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(54) A fall protection system

(57) A fall protection system (1) for securely coupling a user (11) to a support structure (5). The fall protection system comprises a mast (2) arranged to be vertically mounted in a state of use, having a top end (6) and a base end (7); a user connection assembly (3); and a tether connector (10); wherein the mast comprises a structure connection portion, at which the mast is arranged to be removably connected to the support structure, and an energy absorbing deformation portion (15) positioned closer to the top end than the structure connection portion, wherein the fall protection system is rearrangeable between an inactive state and a ready-to-use state. In the ready-to-use state:

- the user connection assembly protrudes from the mast substantially radially of the mast, and has a proximal end (8), connected with the mast at the top end, and a distal end (9);
- the tether connector is arranged at the user connection assembly, and
- the energy absorbing deformation portion is arranged to deform when exerted to a bending force caused by a falling user tethered to the tether connector. Thereby, the energy absorbing deformation portion absorbs energy and reduces the force exerted to the mast at its structure connection portion.

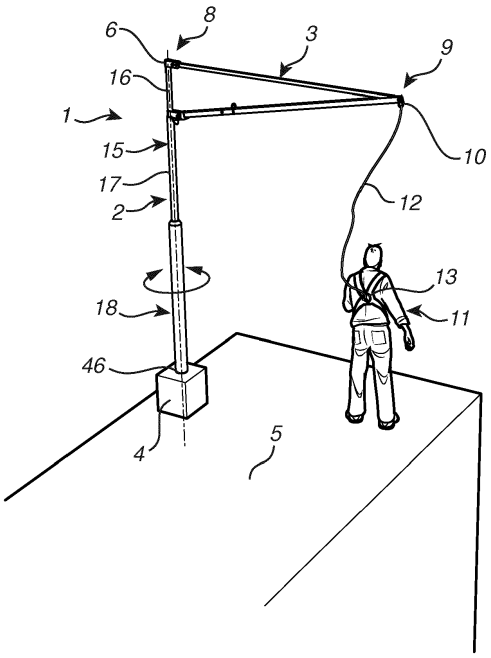

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a fall protection system for securely coupling a user to a support structure, wherein the fall protection system comprises a vertical mast connectable with a support structure, a user connection assembly protruding from the mast at a top end thereof, and a tether connector arranged at the end of the user connection assembly, wherein the mast comprises a structure connection portion at which the mast is arranged to be removably connected to the support structure.

BACKGROUND OF THE INVENTION

[0002] Many occupations require workers to work at dangerous heights. In some examples such occupations may involve the shipping industry. Workers may be required to work on top of shipping containers or trailers of semi-trucks. Workers may need to inspect containers. Containers may require maintenance such as repair or painting. Securing containers to lifts or trucks may involve workers working above and about such containers. In some cases loading may be performed from above certain containers.

[0003] The construction industry also may expose workers to dangerous heights. High-rise building construction may require workers to operate at dangerous heights. Often these workers may operate equipment on surfaces high above the ground elevation. These workers may perform duties at these heights without walls or rails surrounding these surfaces. Some of these surfaces may even have a slope which might facilitate falling off the surface.

[0004] Should a worker fall from the heights at which he/she works, harm can result. If a person's fall is arrested too abruptly, a person's skeletal system may be broken. If a person's head receives too large a stropping force, the person may receive a concussion, a broken skull, or even brain damage. If a user's fall is arrested abruptly, the user may hemorrhage internally as a result of the blow to the body. Fallen users may be permanently handicapped by excessive forces that occur from a fall.

[0005] To provide a secure working environment in the above and other similar circumstances, a fall protection system of the kind described above is used. One example of a prior art fall protection system is disclosed in EP 1400642. It has shown that a drawback of the prior art system is that when a person does fall, and is arrested by the system, the forces exerted on the support structure at the locations where the mast of the system is fastened tend to cause damage on the support structure.

SUMMARY OF THE INVENTION

[0006] It would be advantageous to decrease the forces exerted on the support structure on occasions of fall.

[0007] To better address this concern, in a first aspect of the invention there is presented a fall protection system for securely coupling a user to a support structure, the fall protection system comprising a mast arranged to be vertically mounted in a state of use, having a top end and a base end; a user connection assembly; and a tether connector. The mast comprises a structure connection portion, at which the mast is arranged to be removably connected to the support structure, and an energy absorbing deformation portion positioned closer to the top end than the structure connection portion. The fall protection system is rearrangeable between an inactive state and a ready-to-use state. In the ready-to-use state the user connection assembly protrudes from the mast substantially radially of the mast, and has a proximal end, connected with the mast at the top end, and a distal end; the tether connector is arranged at the user connection assembly, and the energy absorbing deformation portion is arranged to deform when exerted to a bending force caused by a falling user tethered to the tether connector, the energy absorbing deformation portion thereby absorbing energy and reducing the force exerted to the mast at its structure connection portion.

[0008] Due to the deformation portion, which absorbs energy, the force exerted on the support structure at the location or locations where the mast is fastened is decreased, and thus the risk of damaging the support structure is decreased as well.

[0009] In accordance with an embodiment of the fall protection system, the energy absorbing deformation portion is arranged to deform plastically. This embodiment is advantageous in that the properties of the energy absorption can be set by dimensioning the very material of the deformation portion as to length, width, thickness, etc.

[0010] In accordance with an embodiment of the fall protection system, the mast has a lower bending strength at the energy absorbing deformation portion than at a portion adjacent to and below the energy absorbing deformation portion. Thereby the mast is arranged to absorb energy by bending in the deformation portion.

[0011] In accordance with an embodiment of the fall protection system, the energy absorbing deformation portion comprises a first deformation segment of a lowest bending strength, and a second deformation segment of a second lowest bending strength, wherein the first deformation segment constitutes a top segment of the energy absorbing deformation portion, and the second deformation segment extends adjacent to the first deformation segment, and closer to the base end than the first deformation segment. Two deformation segments provides for obtaining of the desired function in a relatively simple way with a useful amount of freedom in designing the energy absorbing deformation portion.

[0012] In accordance with an embodiment of the fall protection system, the user connection assembly comprises an upper elongated element having a proximal

end pivotally connected with the mast at the top end thereof, and a distal end, and a lower elongated element having a proximal end and a distal end, the distal end of the lower elongated element being pivotally connected with the upper elongated element at its distal end, and the proximal end of the lower elongated element, in the ready-to-use state, being removably connected with the mast closer to the base end than the proximal end of the upper element is, the interconnected distal ends of the upper and lower elongated elements forming the distal end of the user connection assembly. Thereby the user connection assembly is easily unfoldable and foldable.

[0013] In accordance with an embodiment of the fall protection system, the first deformation segment extends between the connection points of the upper elongated element and the lower elongated element.

[0014] In accordance with an embodiment of the fall protection system it is portable. Thereby it is possible for a single user to manage to arrange the fall protection system at a support structure.

[0015] In accordance with an embodiment of the fall protection system, the tether connector is attached at the distal end of the user connection assembly.

[0016] In accordance with an embodiment of the fall protection system, it further comprises a user tethering device, which comprises a self-retracting lifeline unit, which is removably connected with the tether connector in the ready-to-use state. Thereby a comfortable use of the fall protection system is provided.

[0017] In accordance with an embodiment of the fall protection system, in the inactive state the user connection assembly is folded, the upper elongated element is received in a groove of the lower elongated element, and the user connection assembly extends along the length of the mast from the top end towards the base end. Thereby, in the inactive state the user connection assembly uses a small space.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention will now be described in more detail and with reference to the appended drawings in which:

Fig. 1 shows an embodiment of the fall protection system according to the present invention, in one application;

Fig. 2 illustrates the function of the fall protection system in Fig. 1 when a fall occurs;

Fig. 3 shows an embodiment of the fall protection system according to the present invention, in another application;

Fig. 4 is a view obliquely from below of an embodiment of the fall protection system according to the present invention in a ready-to-use state;

Fig. 5 is a view obliquely from above of the fall protection system of Fig. 4;

Fig. 6a shows the fall protection system of Fig. 4 in an inactive state;

Figs. 6b to 6d illustrate the operation of unfolding the fall protection system of Fig. 4;

Fig. 7 is an enlarged view of a part of the fall protection system shown in Fig. 4;

Fig. 8 shows an embodiment of the fall protection system according to the present invention, in yet another application.

DESCRIPTION OF EMBODIMENTS

[0019] Embodiments of the fall protection system according to the present invention are shown in the drawings. Like reference numerals refer to like elements throughout. Referring to Figs. 1, 2, 4 and 5, the fall protection system 1 comprises a mast 2 and a user connection assembly 3. In Figs. 1 and 2 the fall protection system 1 is shown in a state of use, where it has been rearranged from the inactive state to the ready-to-use state and vertically mounted at a support structure 4, which in the shown application is constituted by a cast-in-site concrete base joined with a concrete floor 5 of a building under construction. Such a support structure 4 is well described in prior art and will not be described in more detail here. It should, however, be mentioned that the support structure 4 has an anchoring member centrally cast into the concrete base, and that the mast 2 has been received in the anchoring member. The mast is removable from the support structure 4, and it is also rotatable in the support structure 4.

[0020] The mast 2 has a top end 6 and a base end 7. The user connection assembly 3 protrudes substantially radially, i.e. horizontally, from the mast 2, and has a proximal end 8, which is connected with the mast 2 at its top end, and a distal end 9. This means that the mast 2 may or may not extend above the user connection assembly 3. The fall protection system further comprises a tether connector 10, which is connected with the user connection assembly 3 at its distal end 9. In Figs. 1 and 2 a user 11 is shown as tethered to the fall protection system 1 via a wire, or the like, 12 connected between the tether connector 10 and a body harness 13. In Fig. 2 the user is shown after having fallen over the edge of the floor 5, wherein a part of the mast 2 has been bent.

[0021] The mast 2 has a structure connection portion 14 extending a distance from the base end 7 towards the top end 6, i.e. upwards in the figures. At least a base end part of the structure connection portion 14 is received in the concrete stand. Furthermore, the mast 2 has an energy absorbing deformation portion 15, positioned closer to the top end 6 than the structure connection portion 14. In this embodiment, the deformation portion 15 extends a distance from the top end 6 towards the base end 7. The deformation portion 15 is arranged to deform when exerted to a bending force caused by a falling user tethered to the tether connector 10, wherein at least a part of the energy of the fall is absorbed by a plastic deformation of the deformation portion 15. In other words the

deformation portion 15 remains bent after the fall. By this absorption of energy in the deformation portion 15 less force is exerted on the support structure 4, and the fastening means attaching the mast 2 to the support structure 4. The prior art fall protection systems of the similar kind mentioned above have strictly rigid masts, which do not absorb energy in any corresponding way. There is an example of a user connection assembly that has a built-in spring though. However, that spring has a different purpose and is not integrated in the mast. Instead it is merely arranged to soften the fall and thereby decrease the stress that the user's body is exposed to. The deformation portion 15, but not the rest of the mast 2, deforms due to having a lower bending strength than the rest of the mast 2, i.e. below the deformation portion 15, constituting a non-deformation portion 18, which includes the structure connection portion 14 and which extends from the base end 7 to the deformation portion 15. An end-most segment 19 of the non-deformation portion 18, including the base end 7 of the mast 2, and being an end-most segment of the structure connection portion 14 as well, has a smaller diameter than the rest of the non-deformation portion 18 in order to fit with current anchoring members. However, it should be noted that, as shown in the figures, some of the wider segment of the non-deformation portion 18 is also received in the anchoring member. An approximate and exemplifying upper limit for the part of the mast 2 that is received in the anchoring member 46 of the concrete support 4 is shown by a peripheral broken line 20 in Fig. 4.

[0022] More particularly, in the shown embodiments the deformation portion 15 is constituted by two different segments having different bending strength. Thus, the deformation portion 15 has a first, or upper, deformation segment 16 of a lowest bending strength, and a second, or lower, deformation segment 17 of a second lowest bending strength. The first deformation segment 16 consequently constitutes a top segment of the deformation portion 15, and also of the whole mast 2, and the second deformation segment 17 extends adjacent to the first deformation segment 16, and closer to the base end 7 than the first deformation segment 16.

[0023] In the shown embodiments the difference in bending strength has been obtained by manufacturing the different parts 16, 17, 18 of the mast 2 with different dimensions as to diameter and thickness of material. As an illustrating example of a mast 2 which has been tested, having no limiting effect on the scope of the claims and being just one of many different examples, the diameter of the first deformation segment 16 had an outer diameter of 51 mm, and a material thickness of 3.2 mm, the second deformation segment 17 has an outer diameter of 60.3 mm, and a material thickness of 3.2 mm, and the non-deformation portion 18, except for the end-most segment 19, has an outer diameter of 70 mm, and a material thickness of 3.2 mm. As will be readily understood by the person skilled in the art, this merely one example of many different possible combinations of number of deformation segments, and measures of deformation segments.

[0024] The deformation segments 16, 17 do not start deforming until the force exerted on them exceeds a deformation threshold. The threshold is predetermined such that the mast 2 deforms only elastically when a person of average weight, e.g. 70 kg, hangs statically in the tether connector 10, i.e. the mast 2 may bend but will return to its original shape when the load is removed. However, if the same person falls from a surface the mast 2 will deform plastically, i.e. it will remain bent when the load is removed.

[0025] Inter alia due to the deformation portion, by means of which it has been able to lighten the fall protection system 1 relative to the known fall protection systems, it has been possible to make the fall protection system, according to the preferred embodiments, portable. By portable is meant that an average user is able to carry the fall protection system. By going in the opposite direction of the above-mentioned prior art fall protection system disclosed in EP 1400642, which is very heavy and strong, and which has a mast that will not deform plastically when a user falls, and deliberately developing a mast that is meant to deform plastically, though only when desired, it has been possible to substantially cut the weight as well. It is to be noted that of course the length of the mast and the size of the user connection assembly will affect the weight too, and by making the fall protection system small enough it will be portable even with such large material dimensions as the prior art system, but then it would be too short for some application. However, in accordance with the present invention a portable fall protection system that can be used in all applications where the prior art system can be used has been obtained. In order to exemplify this, in one embodiment the length of the mast 2 is about 3.1 meters, and the user connection assembly 3 protrudes about 2 meters from the mast 2 in the ready-to-use state. Furthermore, length of the first deformation segment is about half a meter and the length of the second deformation segment is about one meter. Of course many other dimensions are feasible as well. The user connection assembly 3 comprises an upper elongated element 21 having a proximal end 22 pivotally connected, such as by means of a through bolt 27 (Fig. 6d), with the mast 2 at the top end 6 thereof, and having a distal end 23; and a lower elongated element 24 having a proximal end 25 and a distal end 26. The distal end 26 of the lower elongated element 24 is pivotally connected with the distal end 23 of the upper elongated element 21, such as by means of a through bolt 28. In the ready-to-use state, the proximal end 25 of the lower elongated element 24 is removably connected with the mast 2, such as by means of a fixing pin 29, closer to the base end 7 than the proximal end 22 of the upper elongated element 21. The interconnected distal ends 23, 26 of the upper and lower elongated elements 21, 24 form the distal end 9 of the user connection assembly 3. The upper elongated element 21 extends horizontally, while the lower elongated element

24 extends obliquely upwards from its proximal end 25 towards its distal end 26. The lower elongated element 24 can be seen as a brace for the upper elongated element 21.

[0026] The first deformation segment 16 extends between the mast connections 31, 32 of the proximal ends 22, 25 of the upper and lower elongated elements 21, 24.

[0027] Furthermore, when the user connection assembly 3 is folded, as shown in Fig. 6a, i.e. when the fall protection system 1 is in the inactive state, the upper elongated element 21 is received in a groove 30 of the lower elongated element 24, and the user connection assembly 3 extends along the length of the mast 2 from the top end 6 towards the base end 7. The groove 30 is provided by the lower elongated element 24 being a U-shaped in cross-section.

[0028] Referring to Figs. 6a to 6d, from the inactive state, the fall protection system 1 is rearranged to the ready-to-use state as follows. Most comfortably, while having the fall protection system 1 lying on the ground, first the user releases the fixing pin 29 at the lower mast connection 32, and starts pulling the lower elongated element 24 away from the mast 2, Fig. 6a. The distal end 23 of the upper elongated element 21 starts pivoting out from the mast 2, Fig. 6b. When the upper and lower elongated elements 21, 24 are aligned or close to aligned the user starts pivoting the proximal end 25 of the lower elongated element 24 about the distal end interconnection towards the base end 7 of the mast 2, while keeping the upper elongated element 21 about perpendicular to the mast 2, Fig. 6c. The pivoting of the lower elongated element 24 is continued until its proximal end 25 reaches the lower mast connection 32, where it is attached with the fixing pin 29, Fig. 6d. The rearrangement of the fall protection system 1 thus involves pivoting the lower elongated element 24 almost a full turn about the interconnection of the distal ends of the lower and upper elongated elements 24, 21. To achieve this, the lower elongated element is provided with a slot 33 at its distal end 26, such that a distal end portion 34 of the lower elongated element 24 is constituted by two parallel walls extending like tongues from the rest of the lower elongated element 24. When the user connection assembly 3 has been unfolded, the user lifts up the fall protection system 1 and places it at the support structure to be used. Should it be needed to hoist the fall protection system 1 with a crane or the like, the lower elongated element 24 is provided with a lifting eye 35.

[0029] According to another embodiment of the fall protection system 40, it comprises the same parts as the embodiment described above, but in addition it comprises a user tethering device 41, which comprises a self-retracting lifeline unit, and which is removably connected with the tether connector 10 in the unfolded state. This embodiment is shown in Fig. 3, where it is mounted at another kind of support structure 42. The support structure 42 is a transportable anchor, which in short comprises a frame structure 43 and heavy weights 44, such as concrete weights, placed in the frame structure 43. The transportable anchor 42 further has an anchoring member 45, and the structure connection portion 14 of the mast 2 has been received therein. A typical situation where the transportable anchor 42 is used is when the user 47 is going to work at the roof of a lorry 48, as illustrated in Fig. 3.

[0030] Another application of the fall protection system 1 is to attach it, to a wall 49, by means of wall connectors, such as clamping members 50, as shown in Fig. 8. The fall protection system 1 is attached to the wall at a wall connection portion 51 comprised in the structure connection portion 14, typically at an upper part thereof. The wall connectors 50 are arranged such that the mast 2 becomes rotatable when mounted at the wall 49.

[0031] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments.

[0032] For instance according to another embodiment, the upper elongated element of the user connection assembly is a wire.

[0033] Other numbers of deformation segments than two may be provided, such as one deformation segment or three deformation segments.

[0034] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A fall protection system for securely coupling a user to a support structure, the fall protection system (1) comprising a mast (2) arranged to be vertically mounted in a state of use, having a top end (6) and a base end (7); a user connection assembly (3); and a tether connector (10); wherein the mast comprises a structure connection portion (14), at which the mast is arranged to be removably connected to the support structure (5), and an energy absorbing deformation portion (15) positioned closer to the top end than the structure connection portion, wherein the fall protection system is rearrangeable between an inactive state and a ready-to-use state, wherein, in the ready-to-use state:

    - the user connection assembly protrudes from

the mast substantially radially of the mast, and has a proximal end (8), connected with the mast at the top end, and a distal end (9);
- the tether connector is arranged at the user connection assembly, and
- the energy absorbing deformation portion is arranged to deform when exerted to a bending force caused by a falling user tethered to the tether connector, the energy absorbing deformation portion thereby absorbing energy and reducing the force exerted to the mast at its structure connection portion.

2. The fall protection system according to claim 1, wherein the energy absorbing deformation portion (15) is arranged to deform plastically.

3. The fall protection system according to claim 1 or 2, wherein the mast (2) has a lower bending strength at the energy absorbing deformation portion (15) than at a portion adjacent to, and closer to the base end (7) than, the energy absorbing deformation portion.

4. The fall protection system according to any one of claims 1 to 3, wherein the energy absorbing deformation portion (15) comprises a first deformation segment (16) of a lowest bending strength, and a second deformation segment (17) of a second lowest bending strength, wherein the first deformation segment constitutes a top segment of the energy absorbing deformation portion, and the second deformation segment extends adjacent to the first deformation segment, and closer to the base end (7) than the first deformation segment.

5. The fall protection system according to claim 4, the user connection assembly (3) comprising an upper elongated element (21) having a proximal end (22) pivotally connected with the mast (2) at the top end (6) thereof, and a distal end (23), and a lower elongated element (24) having a proximal end (25) and a distal end (26), the distal end of the lower elongated element being pivotally connected with the upper elongated element at its distal end, and the proximal end of the lower elongated element, in the ready-to-use state, being removably connected with the mast closer to the base end (7) than the proximal end of the upper element is, the interconnected distal ends of the upper and lower elongated elements forming the distal end (9) of the user connection assembly.

6. The fall protection system according to claim 5, wherein the first deformation segment (16) extends between the connection points of the proximal ends (22, 25) of the upper and lower elongated elements (21, 24).

7. The fall protection system according to any one of the preceding Claims, wherein the fall protection system (1) is portable.

8. The fall protection system according to any one of the preceding claims, wherein the tether connector (10) is attached at the distal end (9) of the user connection assembly (3).

9. The fall protection system according to any one of the preceding claims, further comprising a user tethering device, which comprises a self-retracting lifeline unit (41), which is removably connected with the tether connector (10) in the ready-to-use state.

10. The fall protection system according to any one of the preceding claims, wherein, in the inactive state the user connection assembly (3) is folded, the upper elongated element (21) is received in a groove (30) of the lower elongated element, and the user connection assembly extends along the length of the mast (2) from the top end (6) towards the base end (7).

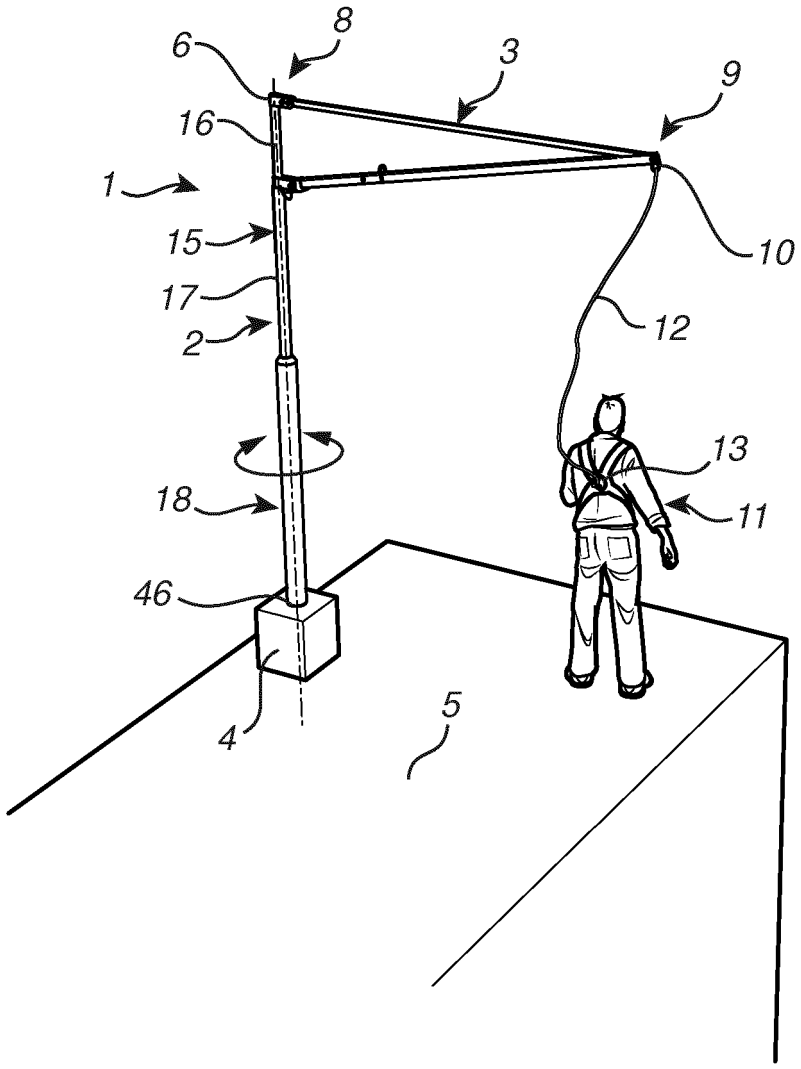

Fig. 1

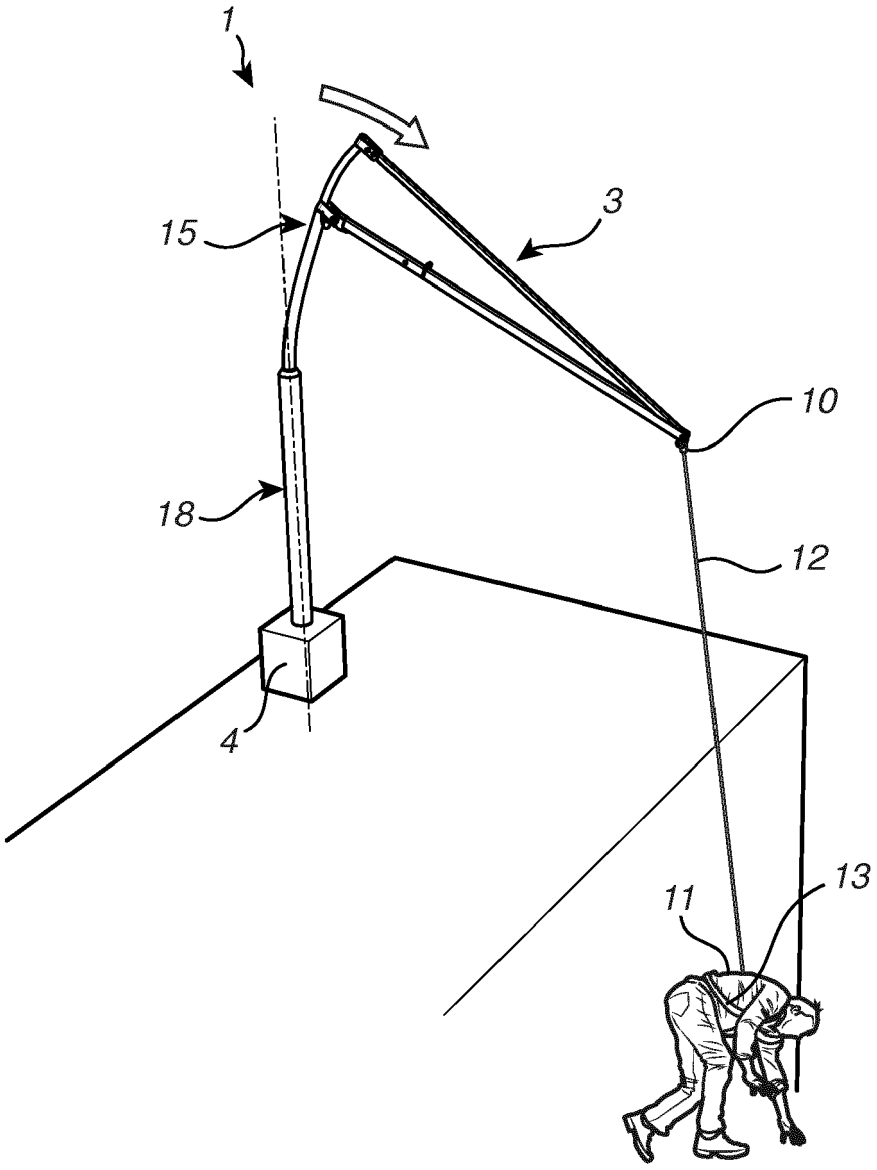

Fig. 2

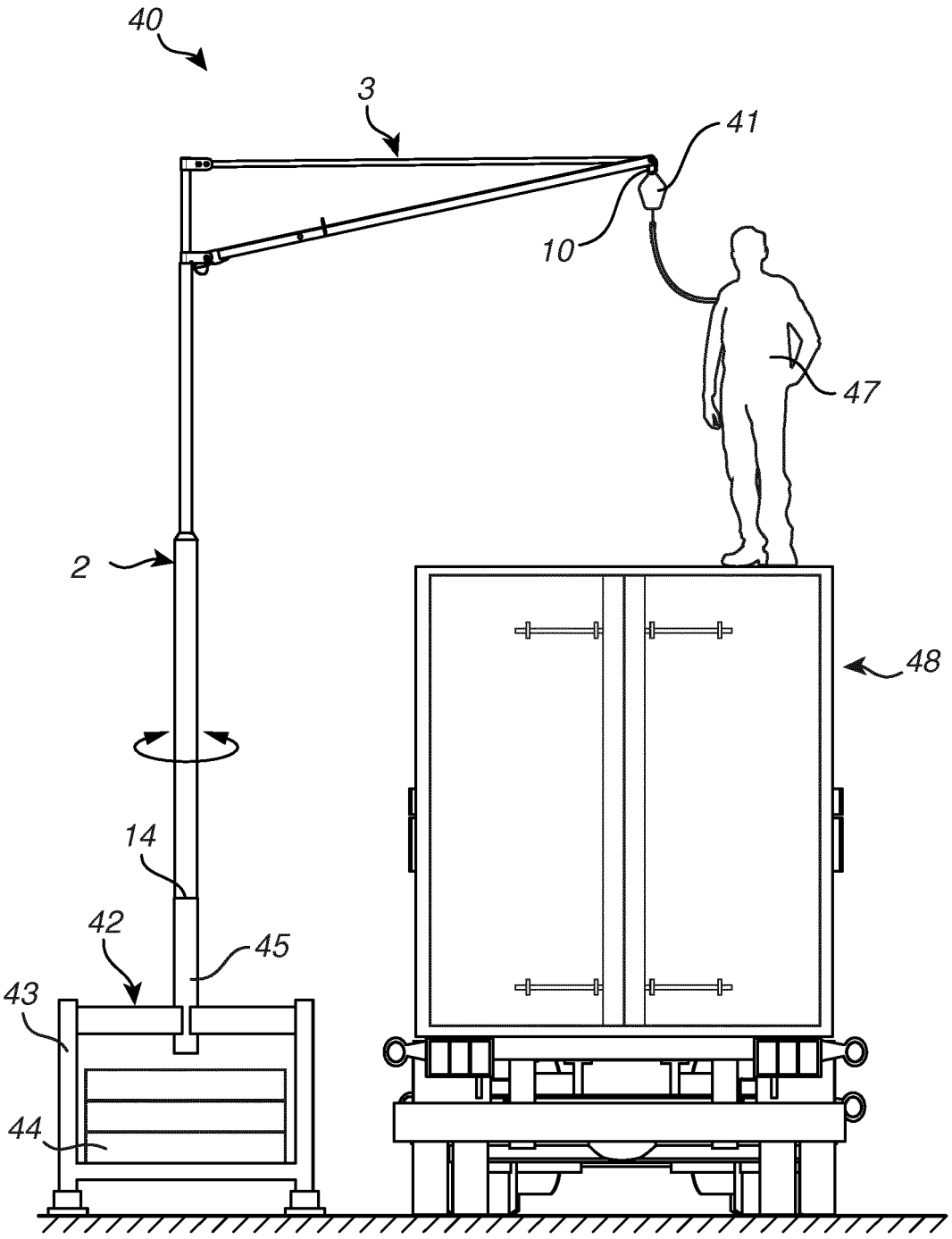

Fig. 3

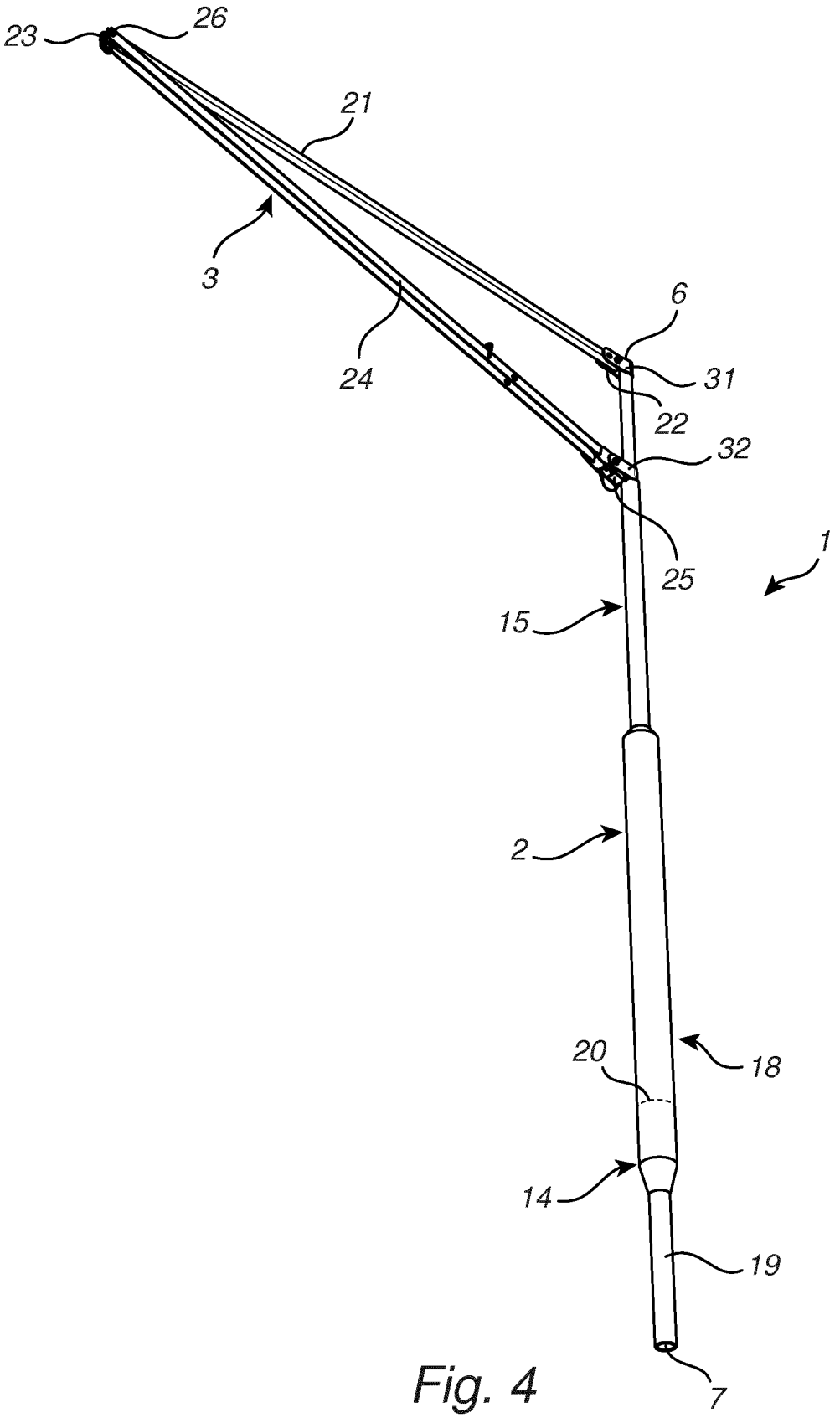

Fig. 4

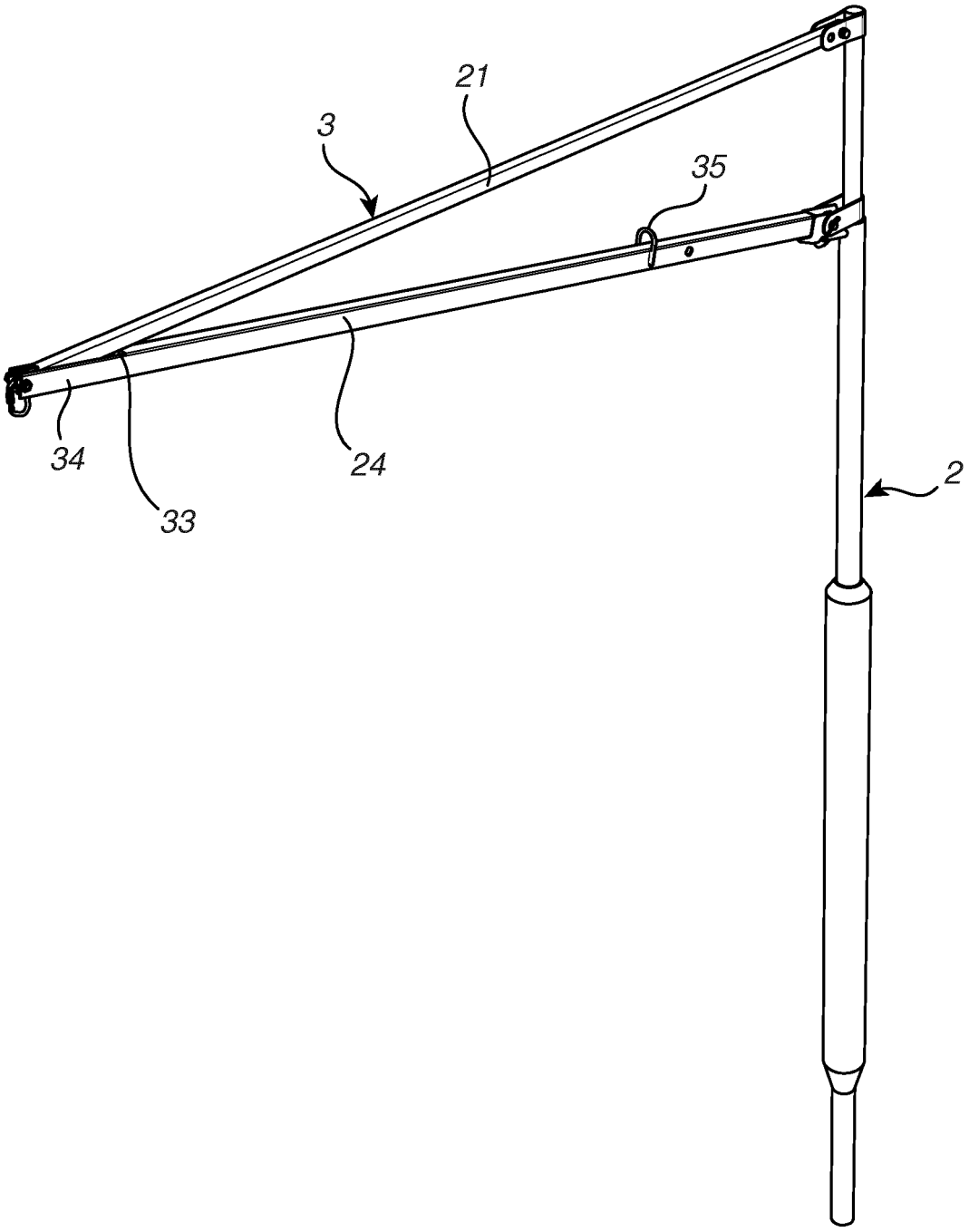

Fig. 5

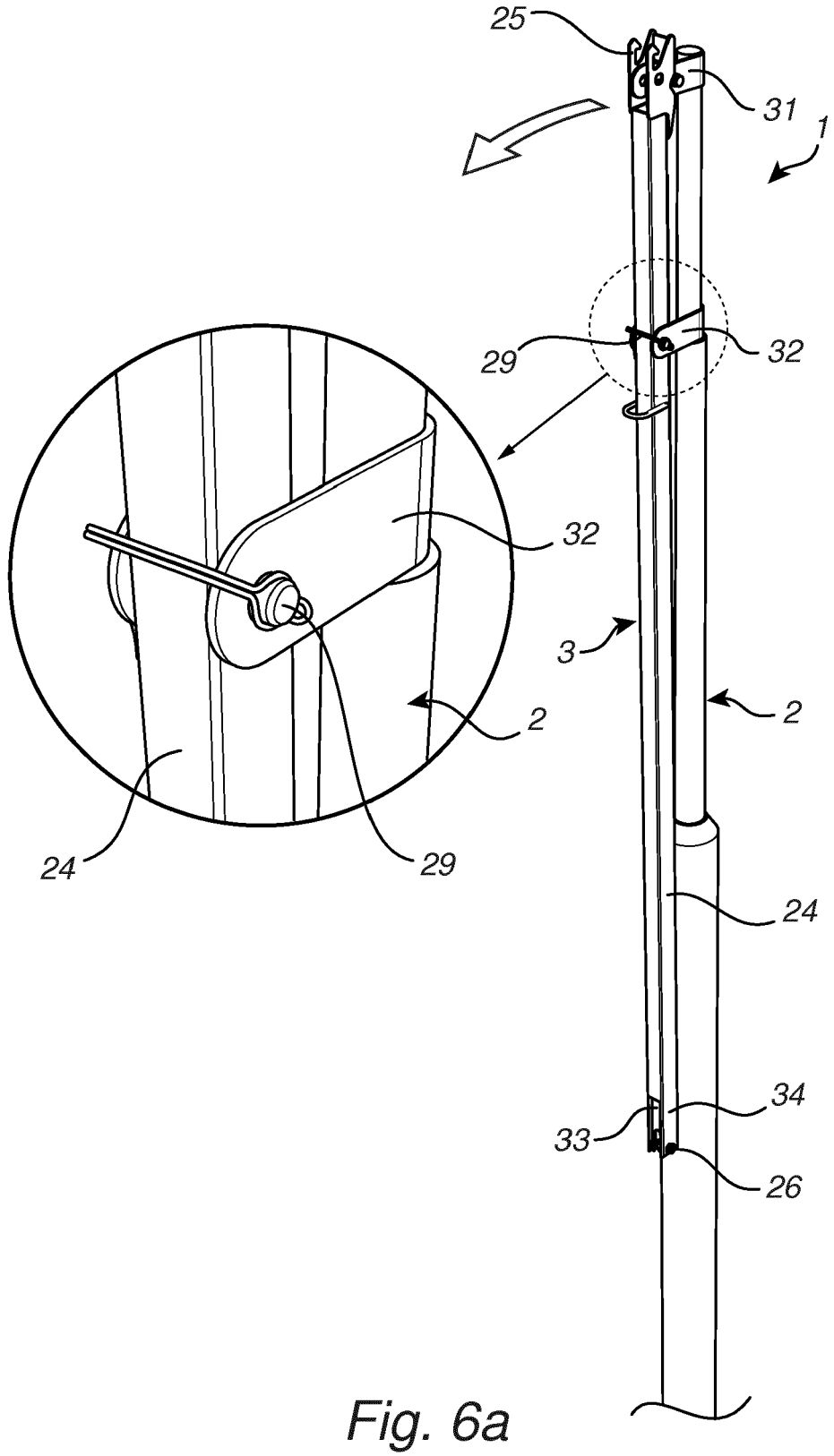

Fig. 6a

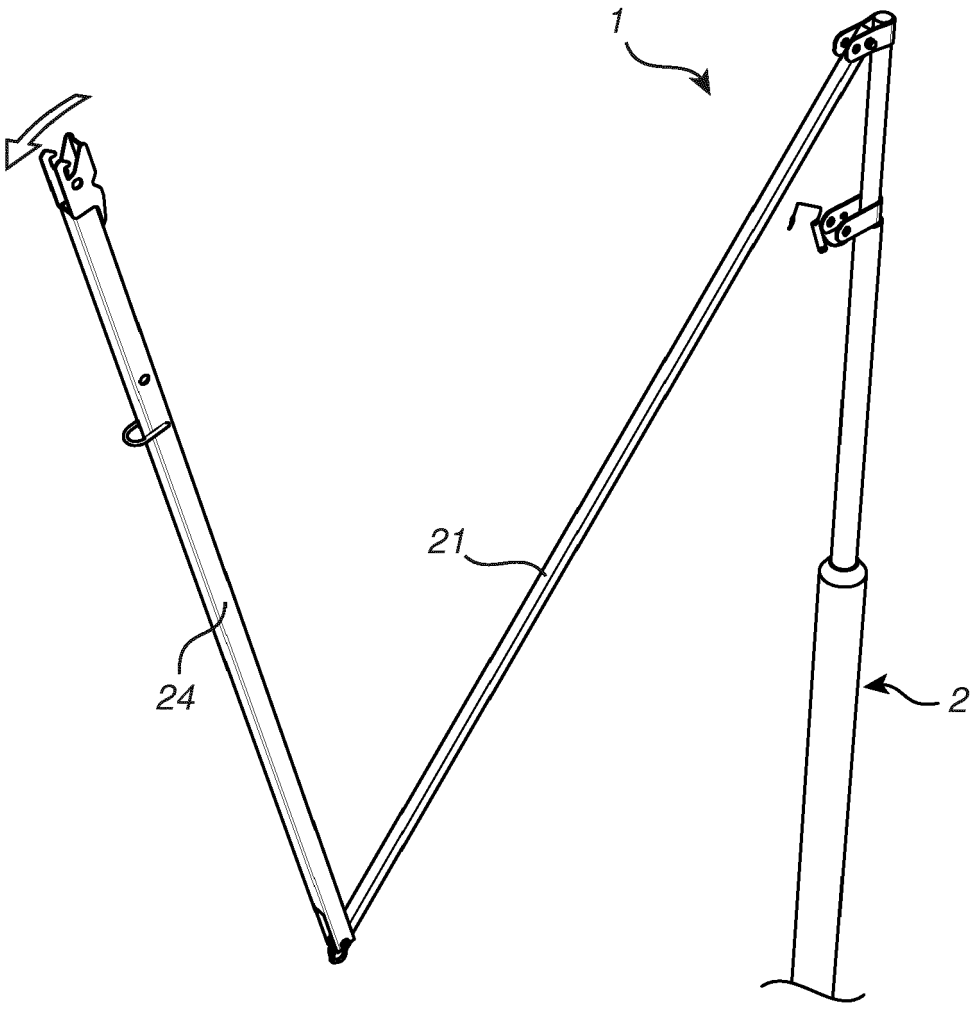

Fig. 6b

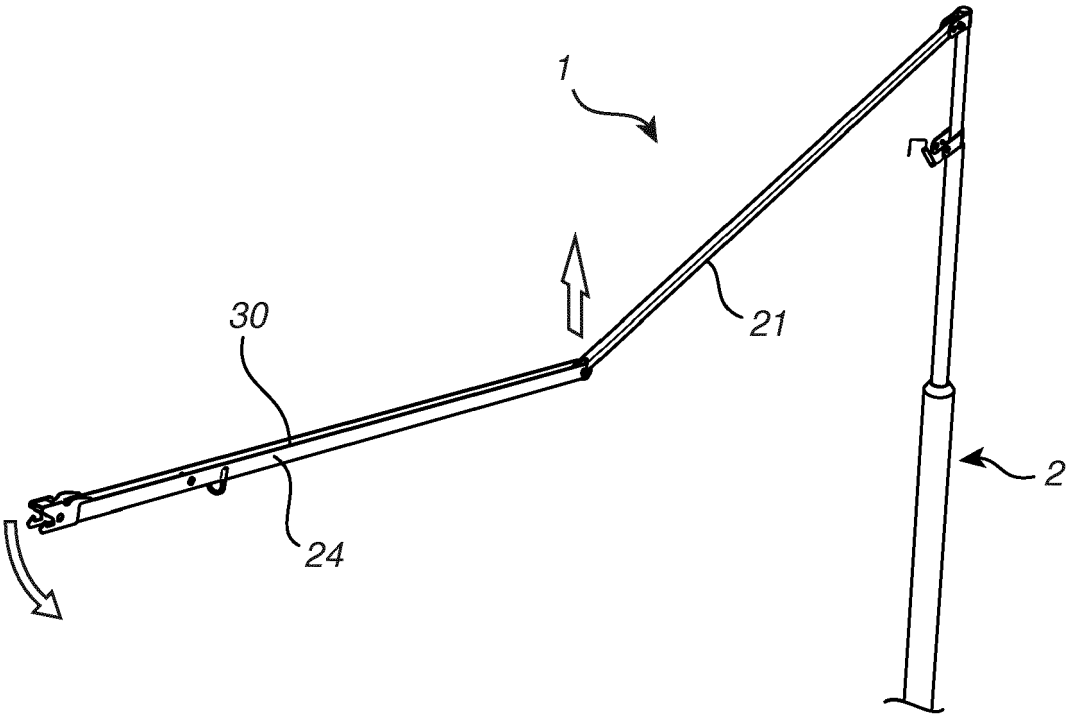

Fig. 6c

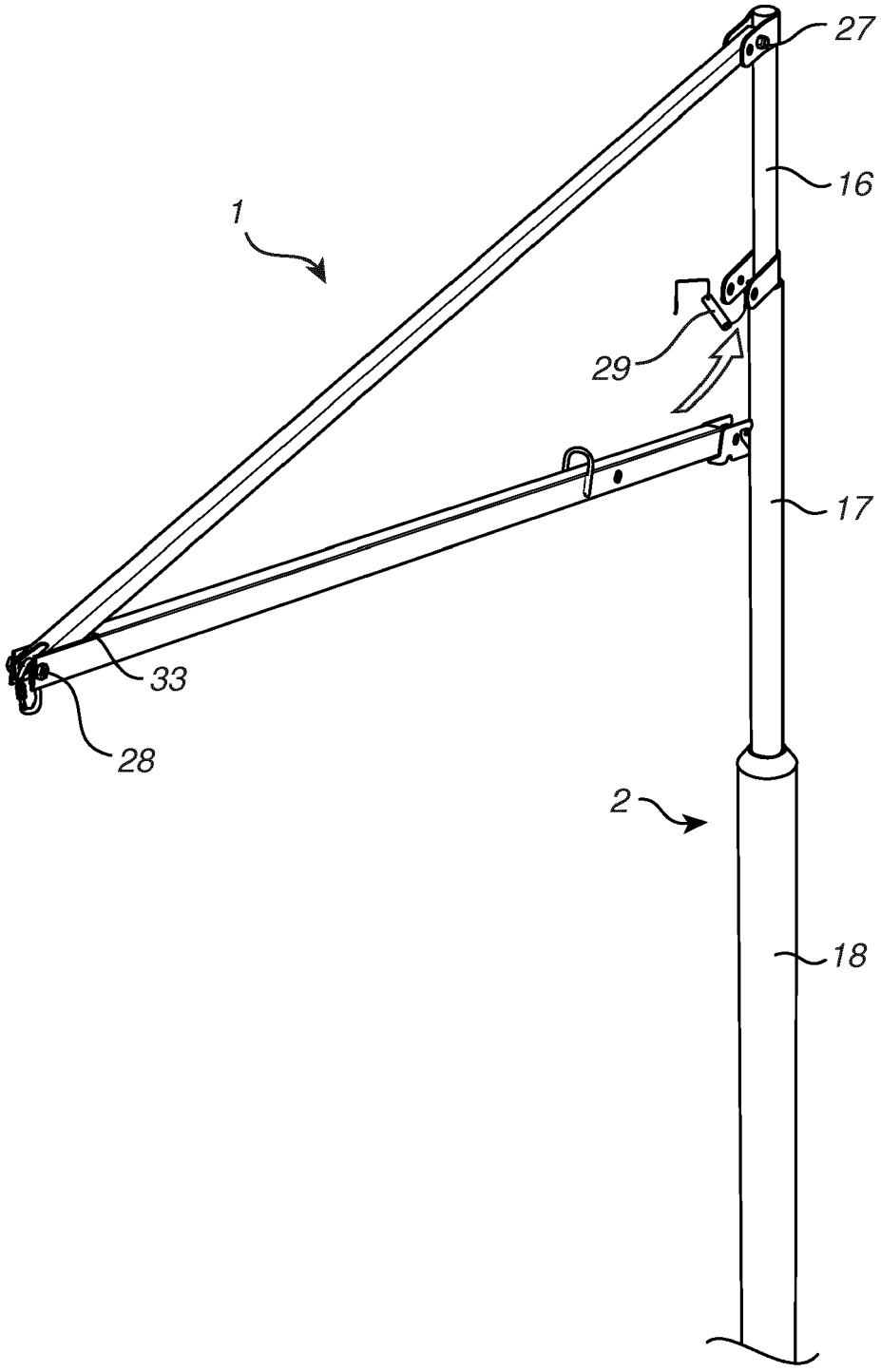

Fig. 6d

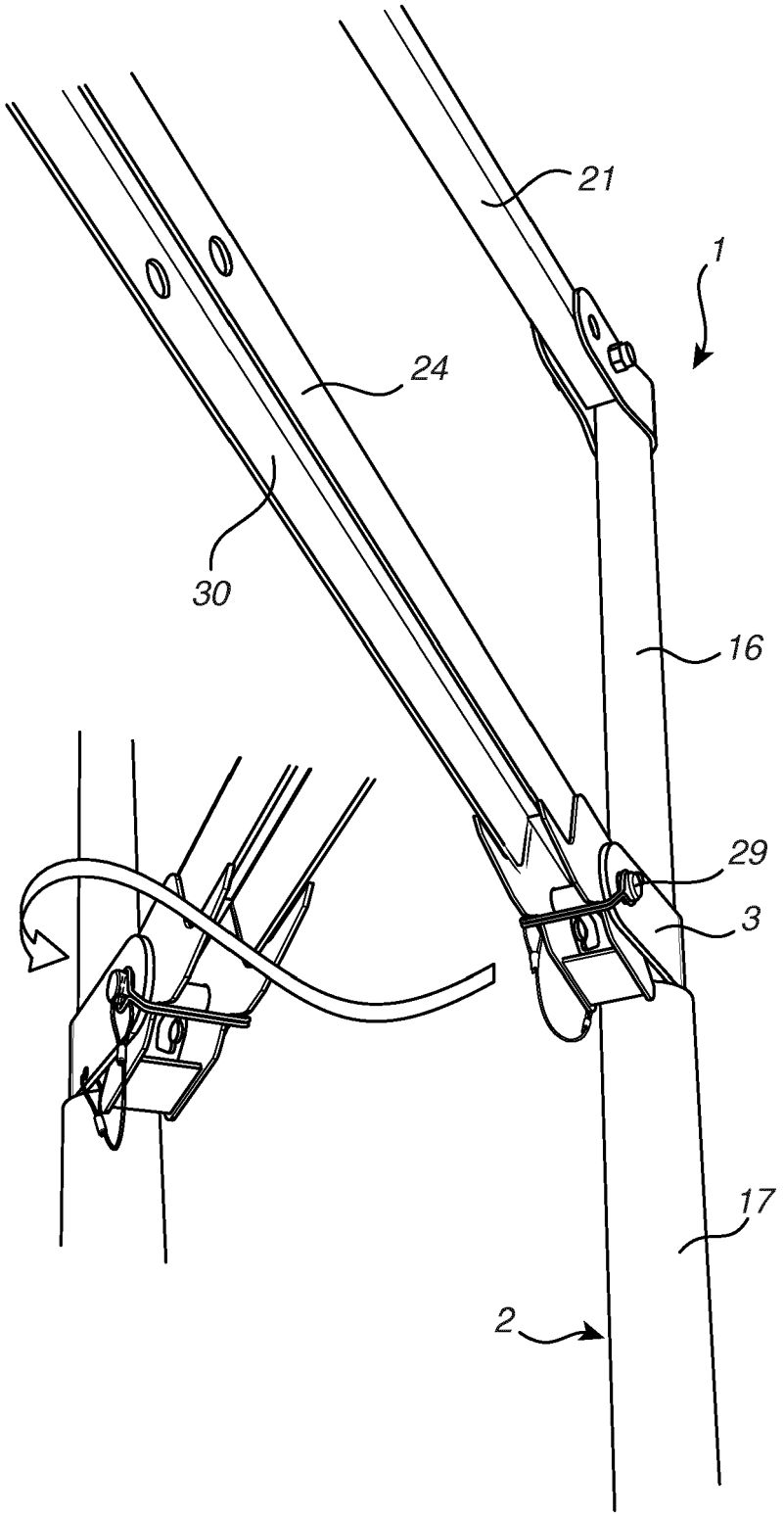

Fig. 7

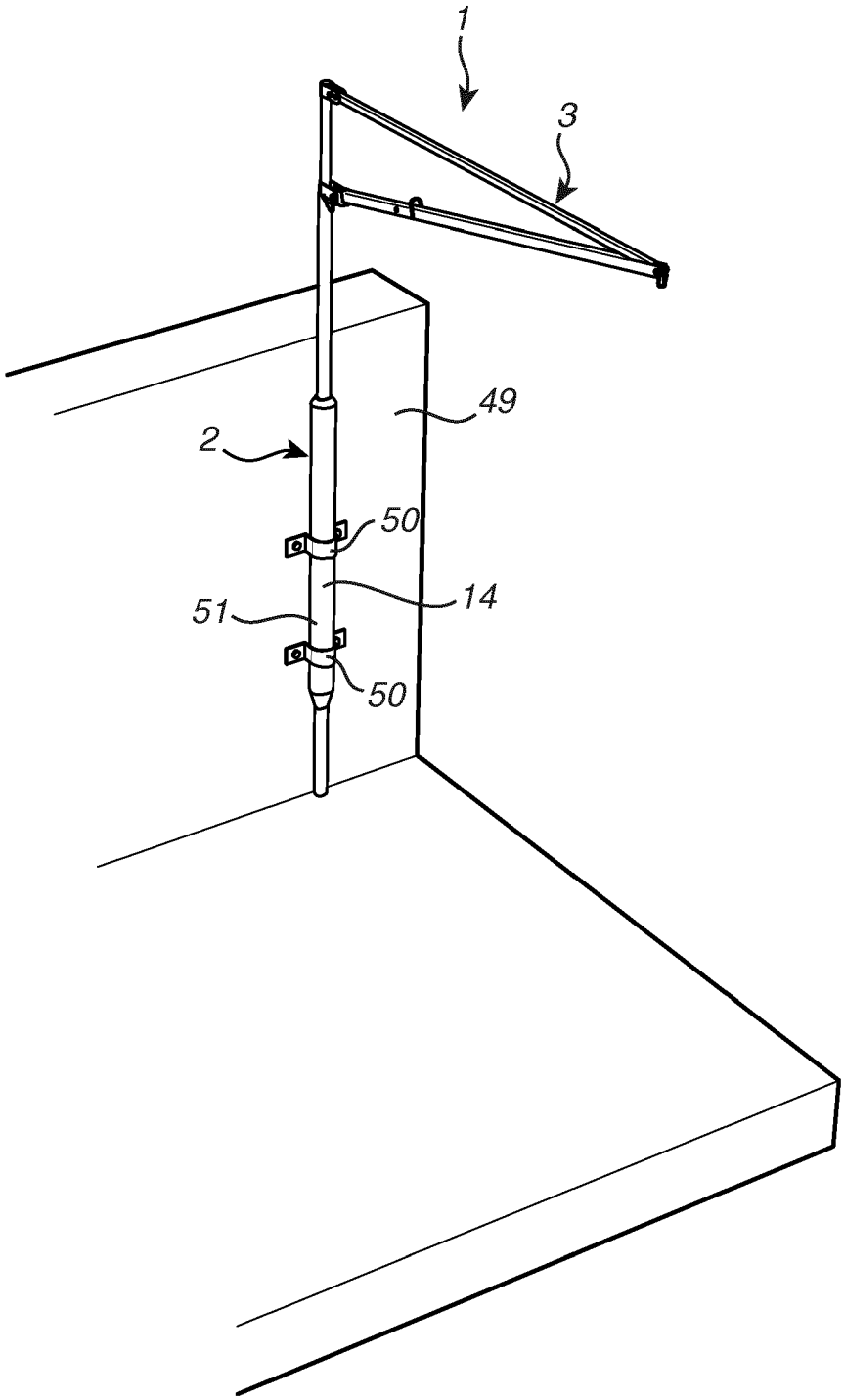

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 7217

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/090927 A1 (PATTON JUSTIN S [US] ET AL) 3 April 2014 (2014-04-03) * paragraph [0003] - paragraph [0009]; figures *	1-8,10	INV. A62B35/00 A62B35/04
X	US 4 852 692 A (FLAHERTY BRIAN J [US]) 1 August 1989 (1989-08-01) * column 2, line 25 - line 59; figures *	1-4,7-9	
X	US 2014/008511 A1 (XAMMAR BOVE PEDRO [ES]) 9 January 2014 (2014-01-09) * paragraph [0013] - paragraph [0020]; figures *	1-8	
X	US 4 607 724 A (HILLBERG JULIAN T [US]) 26 August 1986 (1986-08-26) * column 2, line 28 - line 64; figures *	1-8	

TECHNICAL FIELDS SEARCHED (IPC)

A62B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 March 2015	Vervenne, Koen

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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