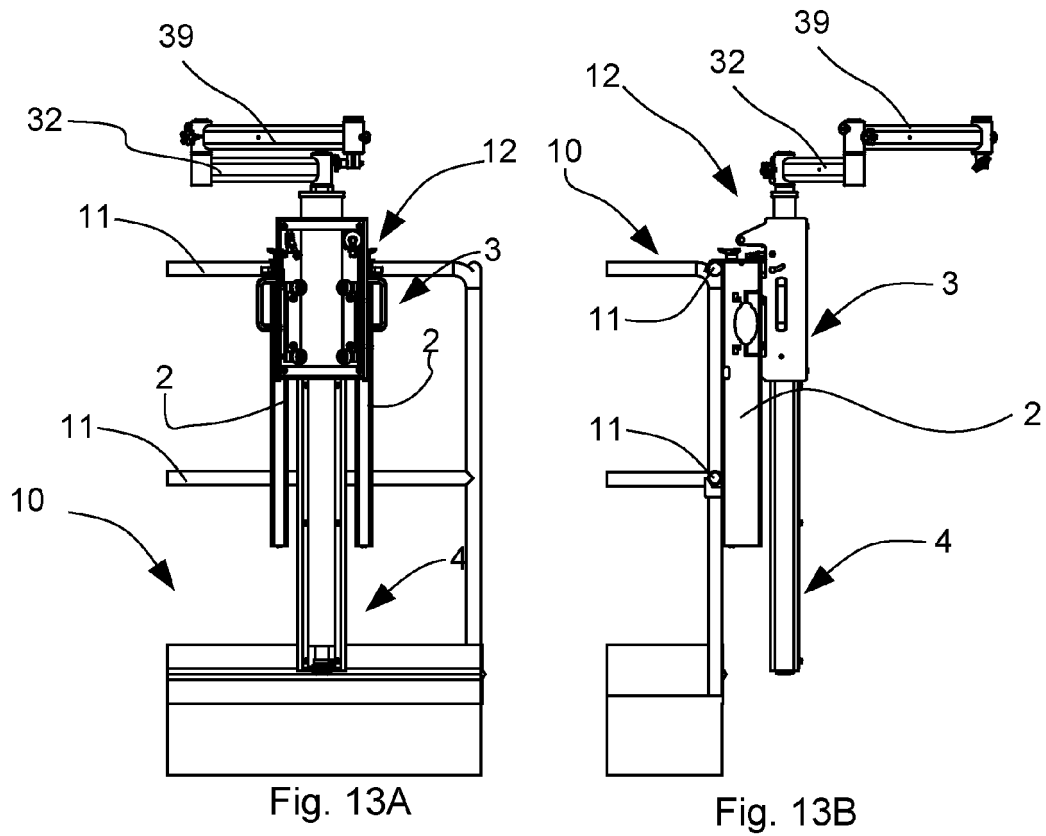


Fig. 12D



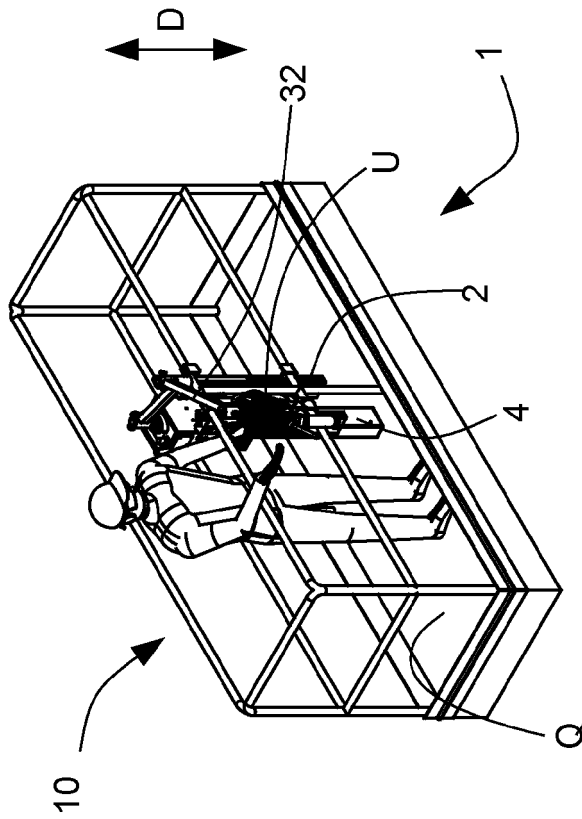


Fig. 14A

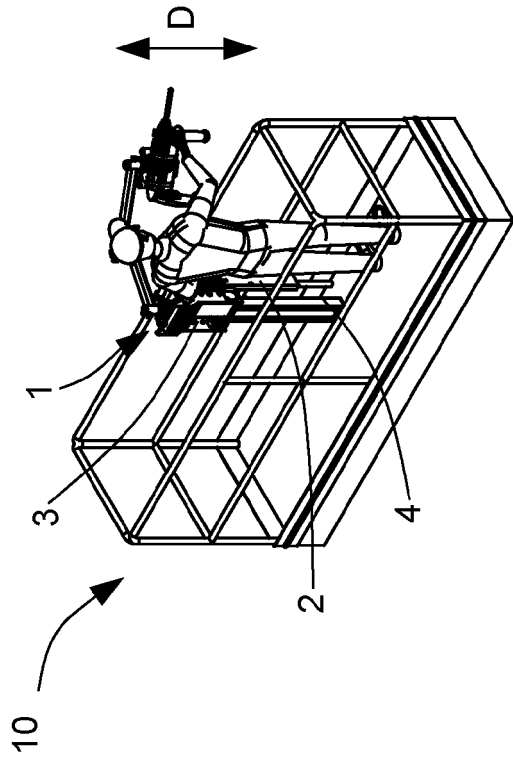


Fig. 14B

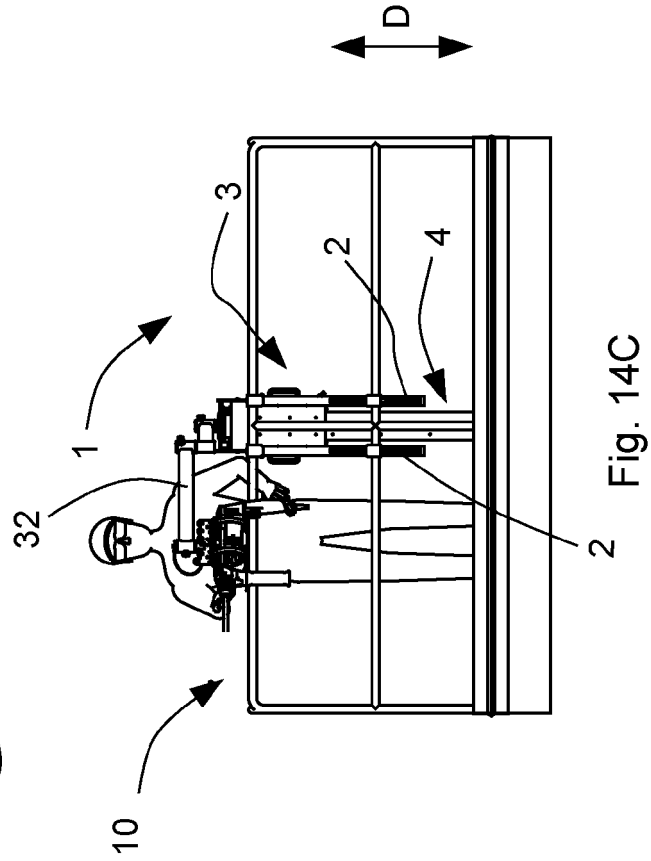
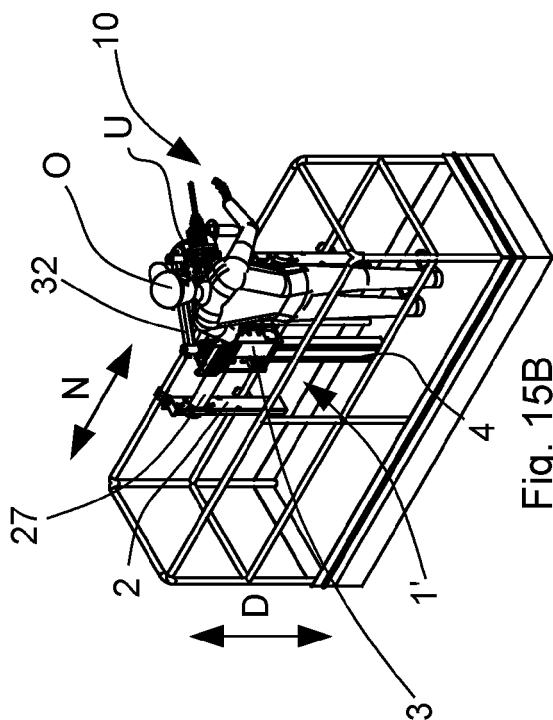


Fig. 14C



**Fig. 15B**

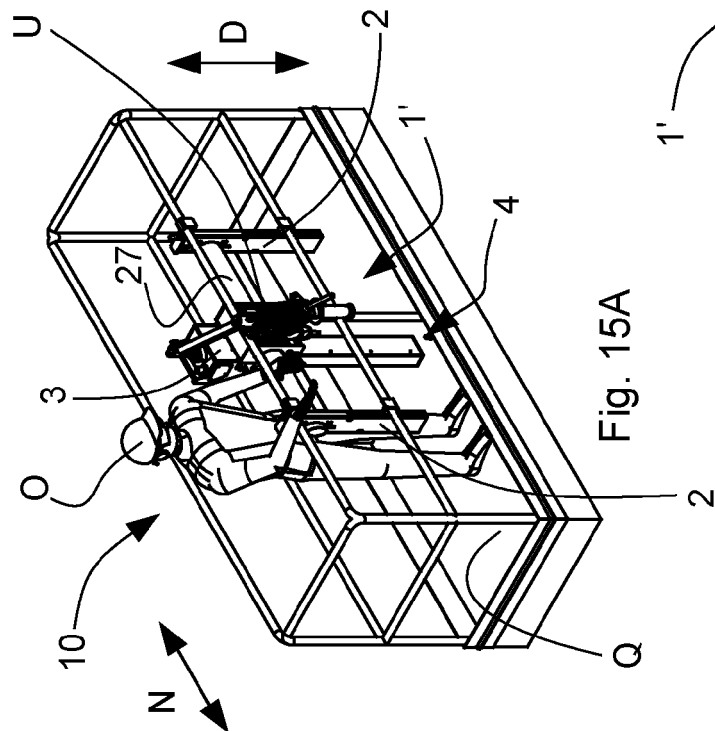


Fig. 15A

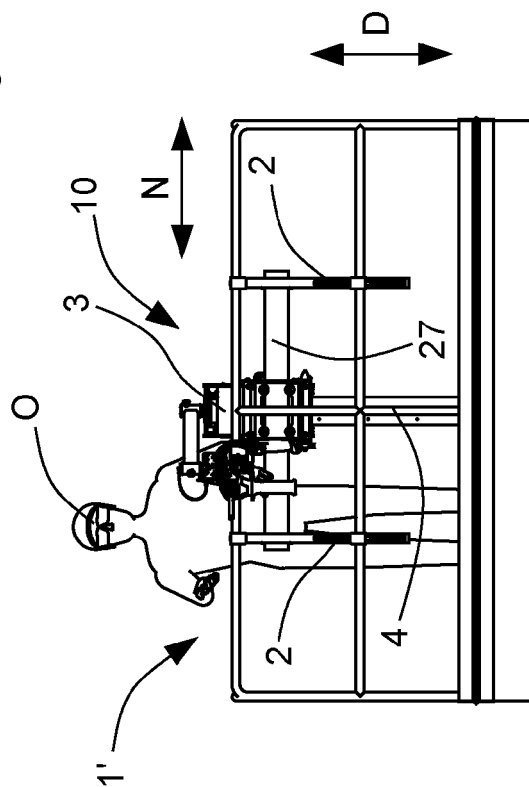
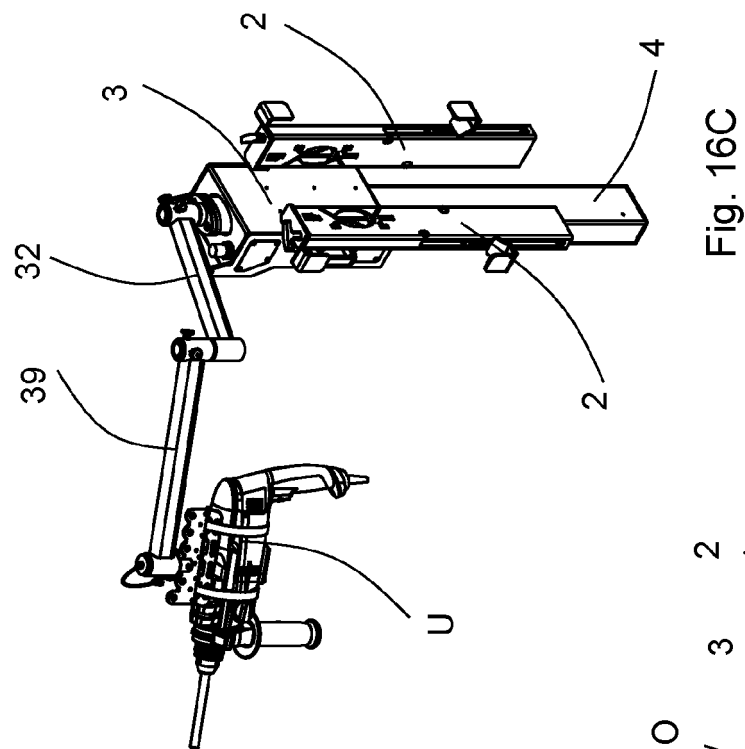
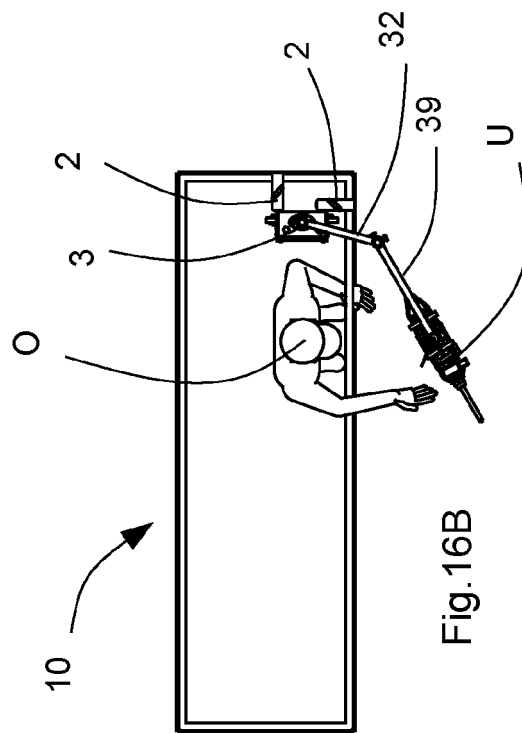
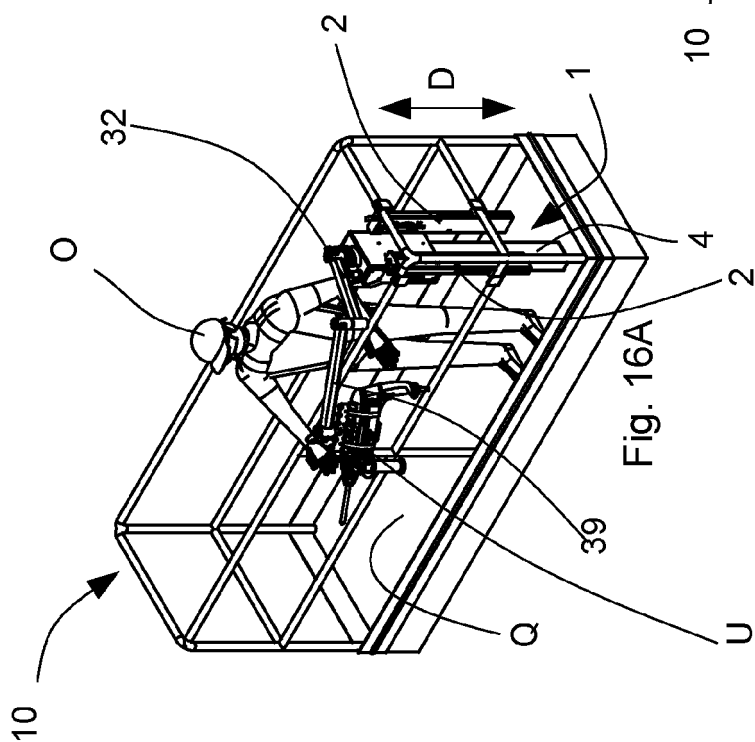


Fig. 15C





## EUROPEAN SEARCH REPORT

Application Number  
EP 21 17 4768

5

10

15

20

25

30

35

40

45

50

55

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 2017/225320 A1 (SWIFT TIM [US] ET AL)<br>10 August 2017 (2017-08-10)<br>* paragraphs [0033] - [0040], [0049] - [0052], [0069] - [0078]; figures *    | 1-18                                               | INV.<br>B25H1/00<br>B66F11/00                      |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | WO 2006/086424 A2 (PARK TECHNOLOGIES LLC [US]; BURNIER TIMOTHY A [US] ET AL.)<br>17 August 2006 (2006-08-17)<br>* paragraphs [0004] - [0008]; figures * | 1-18                                               |                                                    |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | WO 2018/053063 A1 (EKS0 BIONICS INC [US])<br>22 March 2018 (2018-03-22)<br>* paragraphs [0005] - [0023], [0064] - [0072]; figures *                     | 1-18                                               |                                                    |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 3 202 539 A1 (EKS0 BIONICS INC [US])<br>9 August 2017 (2017-08-09)<br>* paragraphs [0002] - [0004], [0017] - [0025]; figures *                       | 1-18                                               |                                                    |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 2005/023015 A1 (ARGENTO SETTIMIO [CA])<br>3 February 2005 (2005-02-03)<br>* paragraphs [0051] - [0066]; figures *                                    | 1-18                                               |                                                    |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 5 580 021 A (GILLANDERS DAVID D [US])<br>3 December 1996 (1996-12-03)<br>* the whole document *                                                      | 1-18                                               | TECHNICAL FIELDS<br>SEARCHED (IPC)<br>B25H<br>B66F |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                         |                                                    |                                                    |
| Place of search<br>The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                         | Date of completion of the search<br>8 October 2021 | Examiner<br>David, Radu                            |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                                         |                                                    |                                                    |

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 17 4768

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-10-2021

10

15

20

25

30

35

40

45

50

55

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| US 2017225320 A1                          | 10-08-2017          | US 2017225320 A1           | 10-08-2017          |
|                                           |                     | WO 2018147899 A1           | 16-08-2018          |
| -----                                     | -----               | -----                      | -----               |
| WO 2006086424 A2                          | 17-08-2006          | US 2006260823 A1           | 23-11-2006          |
|                                           |                     | WO 2006086424 A2           | 17-08-2006          |
| -----                                     | -----               | -----                      | -----               |
| WO 2018053063 A1                          | 22-03-2018          | CN 110267769 A             | 20-09-2019          |
|                                           |                     | EP 3512666 A1              | 24-07-2019          |
|                                           |                     | US 2019247994 A1           | 15-08-2019          |
|                                           |                     | WO 2018053063 A1           | 22-03-2018          |
| -----                                     | -----               | -----                      | -----               |
| EP 3202539 A1                             | 09-08-2017          | EP 3202539 A1              | 09-08-2017          |
|                                           |                     | US 2017217009 A1           | 03-08-2017          |
| -----                                     | -----               | -----                      | -----               |
| US 2005023015 A1                          | 03-02-2005          | CA 2435531 A1              | 31-01-2005          |
|                                           |                     | US 2005023015 A1           | 03-02-2005          |
| -----                                     | -----               | -----                      | -----               |
| US 5580021 A                              | 03-12-1996          | NONE                       |                     |
| -----                                     | -----               | -----                      | -----               |

**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 2017225320 A1 [0012] [0015]