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(54) **Self-lifting support structure for building.**

(57) Self-lifting support structure (11) for the building industry, comprising: vertical columns (13); a horizontal frame (15) associated with said columns and provided with a supporting surface (29) for the load to be carried by the structure; a lifting mechanism (17) positioned be-

tween the frame and the columns and capable of provoking the vertical displacement of the frame with respect to the columns, wherein said structure comprises modular elements, which allow the height of said columns and/or the overall dimensions of said frame to be varied.

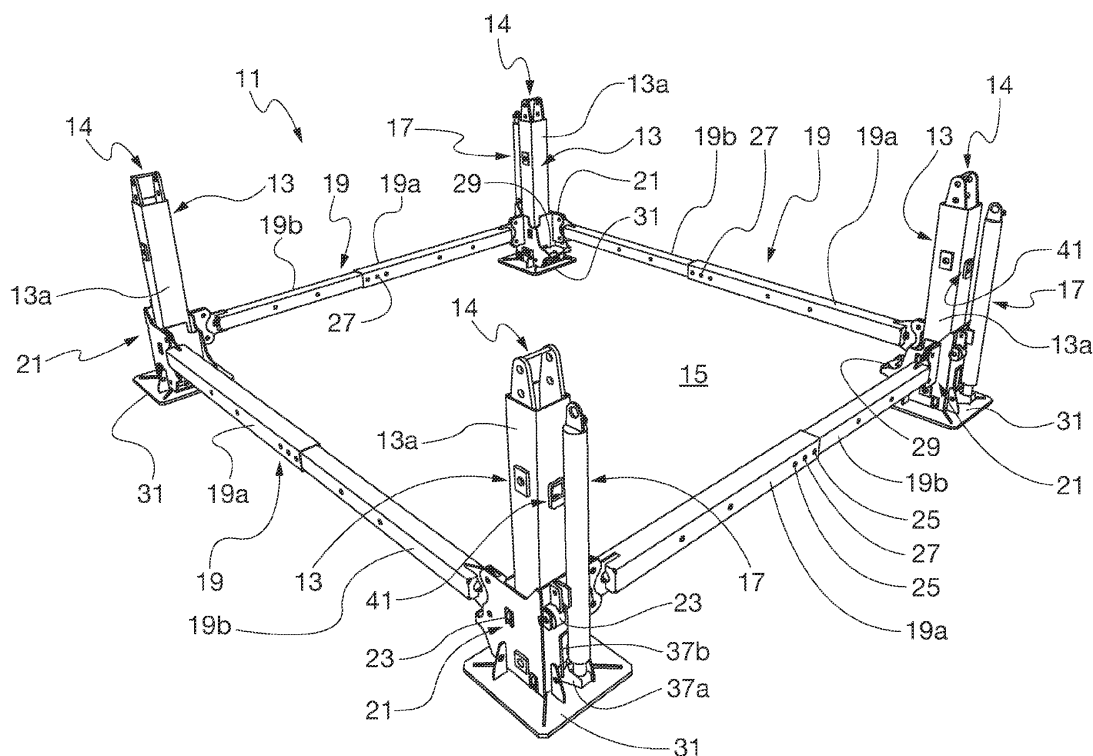


Fig. 1

Description

Technical field

[0001] The present invention relates to a self-lifting support structure for the building industry.

[0002] More precisely, the invention relates to a self-lifting support structure for the building industry, which structure is particularly effective for defining a lifting support plane, which can receive for instance the base of a building crane.

Prior art

[0003] In the building industry, the need to have support structures in order to lift building material, tools and equipment in general to the desired height, e.g. some metres, is well known.

[0004] Structures that can be disassembled, for instance tubular scaffolds, or fixed structures, for instance temporary structures of concrete, may meet such needs, but they demand a long time for being made and consequently cause an increase in the working costs.

[0005] Moreover, the known structures generally have the drawback that they permanently occupy the ground on which they are installed, thereby obstructing the passage of vehicles and people.

[0006] The need to have high support structures, yet of reduced overall size, that is an overall size such that they do not completely prevent use of the ground where they are installed, is particularly felt when the building yard must be prepared in the presence of already existing buildings, in old town centres and more generally in narrow transit areas, as is for instance the case of renovations in old town centres.

[0007] In other circumstances, related in particular to the use of building cranes, it is necessary to have at disposal a raised support plane for the crane, for instance for allowing the crane jib to be at a sufficient height, so as to prevent the jib itself from interfering with existing structures while rotating. In such circumstances, indeed, sometimes the use of a crane with a higher tower may be impossible, due to the reduced available space or the high costs connected with such use.

[0008] In the attempt to solve the above problem, operating machines, in particular building cranes including a lifting base have been proposed in the past.

[0009] IT-U-258953 discloses an example of a self-propelling crane, incorporating a lifting structure integral with the base frame.

[0010] Cranes with a base whose height is adjustable are also disclosed in DE 202004011443 U and DE 202006013743 U.

[0011] The proposed solutions have however some drawbacks.

[0012] Indeed, in the known solutions, the lifting structure is directly integrated into the base platform of the crane itself and thus it cannot be employed for other pur-

poses, such as for instance lifting other building machines or different cranes.

[0013] Moreover, the known solutions are expensive and their cost necessarily adds to that of a standard crane, even if the concerned systems become necessary only in some circumstances.

[0014] Indeed, the cranes can often be used without such structures.

[0015] A further, but not the last drawback of the known solutions is related to the complexity of their construction and to the fact that the maximum height that can be reached is limited by the initial design and by the impossibility, for instance for reasons related to transport, of associating an excessively large and heavy lifting structure with the crane itself.

[0016] Self-lifting modular building scaffolds are also known from US 2005/183905 A1, US 5 579 865 A and US 6 749 041 B1. Such scaffolds are however intended for lifting workers and small equipment to be used by people working on the scaffold, and therefore they cannot be employed for lifting a crane.

[0017] Therefore, it is a first object of the present invention to provide a self-lifting support structure for the building industry that is free from the above drawbacks and is cheap to be manufactured and managed.

[0018] It is a further object of the invention to provide a structure of the above kind, which is suitable for defining a raised support plane, theoretically at any height, and in particular at some metres above the ground.

[0019] The above and other objects are achieved by means of the self-lifting support structure for the building industry, as claimed in the appended claims.

Description of the invention

[0020] Advantageously, the support structure according to the invention comprises modular components, allowing the height of the vertical columns and/or the overall dimensions of the horizontal frame to be varied, thereby allowing use of the same structure in several circumstances and for lifting cranes of different kinds and sizes and to different heights. Advantageously, moreover, thanks to the provision of vertical columns and of a horizontal frame vertically displaceable relative to the columns thanks to lifting devices operating between the frame and the columns themselves, the structure according to the invention is suitable to define a lifting support base, which is cheap and simple to be manufactured and managed and which can be used in the building industry for several applications and, in particular, for lifting and positioning a crane at a desired height, while leaving the passage below free, for instance for vehicles and people.

[0021] Advantageously, according to the invention, the vertical columns are preferably obtained by arranging elementary column portions one on the other, so that the support structure can be lifted to the preferred level simply by using the proper number of said elementary column portions.

[0022] Advantageously, according to the invention, the lifting device includes an engagement terminal removably associated with an engagement element in a corresponding column, and the column further includes a plurality of said engagement elements, thereby allowing the frame to be lifted to the desired height by using a lifting device with reduced extension.

[0023] A further advantage of the invention is that the lifting device can be separated from the structure and can therefore be employed for lifting other structures in other sites.

[0024] Moreover, the structure according to the invention may advantageously be installed also in the presence of slopes, thanks to the modularity of the columns.

Brief Description of the Drawings

[0025] The invention will be described hereinafter by way of example with reference to the accompanying drawings, in which:

- Fig. 1 is a top perspective view of the structure according to the invention, in a first assembling phase;
- Fig. 2 is a top perspective view of the structure shown in Fig. 1, on which the base of a crane is supported;
- Fig. 3 is a top perspective view of the structure shown in Fig. 1, on which the base of a crane is supported, in a second assembling phase;
- Fig. 4 is a top perspective view of the structure shown in Fig. 1, on which the base of a crane is supported, in a third assembling phase;
- Fig. 5 is a perspective view of an assembled crane, of which the base is supported on the structure shown in Fig. 1;
- Fig. 6 is a perspective view of the lifting mechanism of the structure shown in Fig. 1;
- Fig. 7 is an enlarged view of the top portion of the lifting mechanism shown in Fig. 6;
- Fig. 8 is an enlarged view of the bottom portion of the lifting mechanism shown in Fig. 6;
- Fig. 9 is a perspective view of the structure shown in Fig. 1, on which the base of a crane is supported and from which the lifting devices have been removed, in a fourth assembling phase;
- Fig. 10 is a perspective view of the lifting mechanism, according to a first variant embodiment;
- Fig. 11 is a perspective view of the structure including a lifting mechanism, in a second variant embodiment;
- Fig. 12 is a perspective view of the structure, according to a variant embodiment;
- Fig. 13 is a block diagram of the circuit controlling the lifting of the structure according to the invention.

Description of a Preferred Embodiment

[0026] Referring to Fig. 1, there is shown a preferred embodiment of the self-lifting support structure for the

building industry according to the invention.

[0027] Said structure has been generally denoted by reference numeral 11 and it substantially comprises a group of vertical support columns 13 and a horizontal frame 15, capable of vertically displacing relative to vertical support columns 13 thanks to a removable lifting mechanism 17 positioned between columns 13 and frame 15.

[0028] Horizontal frame 15 comprises a plurality of beams 19 associated, preferably in removable manner, with cursors 21 positioned at the corners of frame 15 and vertically displaceable with respect to vertical columns 13.

[0029] In this exemplary embodiment, frame 15 has a substantially square shape and structure 11 has four columns 13, arranged at the corners of the square defined by the frame. However, other shapes of frame 15 are possible, for instance a triangular, rectangular, hexagonal shape etc., and moreover structure 11 can include a number of columns different from the number of corners defined by the frame shape.

[0030] Moreover, cursors 21 are made so as to define an aperture having a shape complementary to the transverse section of the body of column 13, a square shape in the illustrated example, whereby cursor 21 encircles column 13 and is vertically displaceable by sliding with respect to it.

[0031] In order to make such sliding of cursor 21 with respect to the respective column 13 smoother and more regular, cursors 21 are equipped with idle wheels 23, arranged with the rolling surfaces in contact with the surfaces of columns 13.

[0032] Preferably moreover beams 19 of frame 15 are extendable and they will be made for instance of two or more telescopic elements 19a, 19b provided with bores 25 in which locking members, e.g. locking pegs 27, preventing the telescopic elements from mutually sliding, can be received.

[0033] According to the invention, frame 15 defines a corresponding peripheral border and preferably is has no internal elements connecting peripheral beams 19, to the advantage of the lightness and adaptability of the size of frame 15 to cranes and machines of different sizes. Internal connecting elements for the beams can be provided if this is made necessary by the weights to be supported, for instance in case of use of the invention as a parking platform, a footbridge and so on.

[0034] Actually, thanks to such an arrangement, the size of the area of the horizontal surface defined inside frame 15 can be modified at will, depending on the needs.

[0035] Always thanks to such an arrangement, frame 15 may have either a square shape, where the four beams 19 are all configured with the same length, or a rectangular shape, where two parallel beams 19 are configured with a different length with respect to the other two beams.

[0036] In the illustrated example, each cursor 21 further comprises a support element in the form of a hori-

zontal bracket 29, directed towards the interior of frame 15 substantially along the diagonals connecting the corners of the border, e.g. square or rectangular, defined by said frame.

[0037] According to the invention, said bracket 29 defines a corresponding supporting surface, for instance of a supporting plane, which can occupy wholly or in part the area inside the peripheral border defined by said frame 15, or for a further frame, for instance a trellis frame, or yet for the base platform of an operating machine, such as a crane or another machine, that is to be lifted to the height required in a building yard.

[0038] Referring to Fig. 2, there is shown an example of use of structure 11 according to the invention, in which brackets 29 are used for supporting the free end of a corresponding foot 71 of base platform 73 of a crane, in this case a downward rotating folding crane.

[0039] Fig. 2 shows the above arrangement when frame 15 is lowered, i.e. with cursors 21 substantially at the lower end of columns 13.

[0040] According to the invention, frame 15 of the support structure can be vertically displaced, i.e. lifted or lowered along columns 13, by means of a lifting mechanism 17, before or preferably after feet 71 of the crane or another load have been placed on brackets 29 when frame 15 is at a height suitable for that purpose.

[0041] Fig. 3 shows a configuration in which frame 15, and consequently base platform 73 of the crane, have been lifted by an amount substantially corresponding to the length of a column 13 by acting on lifting mechanism 17.

[0042] Always according to the invention, columns 13 preferably have a variable length.

[0043] The length of columns 13 can actually be varied in that such columns 13 are modular. In the example illustrated, such columns 13 are obtained by axially associating elementary column portions 13a. In the alternative, columns 13 might be extendable, e.g. they might be telescopic or folding.

[0044] Moreover, the lower portion of columns 13, intended to rest on the ground, is preferably equipped with fixed or removable supporting feet 31, preferably having a surface area greater than the cross section of the corresponding column 13 to which such feet are associated.

[0045] Thanks to such possibility of varying the length of columns 13, it is consequently possible to modify at will and depending on the needs the height of horizontal frame 15 above the ground on which feet 31 of columns 13 rest.

[0046] Referring in particular to Fig. 4, there is shown the arrangement of structure 11 according to the invention in which each column 13 is obtained by superimposing four portions 13a and equipping the lower portion with a supporting foot 31 through which structure 11 rests on the ground.

[0047] In this exemplary embodiment of the invention, columns 13 are formed by inserting the desired number of portions 13a one above the other, by means of a male

- female coupling joint 14.

[0048] If necessary, especially when the height of columns 13 is considerable, e.g. more than 2 - 3 m, tie rods 33 may be provided, which are preferably arranged oblique and crossing in pairs at the sides of structure 11, between frame 15 and columns 13. Said tie rods may be provided in order to stiffen structure 11 and to make it sufficiently robust to bear the weight of crane 75 and more generally the forces discharging from jib 77 of said crane, especially when the crane is assembled and is being used.

[0049] Referring to Fig. 5, there is shown the arrangement of a structure 11 according to the invention, which has associated therewith a self-assembling, downward rotating folding crane 75, which is shown in operating condition, i.e. with its jib 77 open with respect to tower 79 and with stabilising ballast 81 mounted at the base of said tower.

[0050] In such a configuration, according to the invention, similarly to the case in which feet 71 of platform 73 of crane 75 directly rest on the ground, it is not necessary to secure said feet to brackets 21 and feet 31 of structure 11 to the ground.

[0051] Actually, thanks to the arrangement of horizontal brackets 29 close to columns 13, structure 11 has a reduced lever arm between the supporting area on said brackets and the corresponding column. The structure is thus sufficiently robust and stable for supporting e.g. a conventional building crane and in particular a self-assembling crane, such as the one shown and generally denoted by reference numeral 75.

[0052] Referring now to Figs. 6 to 8, there is disclosed in detail an embodiment of lifting mechanism 17 by which frame 15 can be lifted to the desired height along columns 13 relative to the ground on which feet 31 of structure 11 rest.

[0053] Lifting mechanism 17 comprises in the upper part a first engagement terminal 35 associable with frame 15 and a second engagement terminal 37 associable with a corresponding column 13. Correspondingly, frame 15 and columns 13 comprise a first engagement element 39 capable of cooperating with said first engagement terminal 35, and a second engagement element 41 capable of cooperating with said second engagement terminal 37, respectively.

[0054] In the illustrated example, the first terminal 35 and the first element 39 comprise a respective flange or flange pair, 35a and 39a respectively, which have a hole for the passage of a fastening peg 43.

[0055] Always with reference to the illustrated example, the second terminal 37 and the second element 41 comprise a horizontal foot 37a and a seat 41a, respectively, which seat is formed in the wall of column 13 and is arranged to house a portion of said foot 37a.

[0056] According to the preferred embodiment of the invention, lifting mechanism 17 further comprises a hydraulic lifting device 45 equipped with a cylinder 45a and a corresponding piston 45b.

[0057] In the illustrated example, lifting mechanism 17 comprises four hydraulic lifting devices 45, one for each column 13. Moreover, cylinder 45a is associated with frame 15 in correspondence of cursor 21 thanks to the cooperation between the first engagement terminal 35 and the first engagement element 39, whereas piston 45b is associated with column 13, in correspondence of one portion 13a thereof, thanks to the cooperation between the second engagement terminal 37 and the second engagement element 41.

[0058] Always according to the invention, the reverse arrangement could also be envisaged, where cylinder 45a is associated with column 13, in correspondence of one portion 13a thereof, and piston 45b is associated with frame 15 in correspondence of cursor 21.

[0059] According to a preferred embodiment of the invention, the coupling between the second engagement terminal 37 and the corresponding second engagement element 41 is removable, and moreover columns 13 are equipped with at least two of said engagement elements 41 located at different heights along columns 13 in order to position terminal 41 at different heights relative to the ground on which feet 31 rest.

[0060] Moreover, columns 13 are equipped with means for blocking the downward displacement of frame 15, consisting for instance of through pegs 47 associated with cursors 21 in correspondence of bores provided therein.

[0061] When cursor 21 has been lifted to the desired height along the corresponding column 13 by means of lifting device 45, said cursor is locked with respect to column 13 by means of pegs 47. Thereafter, the second engagement terminal 37 can be disengaged from the corresponding engagement element 41 in order to be positioned at a higher level along column 13, once piston 45b has been retracted into cylinder 45a. In a subsequent step, and once pegs 47 have been removed, cursor 21 can again freely displace upwards and can be lifted by means of device 45.

[0062] It is clear that the sliding in the opposite direction, i.e. downwards, of frame 15 takes place by locking cursor 21 with respect to columns 13 by means of pegs 47, by positioning the second engagement terminal 37 at a lower level along column 13, by releasing cursor 21 from pegs 37 and by acting on lifting mechanism 17 in order to retract again piston 45b into cylinder 45a.

[0063] Thanks to such a feature, and by providing a column 13 of suitable length, for instance by joining together a plurality of column portions 13a, or by providing a column with a plurality of seats 41a, it is possible to lift frame 15 by a considerable extent, e.g. some metres (3 to 5 m), while using a lifting device 45 of reduced size and hence cheap.

[0064] Still according to this preferred embodiment of the invention, also the coupling between the first engagement terminal 35 and the corresponding first engagement element 39 is removable, so that, when cursor 21 has reached the desired height, lifting mechanism 17 can be

removed, for instance by removing peg 43 in the illustrated example, and can possibly be used in another structure of the kind according to the invention, with clear economic advantages.

[0065] Referring to fig. 9, there is shown the arrangement of structure 11 according to the invention from which the four lifting devices 45 have been removed, so that they do not cause dangers or hindrance while the crane is being used, and on which base platform 73 of a crane 75 is supported.

[0066] Referring to Fig. 10, there is shown a variant embodiment of lifting mechanism 17, in which the second engagement terminal 37 and the corresponding second engagement element 41 consist of a pin 37'a and a hole 41'a, respectively, both the pin and the hole being possibly threaded.

[0067] Fig. 11 shows a variant embodiment of lifting mechanism 17 where lifting devices 45 are associated with beams 19 in a substantially horizontal position.

[0068] Deflecting pulleys 48 are installed at the ends of beams 19 and are rigidly connected to the same beams.

[0069] A first end of a tie 50, for instance a chain, is associated with the free end of said devices 45, whereas the second end of the tie is equipped with a fastening element 46, e.g. a hook, for fastening the tie to the upper ends of columns 13.

[0070] According to this arrangement, each tie 50 will have a horizontal portion and a vertical portion with respect to deflecting pulley 48 and, by acting on devices 45, it will be possible to change the ratio between the lengths of such two portions and to obtain the upward or downward movement of structure 11. This embodiment allows assembling mechanisms 17 in simple and quick manner.

[0071] Fig. 12 shows a variant embodiment of structure 11 where two opposite beams 19 comprise a central element 19c and two adjustable end elements 19d. Elements 19d are removably and adjustably connected to central element 19c and include cursor 21 at their ends.

[0072] Also the other two opposite beams 19 are adjustable in length and, in the illustrated example, are made of two extendable or telescopic elements 19a and 19b.

[0073] Lifting mechanisms 17 are mounted in pairs on central elements 19c and they comprise a device 45, pulleys 48 and ropes 49 in a manner similar to what has been illustrated and described with reference to the variant embodiment shown in Fig. 11.

[0074] This solution allows manufacturing and assembling structure 11 in practical and quick manner, since lifting mechanisms 17 and cursors 21 are associated with two beams 19 only.

[0075] Referring now to Fig. 13, there is schematically shown an equipment 51 controlling the lifting of structure 11 according to the invention.

[0076] In the illustrated example, said equipment 51 has been conceived for a self-lifting structure 11 of the

kind described above, equipped with four vertical columns 13, and a corresponding lifting mechanism 17 equipped with four hydraulic lifting devices 45.

[0077] Equipment 51 essentially comprises a pump 53, e.g. a gear pump driven by an electric motor 55, connected to the equipment through a valve 57, preferably an electrically-controlled valve, through which pump 53 feeds a flow divider 59, for instance a gear flow divider, ensuring the output synchronism of the four supply ducts 61 of hydraulic devices 45.

[0078] Said supply ducts 61 are equipped with corresponding restraining valves 63 in order to prevent a spontaneous displacement of hydraulic devices 45 caused by the load supported on frame 15.

[0079] Equipment 51 further has an oil reservoir 65 and a control unit 67.

[0080] According to the invention, structure 11 preferably comprises as many lifting devices 45 as columns 13 are, and said devices 45 can be simultaneously operated in order to allow lifting or lowering frame 15 while keeping it horizontal with respect to the support plane of the structure, i.e. perpendicular to columns 13.

[0081] Preferably, equipment 51 is mounted on board a movable unit, for instance a buggy, and devices 45 will be advantageously equipped with fast hydraulic joints.

[0082] Thanks to such an arrangement, the same equipment 51 may advantageously be used to control different self-lifting structures according to the invention, which are for instance installed in building yards even at a distance from one another, with considerable savings in the management costs.

[0083] Always according to the invention, hydraulic devices 45 could also be associated with a hydraulic circuit mounted on a vehicle, for instance a tractor, or provided on the same crane supported by the structure.

[0084] The embodiments described can undergo modifications without thereby departing from the scope of the invention as defined in the following claims.

Reference numerals

[0085]

11 support structure;
13 vertical column;
13a elementary column portion;
14 joint;
15 horizontal frame;
17 lifting mechanism;
19 beam;
19a central element;

19b end element;
19c, 19d extendable elements;
21 cursor;
23 idle wheel;
25 bore;
27 locking peg;
29 horizontal bracket;
31 supporting foot;
33 tie rod;
35 first engagement terminal;
35a flange;
37 second engagement terminal;
37a horizontal foot;
37b vertical supporting bracket;
39 first engagement element;
39a flange;
41 second engagement element;
43 fastening peg;
45 lifting device;
45a cylinder;
45b piston;
46 locking element;
47 pegs;
48 pulley;
49 tie;
50 tie;
71 foot;
73 base platform;
77 crane jib;

79 crane tower;

81 ballast

Claims

1. Self-lifting support structure (11) for building, comprising:

- vertical support columns (13);
- a horizontal frame (15) associated with said columns and provided with a supporting surface (29) for the load to be carried by the structure;
- a lifting mechanism (17) positioned between the frame and the columns and capable of provoking vertical displacement of the frame with respect to the columns,

characterized in that said structure comprises modular elements which allow the height of said columns and/or the overall dimensions of said frame to be varied.

2. Structure according to claim 1, wherein the frame (15) comprises a plurality of beams (19) associated with cursors (21) positioned at the corners of the frame (15) and vertically displaceable with respect to the vertical columns (13) by means of said lifting mechanism (17).

3. Structure according to claim 2, wherein said cursors (21) define an aperture having a shape complementary to the transverse section of the column body (13), whereby the cursor (21) encircles the column (13) and can vertically slide with respect to it.

4. Structure according to claim 2 or 3, wherein the beams (19) of the frame (15) comprise elements of adjustable length (19a, 19b, 19c, 19d) provided with removable locking elements (27) which prevent mutual sliding of said elements of adjustable length.

5. Structure according to claim 2 or 3 or 4, wherein each of the cursors (21) comprises a support element in the form of a horizontal bracket (29) arranged to receive the free end of a corresponding foot (71) of a base platform (73) of a building crane.

6. Structure according to claim 5, wherein the frame (15) has a substantially square or rectangular shape and the structure (11) has four columns (13), arranged at the corners of the square defined by the frame.

7. Structure according to claim 6, wherein each cursor (21) comprises a support element in the form of a horizontal bracket (29), directed towards the interior of the frame (15) substantially along the diagonals

connecting the corners of the frame.

8. Structure according to claim 1, wherein said columns (13) comprise a plurality of elementary portions (13a) of column mutually axially associable.

9. Structure according to any of the preceding claims, wherein the lifting mechanism (17) comprises at least one lifting device (45) comprising in the upper part a first engagement terminal (35) associable with the frame (15) and in the lower part a second engagement terminal (37) associable with a corresponding column (13), and wherein the frame (15) and the column (13) comprise a first engagement element (39) capable of cooperating with said first engagement terminal (35) and a second engagement element (41) capable of cooperating with said second engagement terminal (37), respectively.

10. Structure according to claim 9, wherein the second engagement terminal (37) is removably coupled to the corresponding second engagement element (41) and wherein the columns (13) are provided with at least two of said engagement elements (41) positioned at different heights to allow positioning the second terminal (37) at different heights with respect to the ground, said columns (13) being further provided with means for preventing downward displacement of the frame (15).

11. Structure according to claim 10, wherein the first engagement terminal (35) is removably coupled to the corresponding first engagement element (39) so as to allow the lifting device (45) to be removed.

12. Building crane comprising, in working condition, a base platform (73), a vertical tower (79) and a horizontal jib (77), **characterized in that** said base platform is associated with a support structure (11) according to any of the claims 1 to 11.

13. Building crane according to claim 12, wherein said support structure (11) defines a free space below, for the passage of vehicles or people.

14. A method of lifting a building crane of the kind comprising a base platform (73), a vertical tower (79) and a horizontal jib (77), said method comprising the steps of:

- providing a self-lifting support structure (11) for building, comprising:

- vertical support columns (13);
- a horizontal frame (15) associated with said columns and provided with a supporting surface (29) for the load to be carried by the structure;

- a lifting mechanism (17) positioned between the frame and the columns and capable of provoking vertical displacement of the frame with respect to the columns,
- modular elements which allow the height of said columns and/or the overall dimensions of said frame to be varied;

- positioning said frame (15) at a suitable height for allowing the base platform of the crane to be placed on said supporting surface (29);
- lifting the frame (15) by means of the lifting mechanism (17) and possibly modifying the height of said columns by means of said modular elements.

15. The method according to claim 14, wherein the lifting mechanism (17) comprises at least one lifting device (45) and wherein the frame (15) comprises a plurality of beams (19) associated with cursors (21) positioned at the corners of the frame (15) and vertically displaceable with respect to the vertical columns (13) by means of said lifting mechanism (17), said method further comprising the step of:

- removing said at least one lifting device (45) when the cursors have reached the desired height.

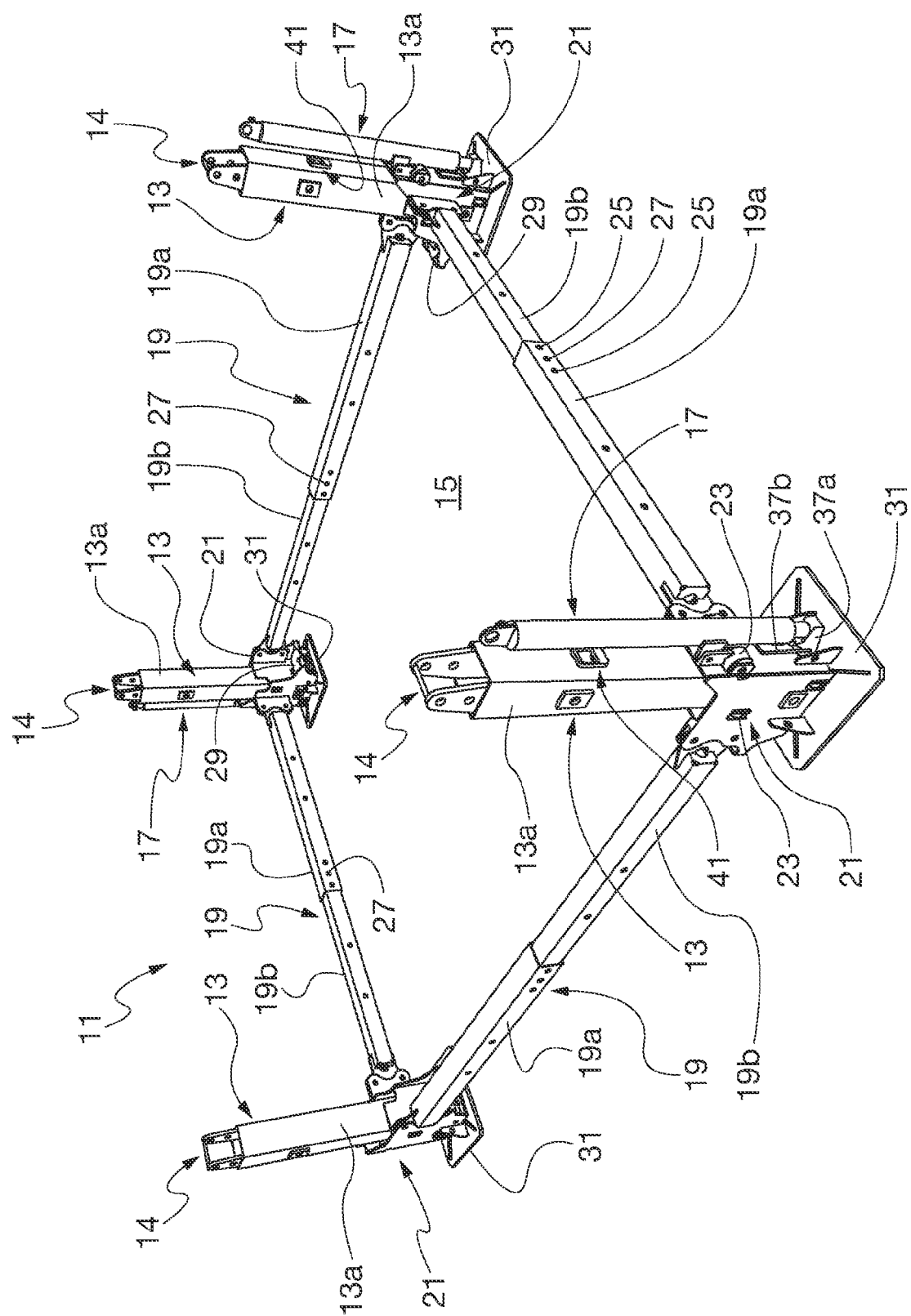


Fig. 1

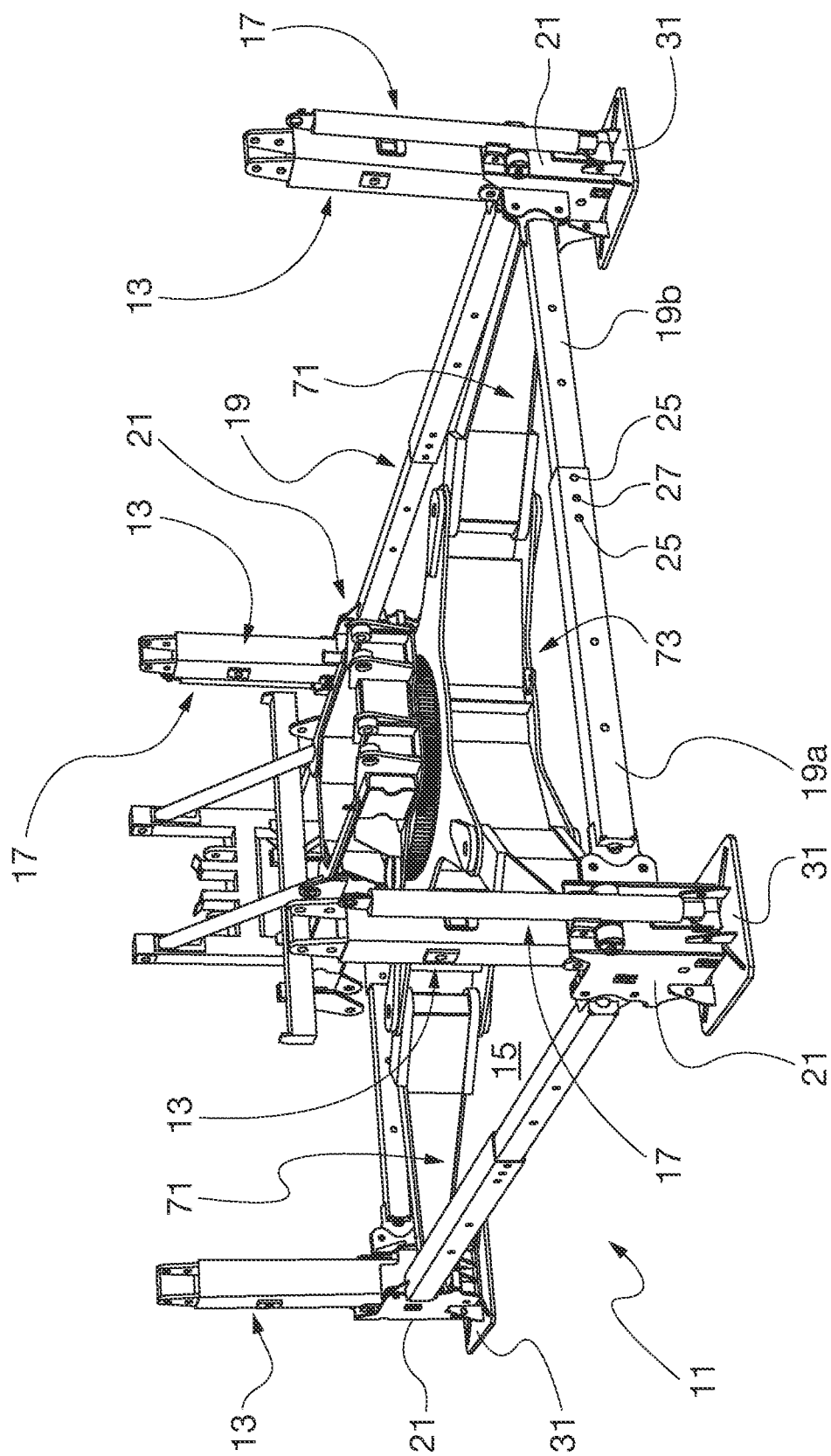


Fig. 2

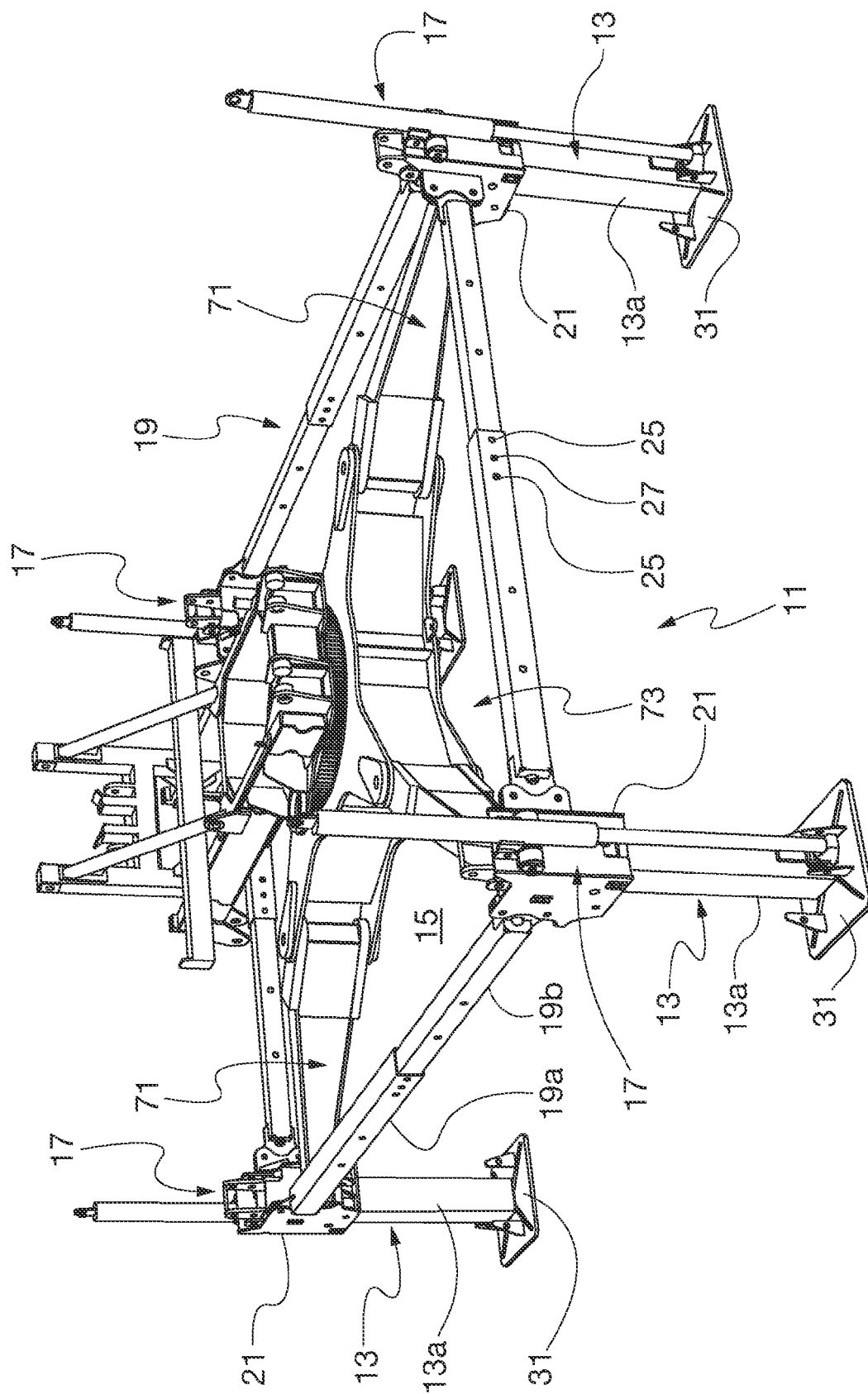


Fig. 3

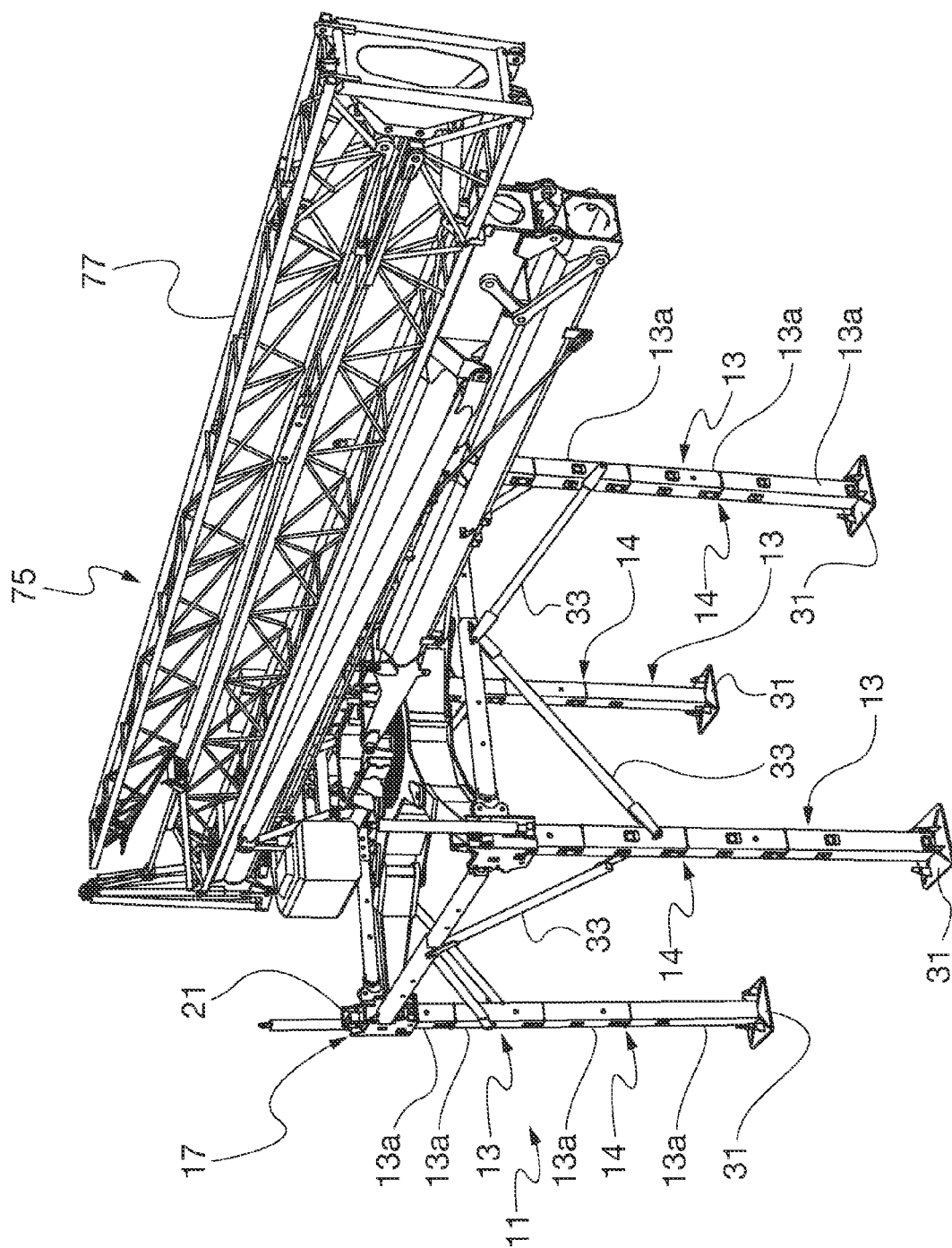


Fig. 4

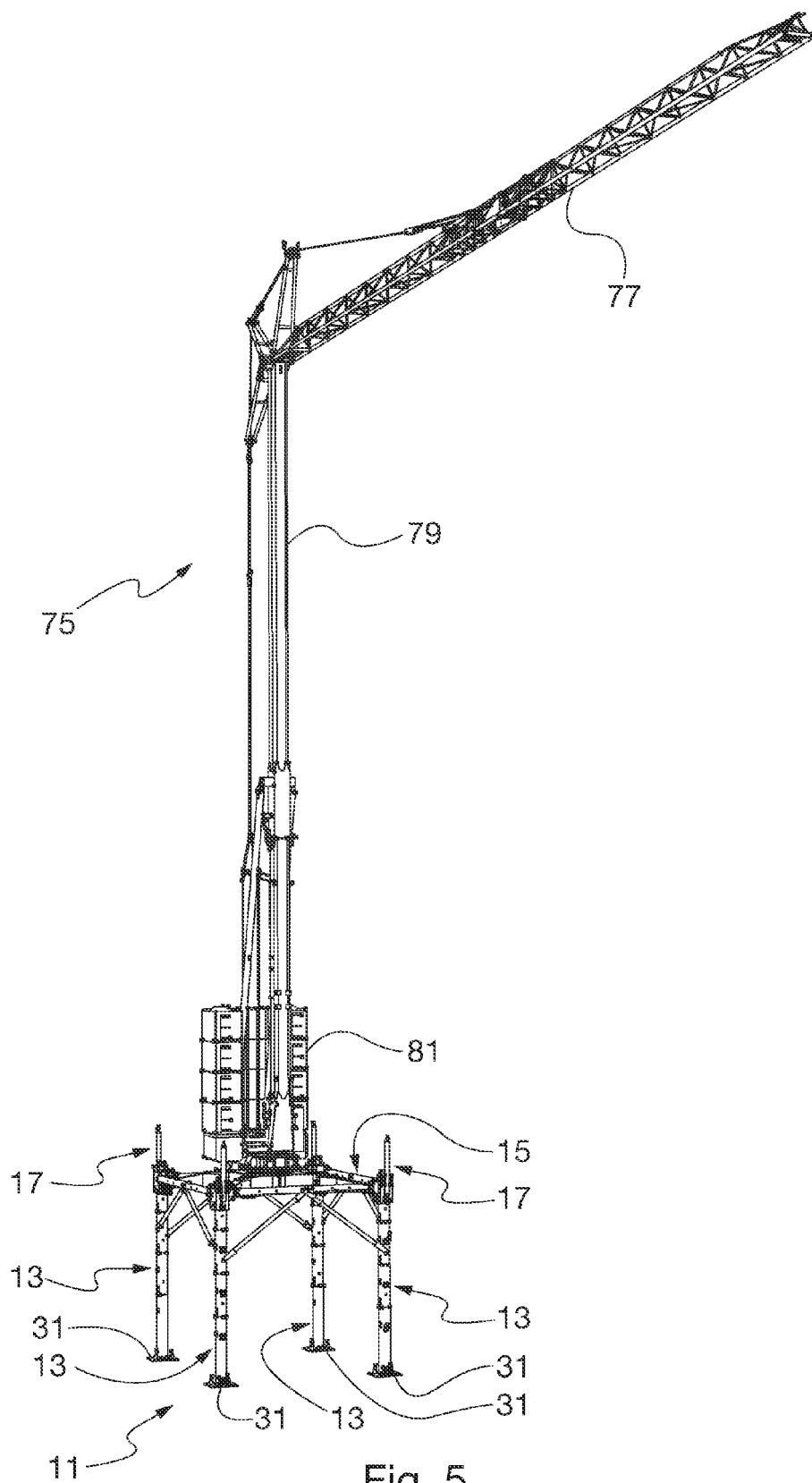


Fig. 5

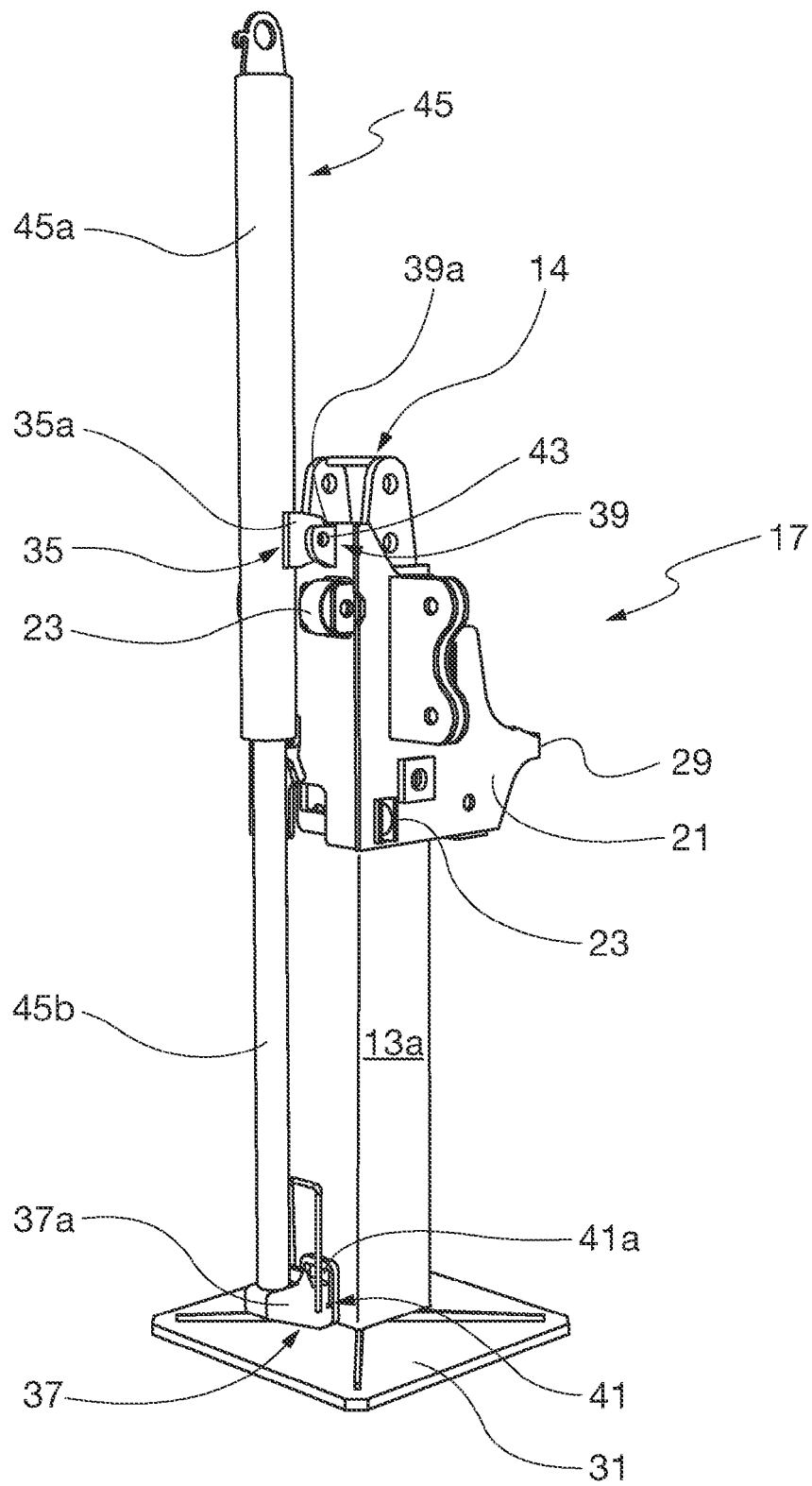


Fig. 6

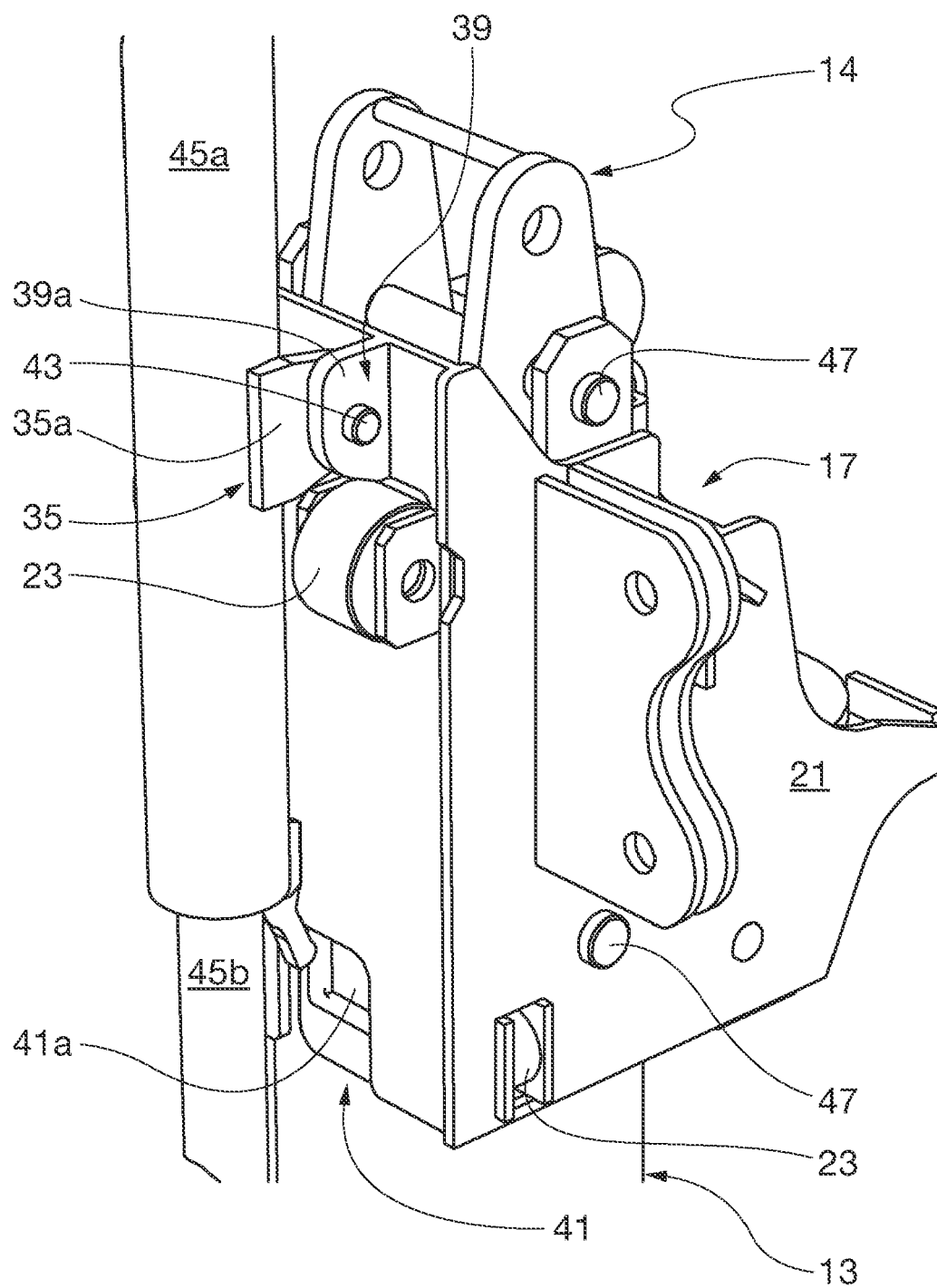


Fig. 7

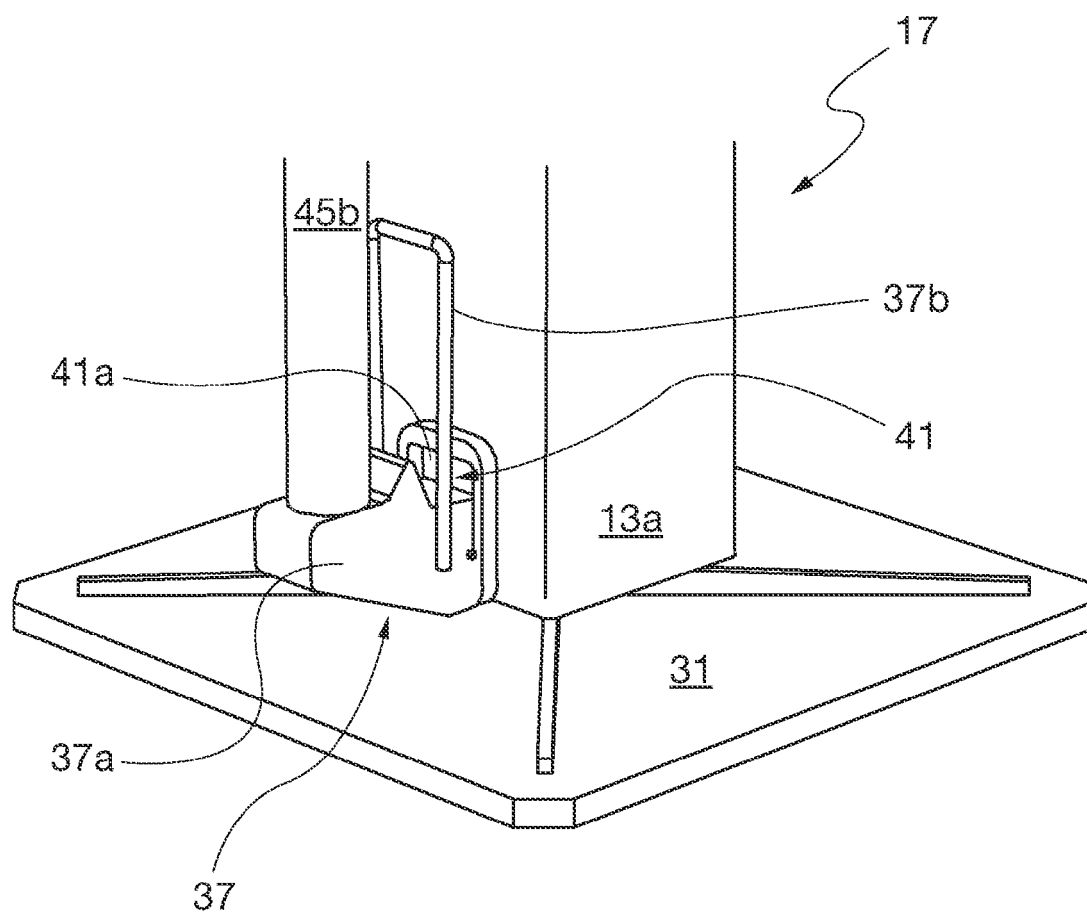


Fig. 8

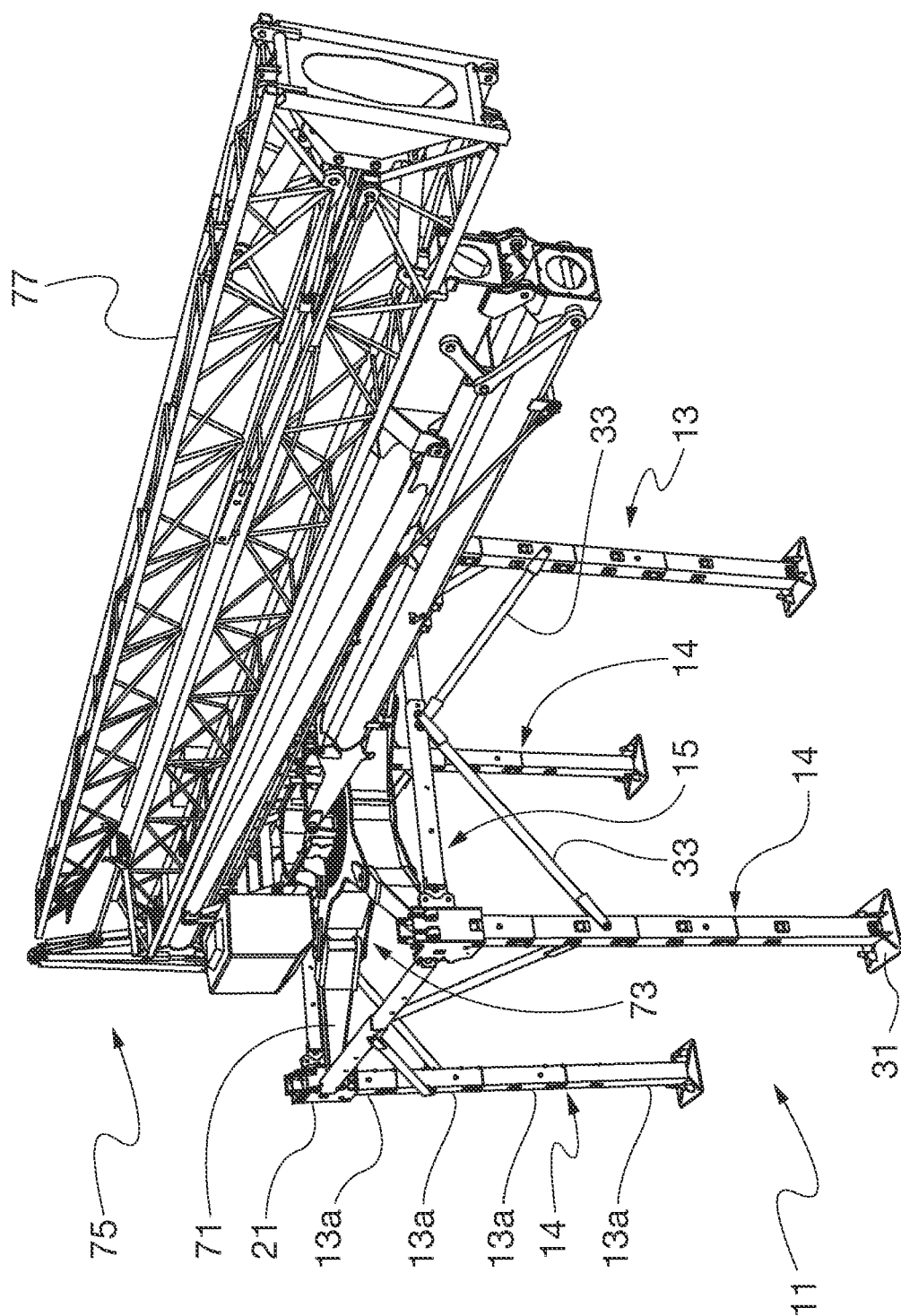


Fig. 9

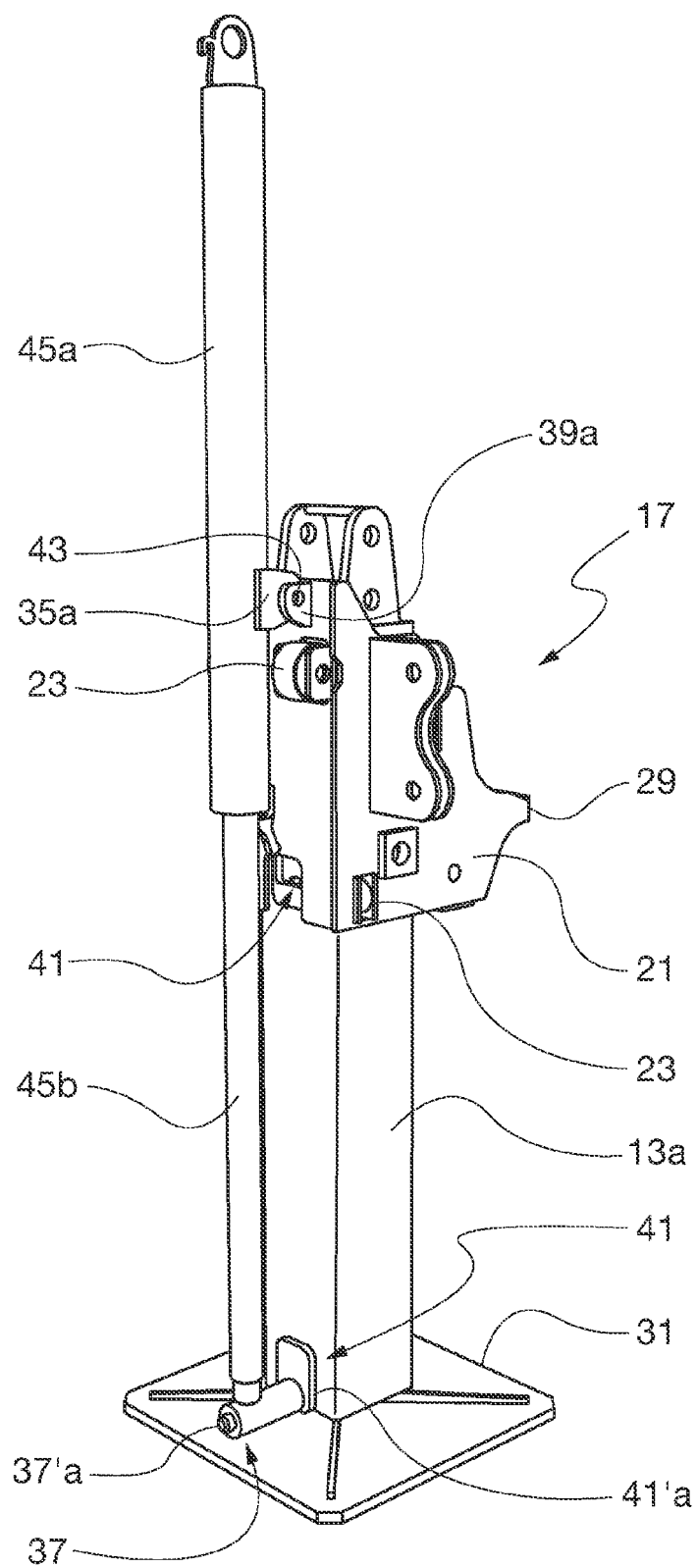


Fig. 10

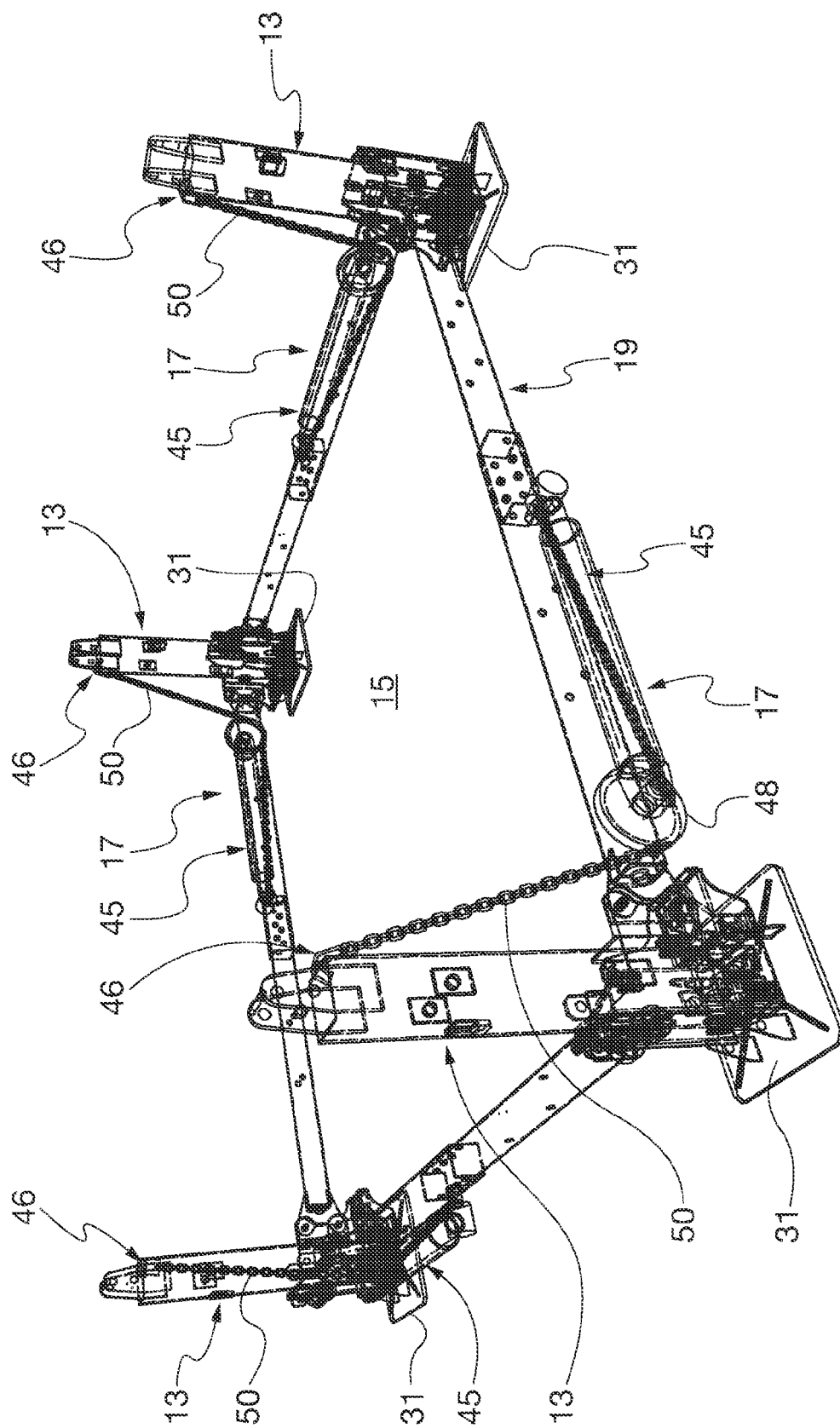


Fig. 11

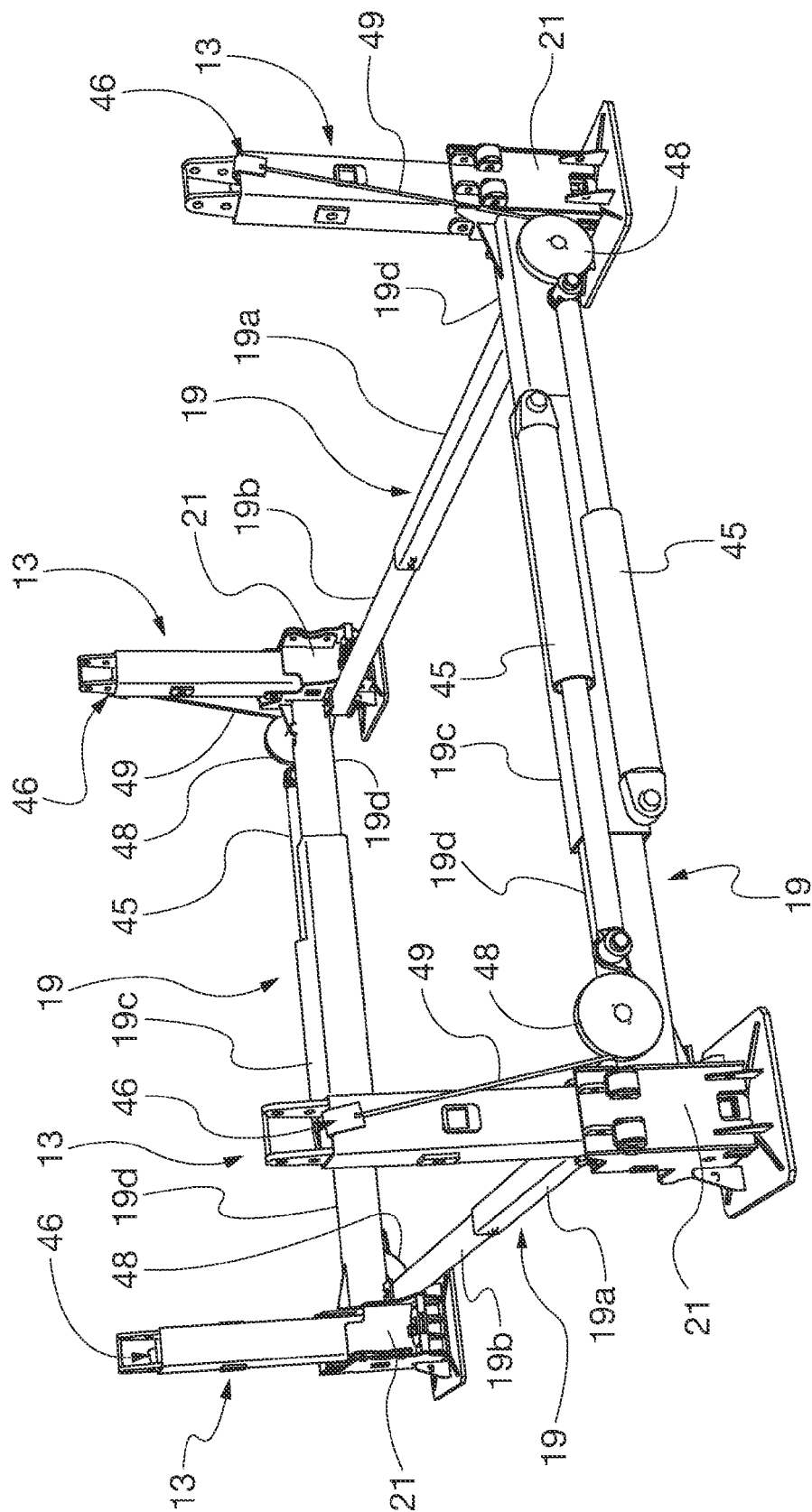


Fig. 12

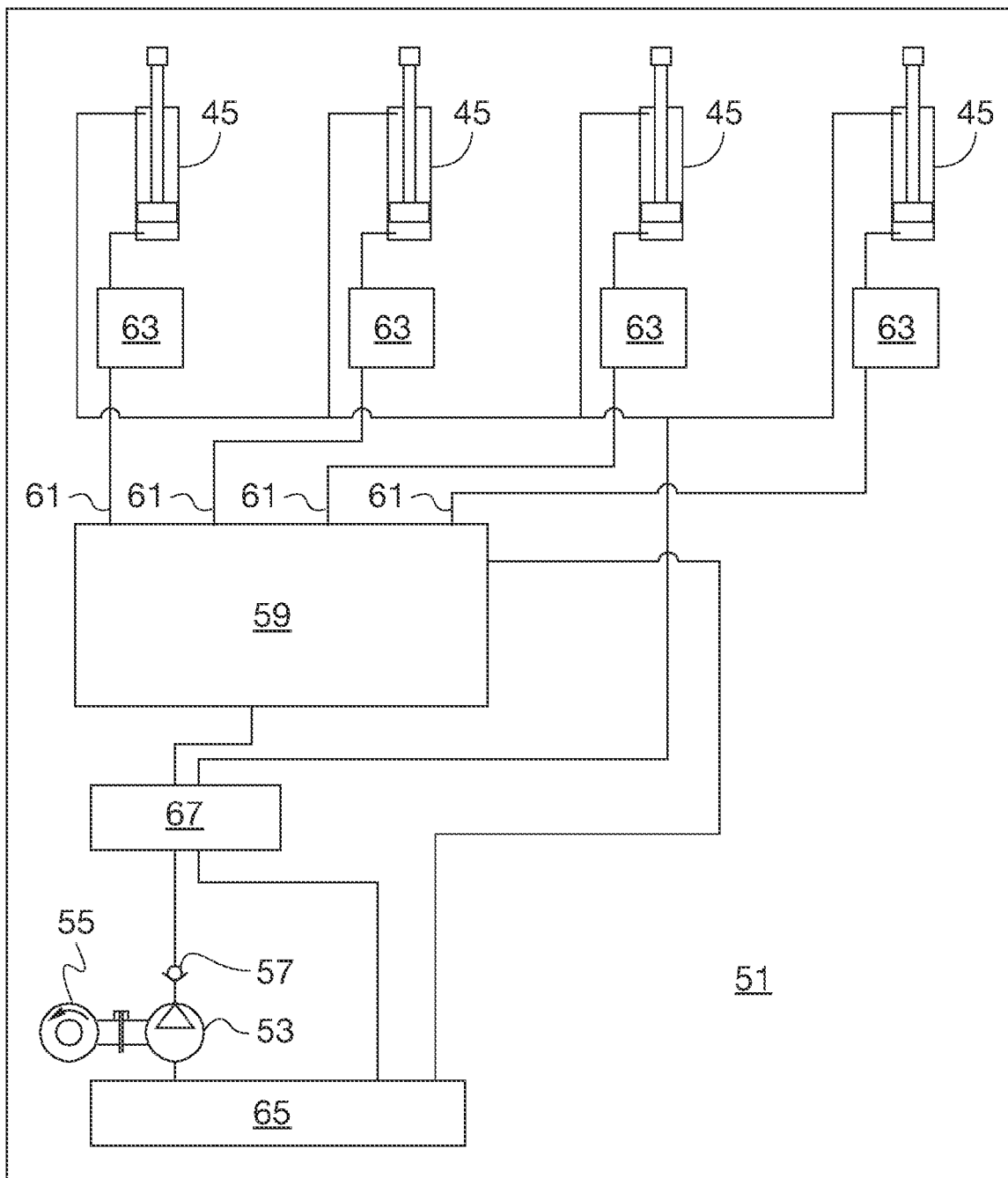


Fig. 13



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